Chewuch River Mile 4.2-5.0 Habitat Enhancement Project

Preliminary Design

Basis of Design Report

SUBMITTED TO

Yakama Nation Fisheries

December 18, 2018

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SUBMITTED TO
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Toppenish, WA

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1. Preface

The Chewuch River Mile 4.2-5.0 Fish Habitat Enhancement Project is located on the Chewuch River between River Mile 4.2 and 5.0 in Okanogan County north of Winthrop, WA (Figure 1). The project study area is located on private and Washington Department of Fish and Wildlife land. The goal of the proposed project is to enhance instream and off-channel rearing habitat for juvenile ESA-listed endangered Upper Columbia spring Chinook Salmon and threatened summer steelhead in accordance with the 2017 Biological Strategy (UCRTT 2017).

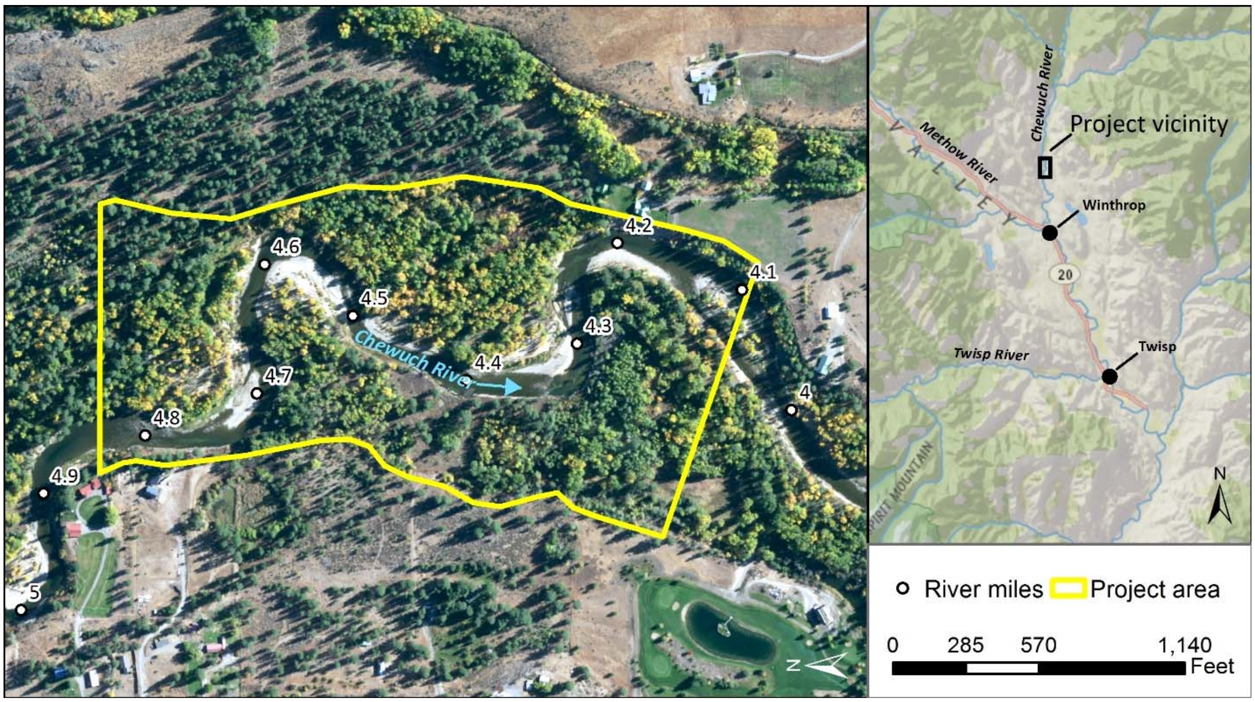


Figure 1. Project area vicinity and locator.

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

The project is sponsored by Yakama Nation Fisheries (YN). Inter-Fluve is the engineering design firm. Mike McAllister (PE) is the licensed engineer of record for this project and Mike Brunfelt (LG) is the project manager.

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

Mike McAllister (PE) is the licensed engineer of record for this project. Table 1 includes project elements, with BPA HIP III activity and risk category:

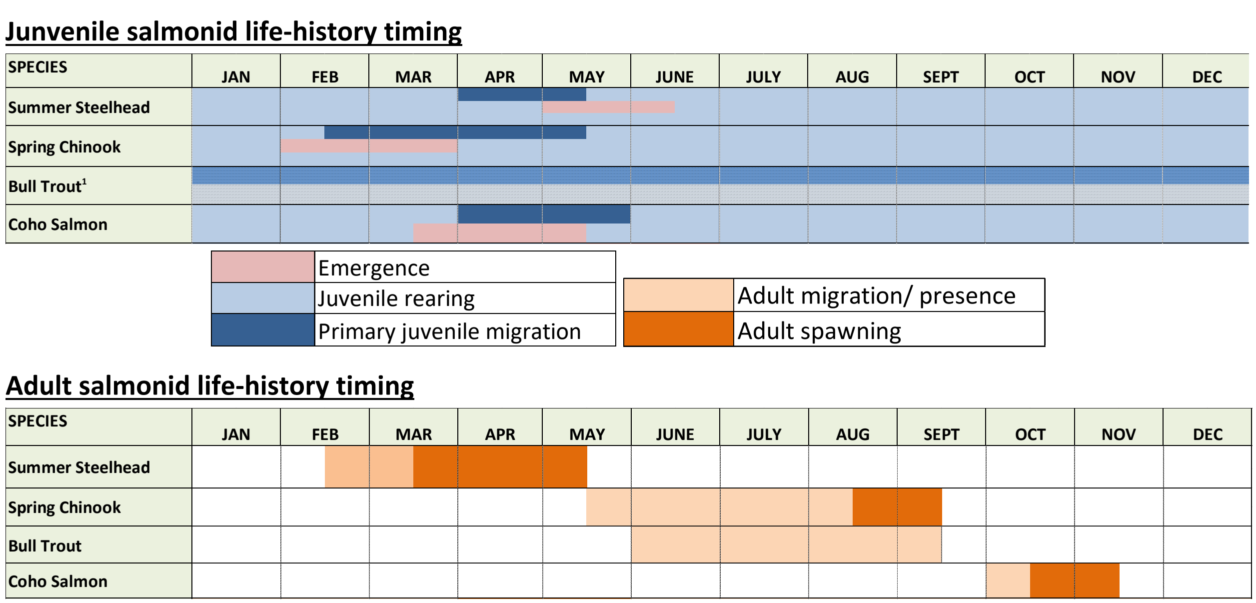
Table 1. Activity categories and risk included in the project.

Description of Proposed Enhancement	Work Element	HIP III Category	HIP III Risk Level
Log structure construction to improve main channel habitat suitability and stability	Install habitat-forming natural material instream structures	2d	Low
Low floodplain enhancement to improve off-channel habitat	Improve secondary channel and wetland habitats	2a	Medium
Revegetation of all disturbed surfaces	Riparian vegetation planting	2e	Low

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

Target fish species known to utilize the project area include spring Chinook Salmon, Coho Salmon, summer steelhead, and Bull Trout. Other species present include Westslope Cutthroat Trout, Pacific Lamprey, Mountain Whitefish, and non-native Brook Trout. A PIT tag array on the Chewuch River above Winthrop provides information on adult run timing, while a screw trap on the Methow River provides juvenile out-migration timing information (Figure 2). Bull trout use the mainstem Chewuch River during adult migration from June through September.

Figure 2. Life history timing of focal species in Chewuch River within the project area (Columbia River DART 2018). [1]See bull trout section 1.3.3 below for more information on juvenile life-history.



1.3.1 Summer steelhead

Adult summer steelhead destined for the Chewuch River pass Wells Dam from July through May, with peak migration in September. Most adults overwinter in the Wells pool, while some hold in large pools in the mainstem Methow River (NWPCC 2004). Adult summer steelhead enter the Chewuch River from February through May, holding in deep pools with overhead cover (DART 2018). Spawning begins in late March, peaks in late-April, and lasts through May. Egg survival is highly sensitive to intra-gravel flow, temperature and is particularly sensitive to siltation earlier in the incubation period (Healy 1991). Fry emerge from the redds 6-10 weeks after spawning (Peven 2003).

Age-0 juveniles spend their first year primarily in shallow riffle habitats, feeding on invertebrates and utilizing overhanging riparian vegetation and undercut banks for cover (Moyle et al. 2002, US Fish and Wildlife Service 1995). Age-0 steelhead use slower, shallower water than Chinook Salmon, preferring small boulder and large cobble substrate (Hillman et al. 1989). Older juveniles prefer faster moving water including deep pools and runs over cobble and boulder substrate (US Fish and Wildlife Service 1995). Juveniles out-migrate between ages one and four, though some hold over and display a resident life history form (NWPCC 2004). Smolts begin migrating downstream from natal areas from April through mid-May (DART 2018).

1.3.2 Spring Chinook

Spring Chinook enter the Chewuch River from late May through early September, with peak spawning occurring in late August and early September. Eggs are very sensitive to changes in oxygen levels and percolation, both of which are affected by sediment deposition and siltation in the redd (Healy 1991, Peven 2003). Fry emerge in the spring and seek out backwater or margin areas with lower velocities, dense cover, and abundant food (Quinn 2005). Near-shore areas with eddies, large woody debris, undercut tree roots, and other cover are very important for post-emergent fry (Hillman et al. 1989, Healy 1991). Age-1 parr utilize deeper pools with resting cover in mainstem habitats more than post-emergent individuals (Figure 3). Spring Chinook express a stream-type life history where they rear for 1 year in freshwater before out-migrating as yearlings from late February through early May (DART 2018).

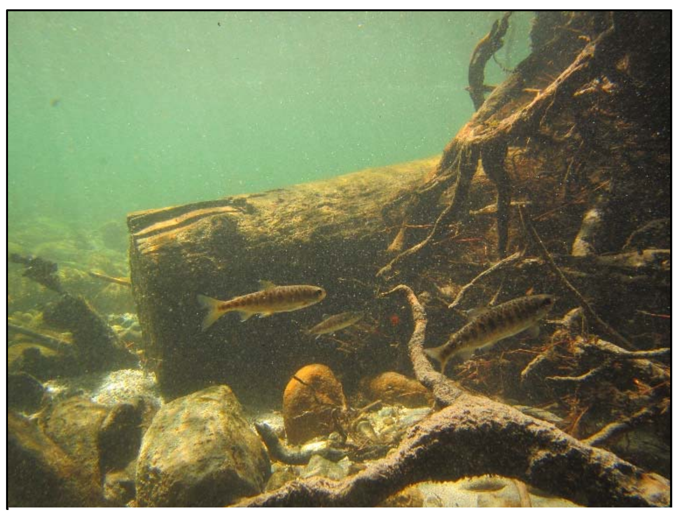


Figure 3. Chinook Salmon parr resting behind a constructed log jam in the Entiat River mainstem between feeding forays.

1.3.3 Bull trout

The Chewuch River supports a population of fluvial and adfluvial bull trout (NWPCC 2004). Fluvial populations of Bull Trout are known to exist in the Methow Basin and would use the project area as a migration corridor on their way to spawning grounds in the Upper Chewuch River and in tributaries such as Lake Creek and Eightmile Creek. Bull Trout from the Columbia River migrate into the Methow subbasin from May through June (BioAnalysts 2002, 2003). Spawning occurs in headwater streams from mid-September through October. Bull trout juveniles rear in headwater streams for at least two years before migrating downstream as adults or sub-adults to express adfluvial life histories, or resident life histories in downstream reaches (McPhail and Baxter 1996).

1.3.4 Limiting factors

The RTT identified several factors affecting habitat conditions in the Chewuch. They are:

- *Channel clearing and LW removal reduced channel complexity in the Chewuch River, and upstream.*
- *Road placement and bank hardening have isolated sections of the main channel from its floodplain and side channels in a few places from the mouth to Eightmile Creek.*
- *Skid roads in riparian areas increase dispersed recreation use impacts to the stream.*
- *Low flows in late summer (through winter) reduce quantity of rearing habitat in the lower Chewuch River.*
- *Livestock grazing has impacts on riparian areas in tributaries and mainstem.*
- *Certain areas with high road densities within the lower Chewuch assessment unit have highly erosive soils and create sediment and bank erosion problems when they fail (see USFS MRA (2011) for additional details).*
- *Road constriction at river mile 1.7 on Eightmile Creek creates a partial barrier for steelhead, bull trout and spring Chinook salmon (Inter-fluve 2010a).*
- *High densities of brook trout in some tributaries like Boulder, Eightmile, and Cub creeks.*
- *Much of the assessment unit (~3/4) has burned since 2001.*
- *Road across Twentymile Creek alluvial fan is an identified issue for steelhead.*

Ecological concerns for the lower Chewuch River have been summarized in the document *A Biological Strategy to Protect and Restore Salmonid Habitat in the Upper Columbia Region* (UCRTT 2017). The lower Chewuch River is considered a tier 1 for protection projects, and includes the following ecological concerns:

1. *Sediment conditions (increased sediment quantity)*
2. *Peripheral and transitional habitats (side channel and wetland connections)*
3. *Channel structure and form (instream structural complexity)*
4. *Riparian conditions (riparian condition and LW recruitment)*
5. *Water quantity (decreased water quantity)*
6. *Food (altered primary productivity or prey species composition & diversity)*
7. *Species interactions (introduced competitors and predators)*
8. *Habitat Quantity (anthropogenic barriers)*

All habitat work within the Chewuch River should address ecological concerns outlined above.

1.4 LIST OF PRIMARY PROJECT FEATURES INCLUDING CONSTRUCTED OR NATURAL ELEMENTS

Enhancement opportunities between RM 4.2-4.6 on the east riverbank and floodplain are on land owned by WDFW and one private landowner.

The proposed project addresses Ecological concerns 2, 3, & 4 that were identified in the Biological Strategy. Key components of the proposal are to (1) create a new perennial side channel, and (2) construct two mainstem large wood structures.

The proposed side channel would be approximately 1,300 feet long and run through the WDFW parcel. The property lines provided by County GIS suggest that the channel outlet (and construction access) would occur on a small portion of private property to the south of the WDFW parcel. Cottonwood and pine trees with diameter (dbh) greater than 12" were surveyed. Taking these into account, the channel alignment avoids as many cottonwood trees as possible while not impacting delineated wetlands. Site disturbance would be kept to a minimum by keeping construction access within the footprint of the side channel; however, some trees would still need to be removed. All removed trees and shrubs would be salvaged and used to enhance stream habitat. Additional logs with roots would be imported to provide optimal habitat and maintain scour at constructed pools. A constructed bar-apex log structure would form and maintain the side channel inlet. This structure is shown encroaching somewhat into the mainstem in order to counterbalance the increased conveyance area created by the new side channel. The actual configuration of this log structure and the degree of encroachment will be determined by hydraulic analysis during a future design phase.

Another log structure is proposed to enhance adult holding and juvenile rearing approximately 200 feet downstream of the side channel inlet. This location is at an existing pool where the bank is relatively clear of existing trees, affording area to partially bury the log structure. The access route to this site would thread through the trees to limit disturbance.

These conceptual designs have been taken to a level that shows the anticipated configuration, with intent to maximize habitat, increase diversity of terrain and wetted areas, while minimizing impacts to natural resources. As the design progresses, some changes to this configuration may become necessary as hydraulic modeling, sediment transport characteristics, and earthwork calculations inform design details. This report will be updated accordingly.

1.5 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

1.5.1 Infrastructure and flood risk

There are no structures or known infrastructure near the project that would be at risk. The project will be designed with the intent of causing zero rise to the 100-year flood water levels. In the event that a "no-rise" condition cannot be met, the designing professional engineer will provide a hydraulic report declaring each location and magnitude of rise and description of actions to mitigate the rise. This report may provide justification for the FEMA designated floodplain manager to issue an exemption from no-rise certification per the *FEMA Region 10 Policy on Fish Enhancement Structures in the Floodway*.

1.5.2 Design criteria

Design criteria for large wood and secondary channel habitat associated with the project are as follows:

- All imported large wood will be stabilized by partial burial and timber piles, designed to withstand the predicted hydraulic effects of floods up to the 100-year recurrence peak flow. Small wood, slash, and small trees salvaged on site and used to increase complexity within constructed side channels will not be ballasted.
- Large wood habitat will be designed to function at all flows. Each pool will have perennial connection to woody structure for habitat. Lower wood to provide low-flow cover. Higher wood to provide complexity, and promote scour for pool maintenance.
- Side channel will be designed to function at all flows greater than typical summer low-flow (see hydrology section). Side channel slope and shape will be designed to transport sand and small gravel, which are abundant and frequently transported sediments in the Chewuch River. The inlet condition will be configured to encourage scour, maintaining the inlet by discouraging deposition, sun staining low-flow connection to surface water.
- Disturbed areas will be replanted following construction.

1.5.3 Risk of failure to perform

Some risk of failure is inherent to any feature existing in a dynamic system such as this, where unanticipated natural events such as landslides, debris flows, ice jams/flows, and wildfires could conceivably move, damage, or destroy large wood, or alter the course of the river.

The design accounts for the relatively predictable effects of the river, such as the modeled hydraulic effects of large floods and the expected loading and transport of sediment and natural woody debris. As such, the large wood elements in these plans are designed to withstand the forces of the 100-yr flood. The wood elements are at geomorphically appropriate locations and configurations. They are expected to maintain function as habitat for decades but they will eventually decay and break apart. The small soft pieces of wood that eventually abrade or break away will not increase the natural background levels of flooding, debris formation, or damage by impact.

Comparison of mainstem and side channel length and slope do not reveal fundamental indicators that the proposed side channel will fail to perform. Perennial flow and regular flooding in the side channel should discourage beaver. However, beaver dams or debris jams that form in the side channel could facilitate deposition of fines in the side channel a gradual transition to wetland. The mainstem is wide and relatively clear of debris, whereas the side channel would be narrow, and hemmed in by a dense riparian forest and woody debris. The river can readily convey flood, sediment, and debris so there would be little pressure to avulse into the small and rough side channel. There is risk that a large and persistent mainstem logjam could force a cut-off through the floodplain through the proposed side channel or other pathway. As meander length continues to develop in the mainstem, extending the length of river to the point where sediment transport is significantly impaired, the risk of avulsion increases. In general, the current mainstem migration rate and trend, and the proposed side channel planform and slope, would provide a configuration that would tend to preserve the existing river form and processes, while allowing a fraction of flow through and onto the floodplain, which is very resistant to flow expansion and cutoff.

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

Disturbance areas and access are depicted in the drawing set. Disturbance will be limited to access routes, the side channel footprint, and extents of log burial. Excavation and hauling will largely remain within the side channel limits, working back to the main access point. Trees will be avoided to the extent possible. All removed trees will be utilized in the project to provide habitat or floodplain roughness. The timing of construction will be connected with the July in-water work period for the Chewuch River.

2. Resource Inventory and Evaluation

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

Historical aerial photo records were examined to evaluate channel migration, changes to the channel, riparian, and floodplain conditions. Historical impacts or changes relating to flooding and management activity are inferred within the photo record. Images of the project area vicinity were retrieved from the USGS Earth Explorer for years 1947, 1968, 1985, 1990, 2006, and 2017. A BLM GLO plat map was obtained for 1895. Stream centerlines were digitized at the 1:2,000 scale to evaluate change over time.

2.1.1 Figure 4: 1895, 1947, 1968 Period of Record

The stream centerline in the 1895 plat map shows a relatively straight channel within the project area. The absence of meander bends is indicative of several meander bend cutoffs that may have occurred prior to the GLO survey in 1895. A mature meander bend cutoff occurred between 1895 and 1947 downstream of the project area. Since that time meander bend formation and associated channel length have increased. From 1947 to 1968 meander bend development continued through the reach. A 100-year reginal flood occurred in 1948 and likely created much of the initial lateral bank migration and bar forms shown in the 1968 photo. No large floods occurred in the 1950’s and 60’s.

The 1947 image shows riparian clearing or thinning on river right directly west of RM 4.5. Although valley bottom clearing on the right bank has occurred, no impingement (riprap) or development within the meander corridor can be observed between 1895 and 1968.

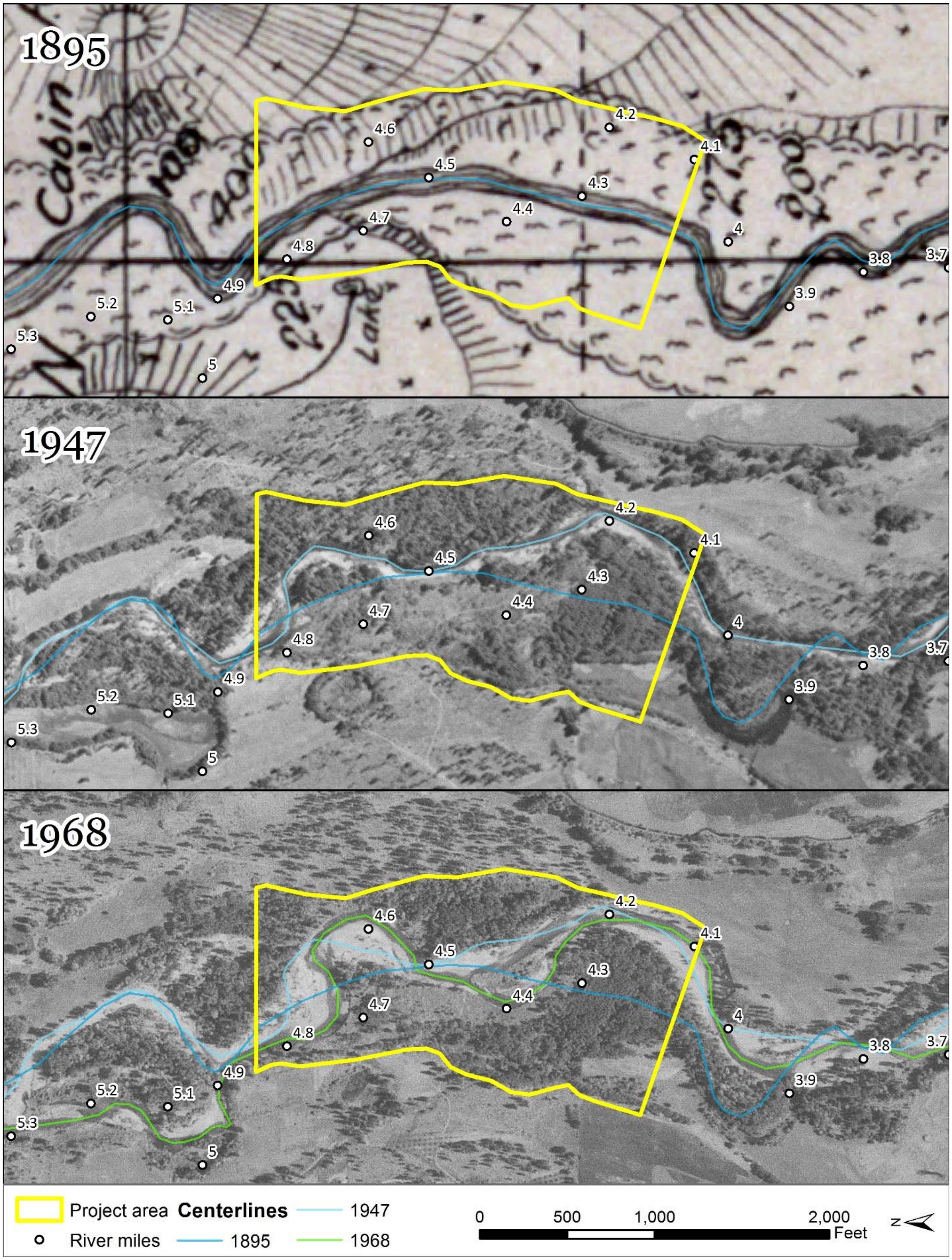


Figure 4. Historical aerial images and plat map, and centerlines of the project area vicinity.

2.1.2 1985, 1990, 2006

Aerial images from 1985, 1990, and 2006 show continued meander migration and down valley meander bend translation, albeit, at a slower rate than the previous images (Figure 5). Southward bank erosion is observable near RM 4.7 and RM 4.3. Westward meander migration is present at RM 5.0 upstream of the project area, and the gravel bars have revegetated over time.

The 2006 aerial image shows several buildings located south of RM 4.9 upstream of the project area. Riparian conditions within the project area have not changed noticeably from 1947 to 2017. The 2017 aerial image shows that areas disturbed by meander migration from 1895 to 2017 have revegetated with primarily deciduous species as shown by yellow fall leaf colors (Figure 6). Although the channel has experienced down valley meander bend translation, no excessive rates of change can be observed. The meander corridor has not been impinged or shows any significant alteration, clearing or development in the photo record.

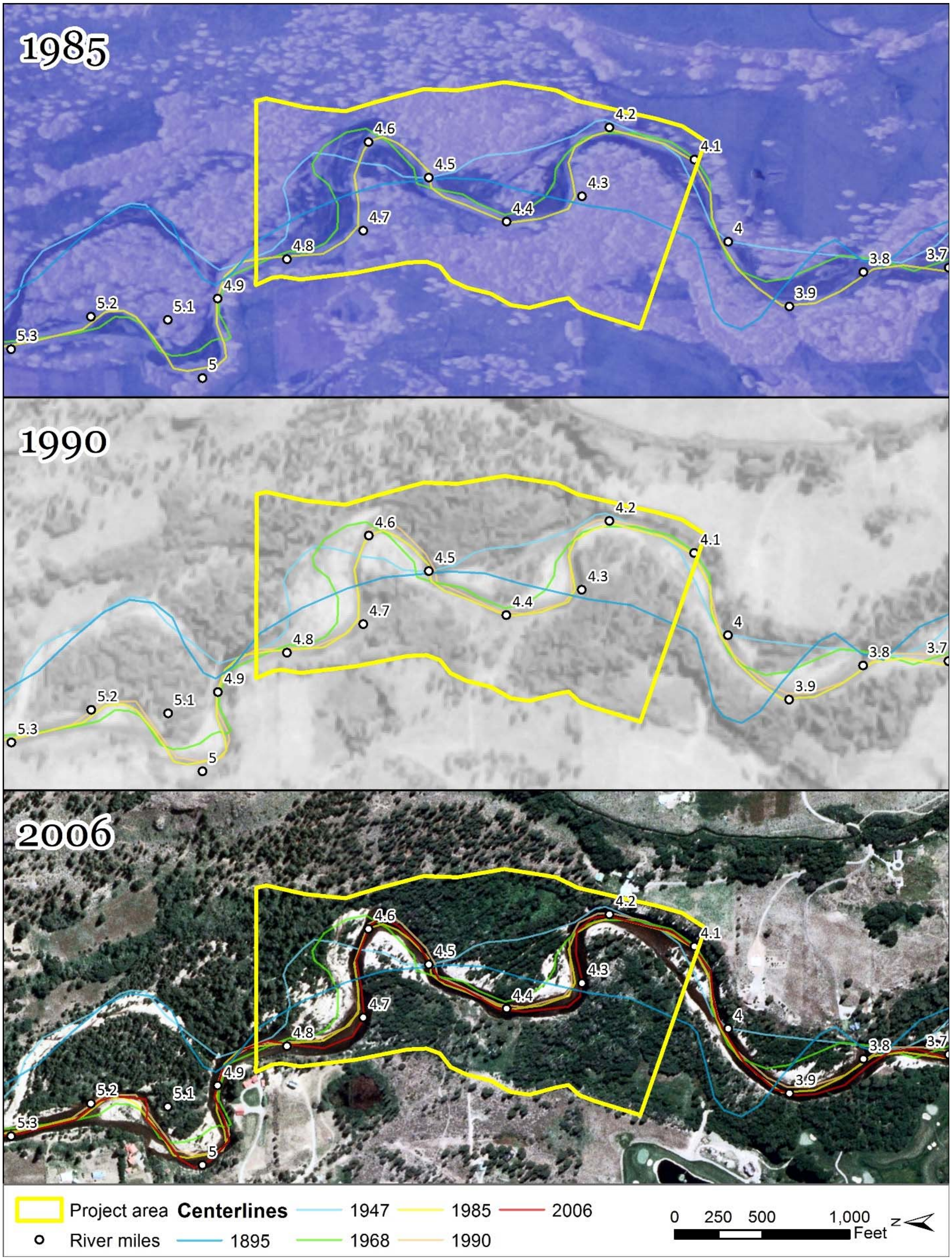


Figure 5. Historical aerial images and centerlines of the project area vicinity.

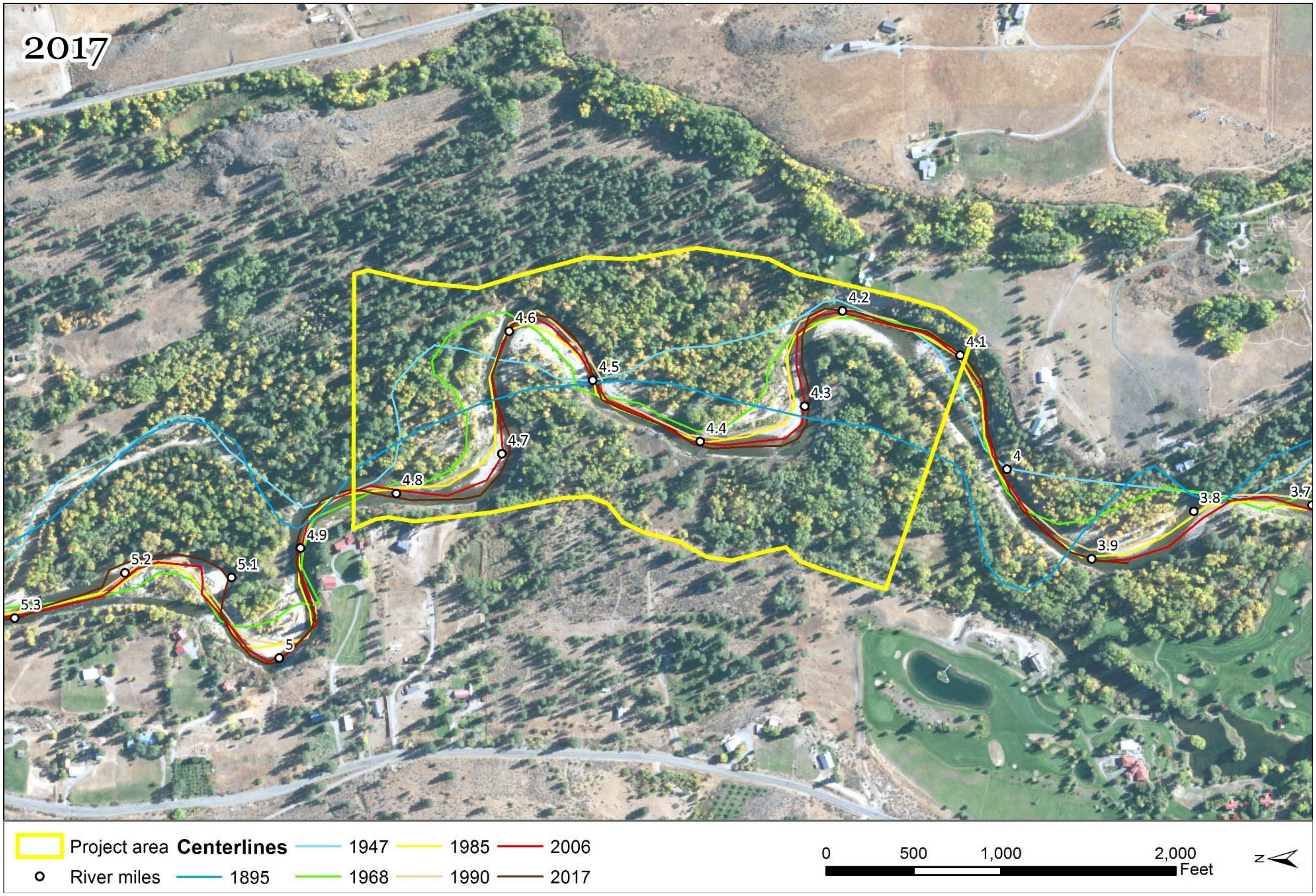


Figure 6. Historical aerial images and centerlines of the project area vicinity.

2.2 INSTREAM FLOW MANAGEMENT AND CONSTRAINTS IN THE PROJECT REACH

There are no flow management or constraints in the study area.

2.3 DESCRIPTION OF EXISTING GEOMORPHIC CONDITIONS AND CONSTRAINTS ON PHYSICAL PROCESSES

The Chewuch River runs through a glaciated valley. Regional rock characteristics have played an important role in determining post glacial valley width and shape, and in turn, river length and channel slope. A significant change in rock strength and erodibility occurs between RM 9 and RM 10. Here the Pasayten Fault forms a dividing line between hard crystalline rock of the upstream watershed and soft sedimentary rocks downstream and into the Methow Valley. Downstream of the Pasayten Fault, the Chewuch Valley is wider and more developed due to the relative ease with which the glacial advance eroded softer sedimentary rocks. The project reach (RM 4.2 – 5) is within this softer rock and the river here has developed a wider meander corridor than is commonly found upstream where valley wall rock is harder and more resistant to glacial and alluvial erosion. The floodplain within the project reach is bounded by glacial outwash terraces that vary in height between 30 feet (west) and 120 feet (east). The alluvial channel within the project reach continues to actively migrate across the valley floor. In areas where it contacts much higher outwash terraces, migration is slowed but not stopped.

The project reach is in a stable equilibrium with no significant physical alterations to the natural meander corrider. Historical evidence of tree clearing and cattle grazing on the west side of the valley can be viewed in the 1947 and 1968 aerial photographs. However, no significant agricultural use appears to have occurred in the meander corridor the last ten years. Although change has occurred since the original 1895 GLO survey, no significant un-natural degradation to the bed and banks has occurred in the photo record. There are no constraints on physical process. The study area has a naturally meandering and deforming bed and bank boundaries that are suitable for enhancement to mitigate for habitat and meander corridor degradation in other Chewuch River segments.

2.4 DESCRIPTION OF EXISTING RIPARIAN CONDITION AND HISTORICAL RIPARIAN IMPACTS

A segment of riparian zone has been cleared for agricultural and development along the river right bank upstream of RM 4.75. Understory clearing or thinning has likely occurred on the floodplain west of RM 4.4. Active channel migration has recruited small diameter large wood into the channel and disturbed surfaces have revegetated with deciduous species including alder and cottonwood (Figure 7).

Figure 7. Looking upstream at RM 4.2 from the top of the east glacial terrace. Upland ponderosa pine on the left and alder, cottonwood and willow in the lower east floodplain.

2.5 DESCRIPTION OF LATERAL CONNECTIVITY TO FLOODPLAIN AND HISTORICAL FLOODPLAIN IMPACTS

Historical evidence dating back to 1895 suggest there have been no recent floodplain impacts on the East side of the study area. On the West side of the study area there is evidence of past woody vegetative clearing for pasture. However, it appears there has been no agricultural grazing use in at least the last 10 years and native trees are becoming re-established. Within the project area, there are no levees or riprap present. Both sides of the valley can be flooded at high flows and have erodible channel boundaries.

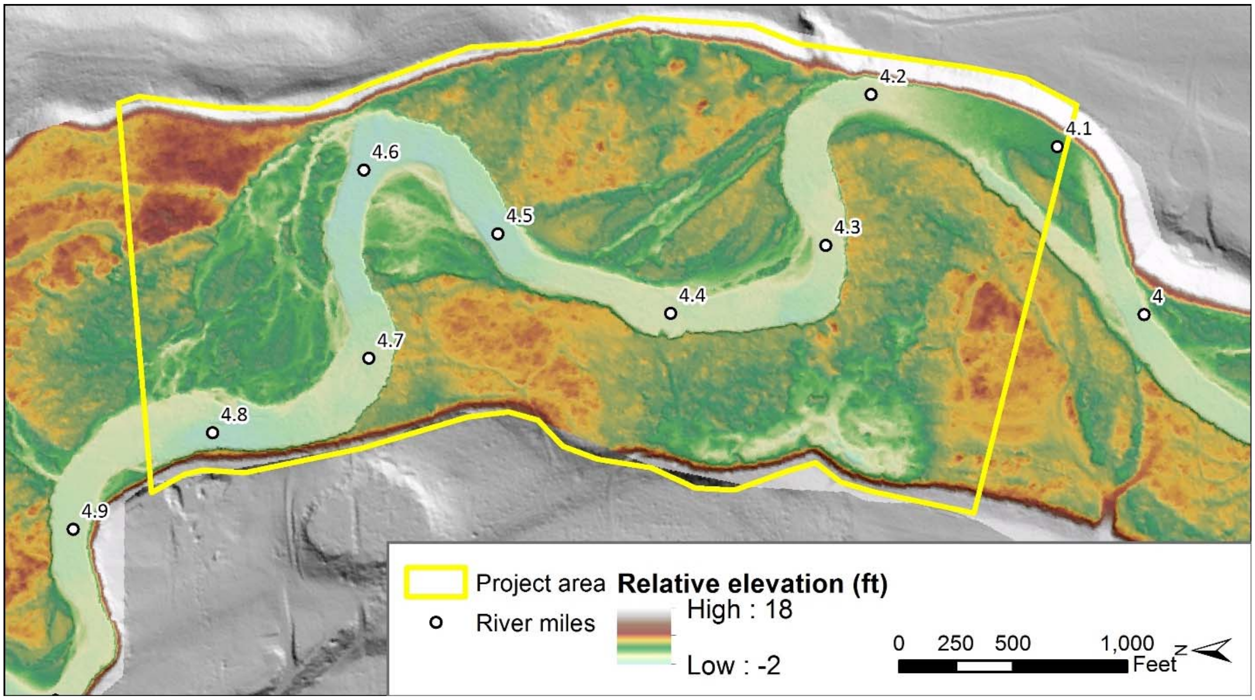


Figure 8. Relative elevation of floodplain surfaces compared to main channel. Surface created using LiDAR data (DOGAMI 2016).

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

Not applicable to this project.

3. Technical data

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

HIPIII conservation measures will be met through the project design, and variances will be submitted for any conservation measures that cannot be met.

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

3.2.1 Elevation data

Project survey was completed in October 2017. The project area was walked to identify and survey potential treatment sites, and to survey cross sections for hydraulic modeling. Survey was completed using RTK GPS and total station survey equipment. Temporary control points were established throughout the project site.

Ground survey data were supplemented with LiDAR data to produce a three-dimensional surface of the project area. All elevation data are references to the Washington State Plane North coordinate system and the NAVD88 vertical datum. Cross sections for the hydraulic model were extracted from the surface where appropriate. LiDAR was used to supplement survey data in upland areas where appropriate and used as a visual base map.

3.2.2 Fish use

Fish presence and life-stage timing data were taken from the 2017 Biological Strategy (UCRTT 2017) and empirical PIT tag and screw trap data from Columbia River Data Access in Real Time (DART 2018). Habitat preference information was taken from the primary literature.

3.2.3 Historical aerial images

A historical plat map of the project area from 1895 was retrieved from the Bureau of Land Management General Land Office. Historical aerial images were retrieved for the project area for years 1947, 1968, 1985, 1990, 2006, and 2017 from USGS Earth Explorer.

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 Bureau of Reclamation previously completed a hydrologic peak flow analysis in the Methow Subbasin Geomorphic Assessment (USBR 2008b). Their study provided the peak flows of various flood recurrence intervals along reaches of the Chewuch River. These floods make up the set of flows to be input to the hydraulic models (Table 2).

Table 2. Peak Discharge Estimates for Chewuch RM 4.2-5 Project Reach (from USBR)

Flow Event	Discharge (cfs)
2-year	2,947
5-year	4,520
10-year	5,540
25-year	6,785
50-year	7,675
100-year	8,531

A low flow of 49 cfs was calculated as the 95% exceedance of daily flows recorded at the USGS Chewuch River gage at Winthrop (12448000).

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

On-site sediment evaluation examination included, channel bed, floodplain and exposed bars throughout the reach. The channel is composed primarily of sand, gravel, cobble and relatively rare boulders (Figure 9). Sand deposits are present adjacent to gravel bars and on flooded surfaces (Figure 10). Banks in the project area are primarily post glacial alluvial deposits except when adjacent to eroding glacial terraces. Glacial lag deposits exist in the reach and are more concentrated near eroding terraces (source area). A pebble count summarizing mobile bed boundary alluvium can be viewed in Figure 11.

Figure 9. Typical material found on gravel bar surfaces was cobble.

Figure 10. Sand deposit on the inside of a gravel bar.

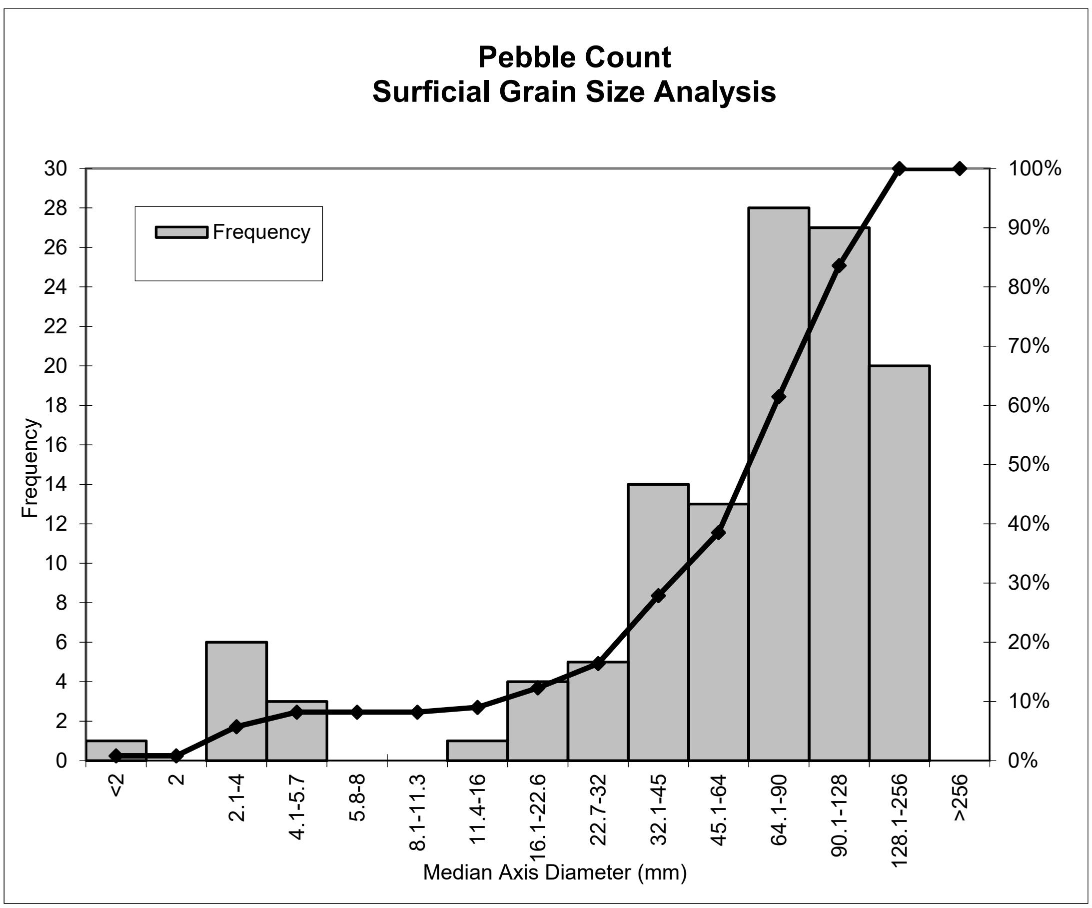


Figure 11. Pebble count taken at RM 4.3.

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

A two-dimensional (2D) hydraulic model and (1D) model was developed for existing conditions and the proposed concept design conditions. Comparing hydraulic models of existing and proposed conditions helps optimize project designs and predict their impacts. The 2D model was used to design the inlet condition of the proposed side channel by calculating the flow distribution between side channel and mainstem, and to depict the inundation patterns velocities in the side channel for the habitat forming flows (low-flow through 25-yr flood). The 1D model was used to quantify the hydraulic effects of the 100-yr flood to support FEMA documentation.

As the project design continues forward, additional modeling may be necessary to optimize the proposed conditions for sediment transport, log structure stability, and riparian/wetland habitat. Revised model output will be included in future design report submittals.

3.6 2D HYDRAULIC MODEL

The 2D hydraulic models for the site were developed in the U.S. Army Corps of Engineers Hydraulic Engineering Center River Analysis System (HEC-RAS) 5.0 software (USACE 2016) for modeling the hydraulics of water flow through natural rivers and other channels. The following sections describe HEC-RAS 5.0 and document the development and output processing of the existing and proposed conditions models for the proposed concepts.

3.6.1 2D Model Capabilities and Limitations

HEC-RAS 5.0 was used in 2D unsteady flow simulation mode for its capacity to model the complex flow patterns, on-site water storage, and temporally variable boundary conditions. The 2D hydraulic model calculates mesh cell face conveyance throughout the simulation, providing relatively fine-scale depth averaged water velocities (magnitude and direction) and water surface elevations. Other hydraulic parameters, such as depth, shear stress, and stream power, can be then be calculated after the simulation using tools in HEC-RAS and ARC-GIS. The model does not simulate vertical variations in velocities or complex three-dimensional flow such as helical, reverse roll, or super-elevation flow.

3.6.2 Model Terrain

The existing conditions model terrain was developed using lidar topography data supplemented by survey in-channel (below water) that provides bathymetry of actual channel bottom that is not collected in lidar. Additional topographic survey in the side channel project area was collected to provide detail for earthwork calculations and improve model accuracy. Topographic and bathymetric survey data was collected by Inter-Fluve in the fall of 2017. The model terrains are projected on the Washington State Plane North Zone, North American Datum 1983 (NAD83), coordinate system with US feet distance units. The terrain elevations are in US feet relative to the North American Vertical Datum of 1988 (NAVD88).

3.6.3 Roughness

Roughness coefficients (Manning's n values) are used by the 2D model to calculate flow energy losses, or frictional resistance, caused by channel bed materials and floodplain vegetation. Existing conditions roughness coefficients were applied across the model extent to represent the various types and densities of vegetation or surface conditions. Roughness coefficients were modified in the proposed conditions models to represent immediate post construction conditions. In general, roughness regions for existing conditions were delineated based on field observations, aerial photos, and proposed designs. Roughness values for each region were selected using published guidelines (Arcement & Schneider 1989) for channel types and vegetation conditions. Table 3 summarizes the roughness values used in the 2D models.

Table 3. Roughness coefficients used in the existing conditions model.

Description	Manning's n values
Channel, cobble bed, bars and banks	0.038
Gravel bars with willow and discontinuous LWD	0.06
Side channel gravel bed, pool-riffles, wood-forced bends	0.05
Mature forest, dense understory vegetation, scattered LWD	0.08 – 0.16

3.6.4 Discharges

The 2,5,10,25-yr flood magnitudes calculated by USBR (Table 2) and low-flow were the flow inputs for the 2D hydraulic model. The 2D model requires a hydrograph (discharge versus time) to run in unsteady mode. A synthetic hydrograph was created that simulated 28 days of flow, beginning at low flow and stepping up to each increasing flood magnitude, which was maintained as a constant flow step in the hydrograph for a period of time long enough to pass through the model mesh before stepping up to the next highest flood and so on. This provided a quasi-steady flow condition for each flood peak.

2D model results are discussed in Section 3.8.

3.7 1D HYDRAULIC MODEL

The U.S. Army Corps of Engineers' Hydraulic Engineering Center River Analysis System (HEC-RAS 5.0.3; USACE 2016) was used to run the steady-state, one-dimensional (1D) model for hydraulic computations to determine elevations in and around the project area. One-dimensional models were run in a steady-state condition under mixed flow regimes in HEC-RAS to represent existing conditions and the proposed conditions shown in the Preliminary Design Plans (Appendix A).

3.7.1 Geometry

The existing conditions HEC-RAS model was developed using October, 2017 survey data and is a representation of the physical terrain along the river and floodplain corridor. Supplemental cross-sectional geometry was extracted from Lidar data in areas outside of project topographic and bathymetry survey. The downstream boundary condition for this model was set to normal depth and located at the upstream end of a riffle with known (surveyed) slope. Manning's 'n' or roughness values were applied to areas that correspond to various types of land cover and channel characteristics. A roughness value of 0.038 was applied to the main channel, and 0.12 was applied to the overbank/floodplain regions. These values are consistent with field observations as well as published guidelines for channel types and vegetation conditions (Arcement & Schneider 1989).

3.7.2 Discharges

The 50- and 100-yr floods provided by USBR (Table 2) were modeled for existing and proposed conditions.

3.8 MODEL RESULTS

The preliminary 1D and 2D hydraulic models predicted the site hydraulics for existing and proposed conditions through the project reach. The results indicate that the proposed project would be feasible; the mainstem habitat structures and side channel would improve mainstem habitat complexity and floodplain function, while not increasing flood hazard to adjacent properties.

3.8.1 Side Channel Flow Distribution

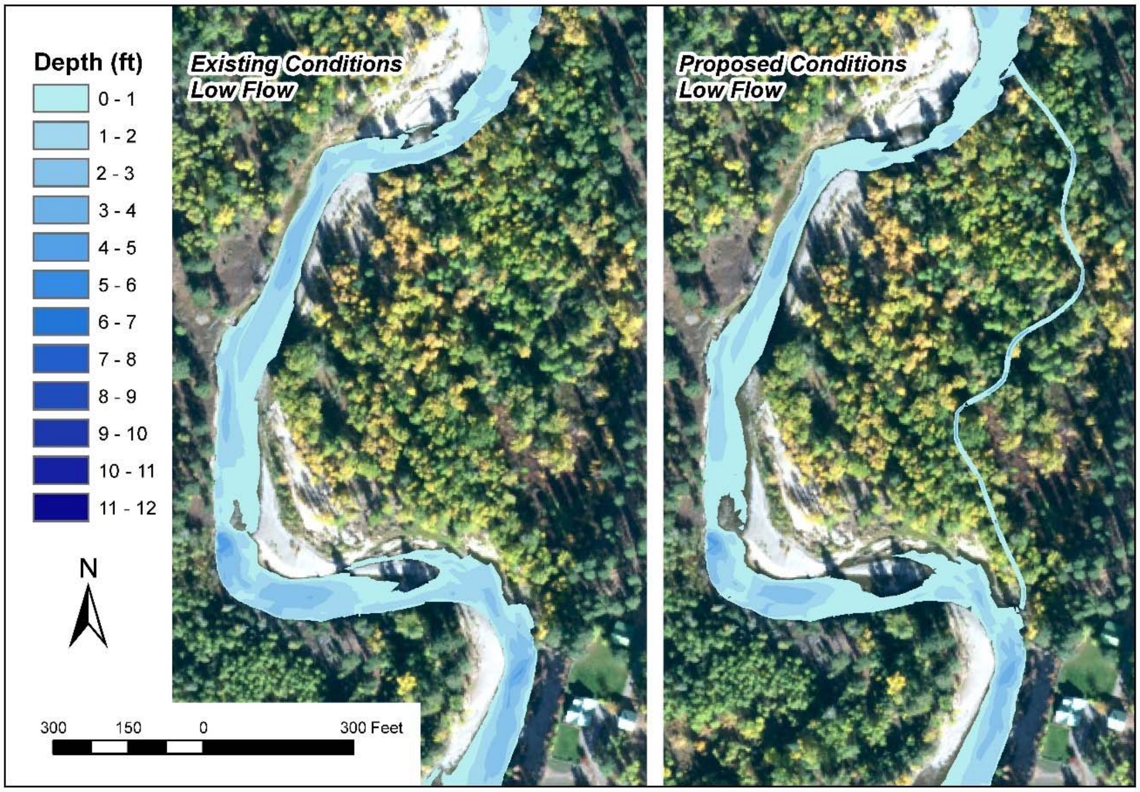
The distribution of flow between mainstem channel and side channel is listed in Table 4. During periods of extremely low flow (<49cfs), the channel inlet may become disconnected from mainstem surface water, but the side channel pools are expected to intercept groundwater where hyporheic flow can maintain cooling and residual depth.

Table 4. Flow distribution between mainstem and side channel

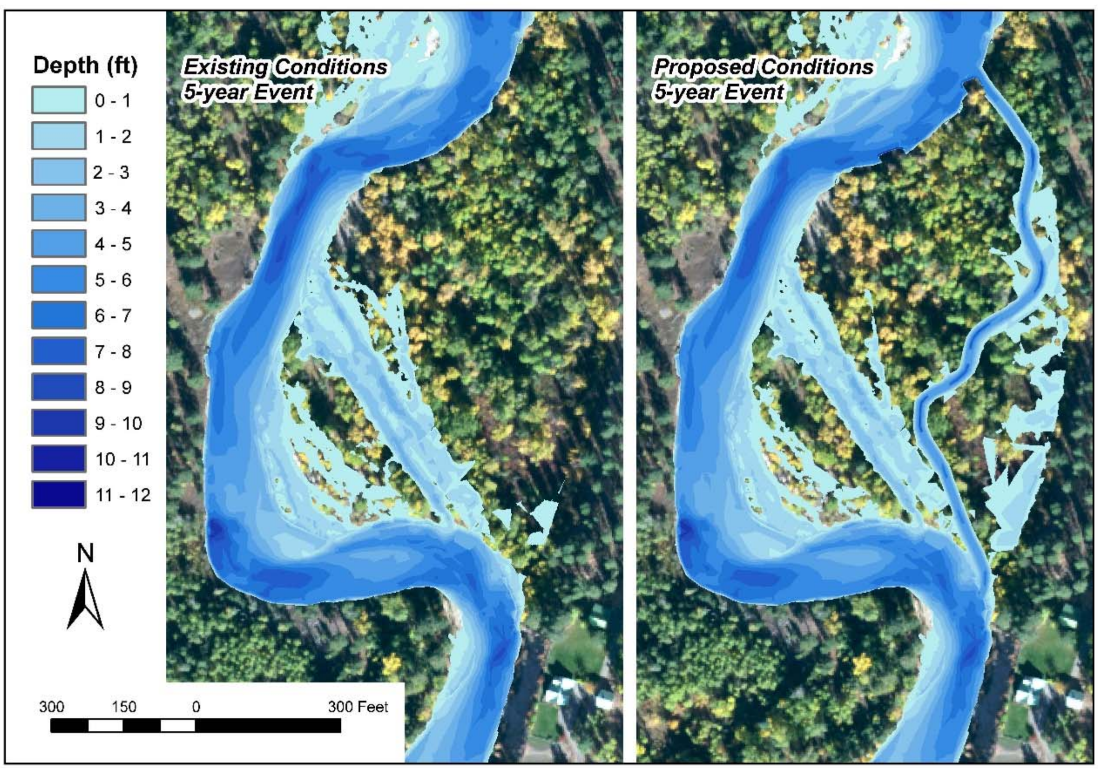
Flow Recurrence	Discharge (cfs)	Main Channel (cfs)	Side Channel (cfs)	Percent Flow in Side Channel
Low Flow	49	48.8	.02	0.4%
2-year	2,947	2698	249	8.4%
5-year	4,520	4025	399	9.0%
10-year	5,540	4741	497	9.5%
25-year	6,785	5515	613	10.0%
50-year	7,675	6012	698	10.4%
100-year	8,531	6465	773	10.7%

3.8.2 Flow Patterns

Figure 12 shows a sequence of side by side figures of inundation patterns and depths results of 2D models of existing versus proposed conditions for low-flow and the 2,5,10,25-year flood discharges. Proposed conditions terrain includes the mainstem log structure, inlet log structure, and side channel.




Depth (ft)
0 - 1
1 - 2
2 - 3
3 - 4
4 - 5
5 - 6
6 - 7
7 - 8
8 - 9
9 - 10
10 - 11
11 - 12
N
300 150 0 300 Feet
Existing Conditions
2-year Event
Proposed Conditions
2-year Event


Depth (ft)
0 - 1
1 - 2
2 - 3
3 - 4
4 - 5
5 - 6
6 - 7
7 - 8
8 - 9
9 - 10
10 - 11
11 - 12
N
300 150 0 300 Feet
Existing Conditions
5-year Event
Proposed Conditions
5-year Event

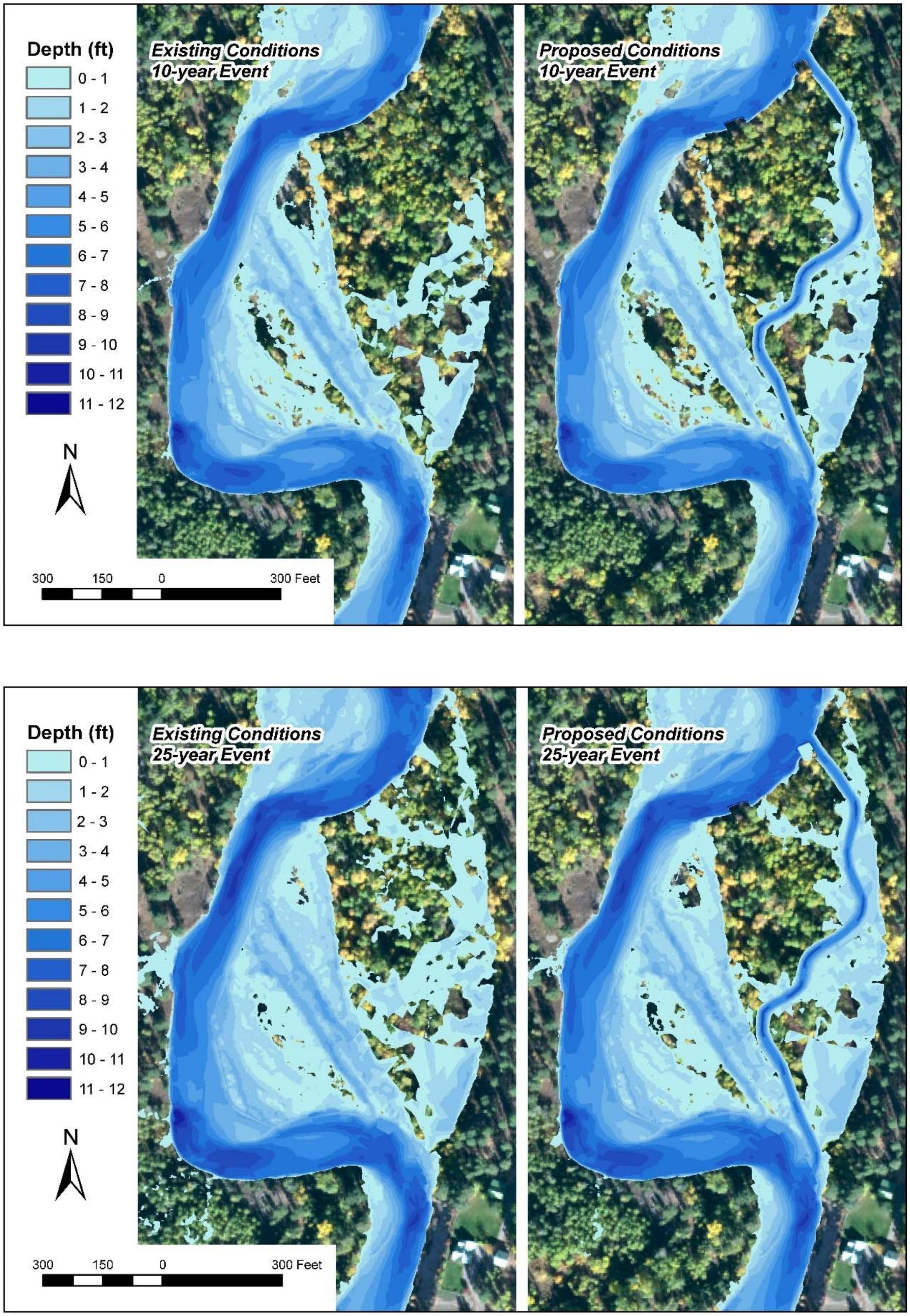


Figure 12. Inundation patterns for modeled flows, existing & proposed conditions.

3.8.3 Velocity Patterns

Figure 13 shows a figures of velocity output of 2D models of existing versus proposed conditions for 2,5,10,25-year flood discharges. Velocities are typically in the range of 2-6 ft/s, well below mainstem velocities, but sufficient for movement of sand and small gravel.

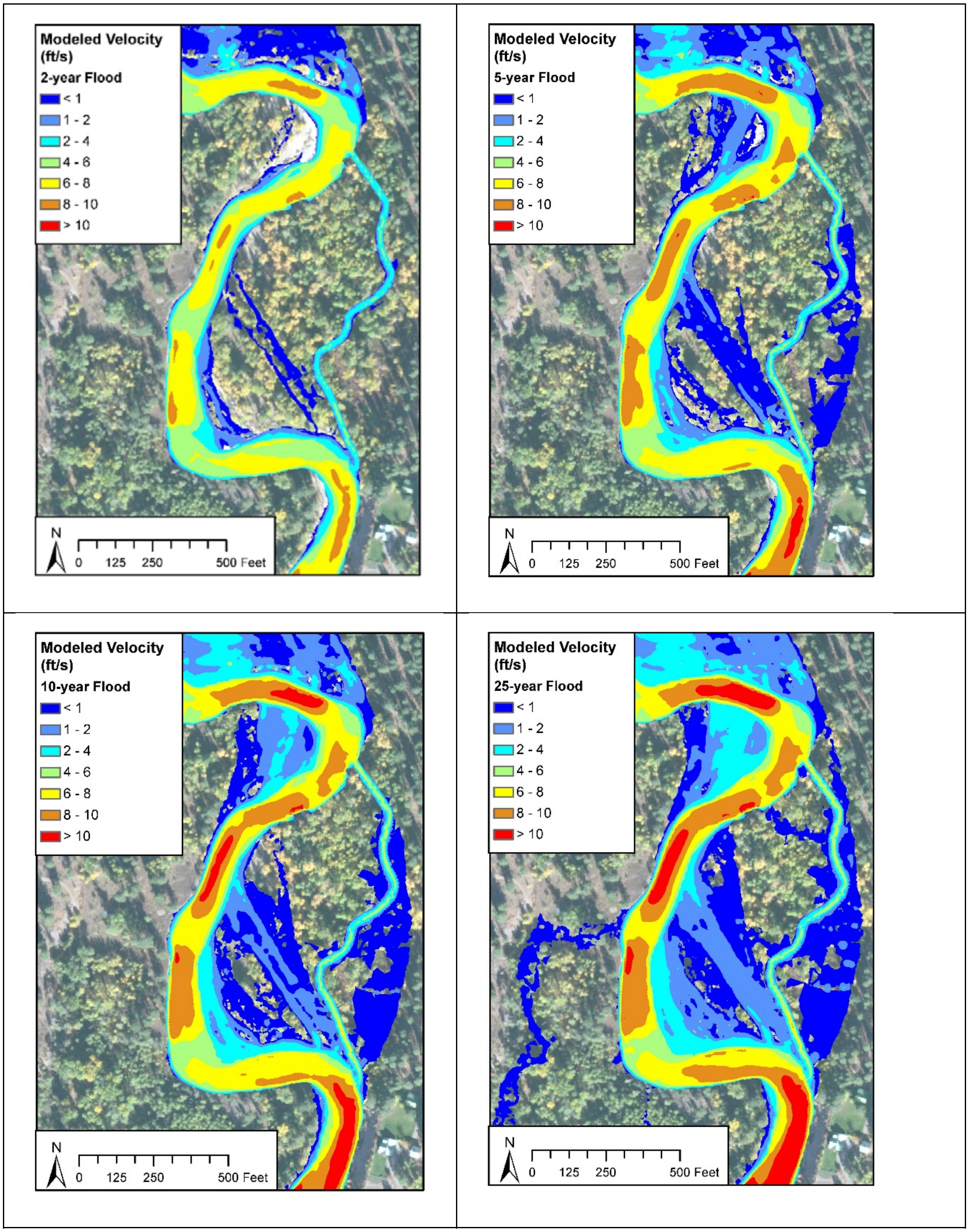


Figure 13. Velocity patterns for modeled flows, proposed conditions.

3.8.4 Base Flood Impacts (100-yr)

Comparing the 1D model's existing and proposed conditions water surface elevations of the 100-yr flood, the proposed project will not increase baseflood elevations, and will decrease levels in some areas (Figure 14). Appendix B includes a table that shows the numerical results of compared water surface elevations and other hydraulic parameters for each model cross section.

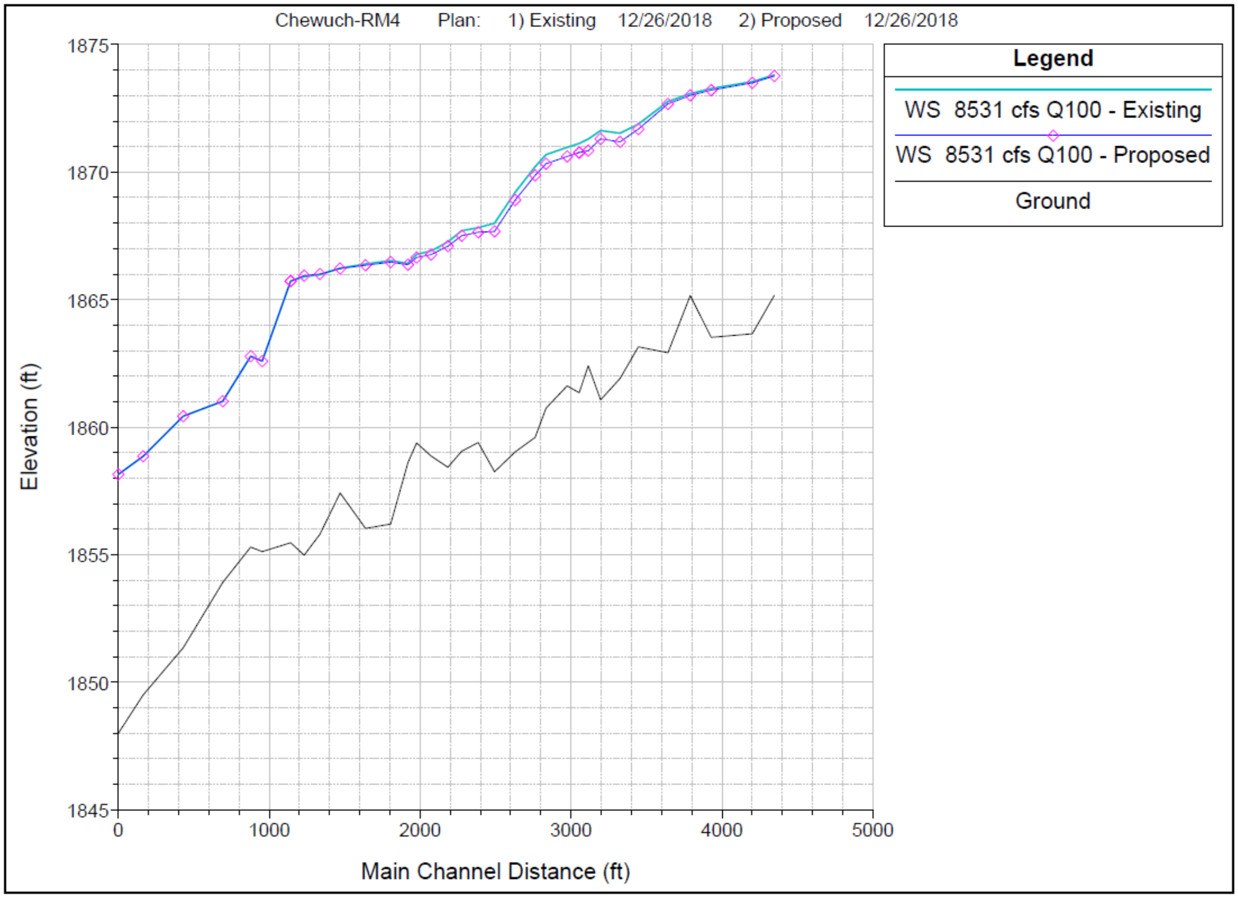


Figure 14. Long profile (centerline) of Chewuch RM4 project reach, existing and proposed conditions.

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

Stability analysis and computations for project elements follow professional practice guidelines for large wood design (Knutson and Fealko 2014 and USBR and ERDC 2016), stream habitat restoration (Cramer 2012), Stability of Ballasted Woody Debris Habitat Structures (D'Aoust and Millar 2000) and institutional knowledge combined with professional judgment for the design of specific project elements.

The included preliminary design plans show project elements that are located and configured at appropriate geomorphic locations to emulate natural large wood accumulations along the mainstem river bank, the head of an island, and woody roughness in side channel from erosion into tree roots and fallen trees. Refinements to the designed locations and configurations of project elements may occur during future phases in response to stakeholder input. The final design report will include stability calculations for project elements, which will be designed to withstand the hydraulic conditions of the 100-yr flood as predicted by the proposed conditions hydraulic model.

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

The preceding analysis is the basis for designs and specifications described in the preliminary design drawings. The future final design phase will require preparation of more detailed design drawings and specifications to provide additional details related to environmental controls and site construction, and to provide bidding contractors with a list of work items and quantities.

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

Not applicable to this project.

3.12 FOR PROJECTS THAT ADDRESS PROFILE DISCONTINUITIES (GRADE STABILIZATION, SMALL DAM AND STRUCTURE REMOVALS): A MINIMUM OF THREE CROSS-SECTIONS – ONE DOWNSTREAM OF THE STRUCTURE, ONE THROUGH THE RESERVOIR AREA UPSTREAM OF THE STRUCTURE, AND ONE UPSTREAM OF THE RESERVOIR AREA OUTSIDE OF THE INFLUENCE OF THE STRUCTURE) TO CHARACTERIZE THE CHANNEL MORPHOLOGY AND QUANTIFY THE STORED SEDIMENT

Not applicable to this project.

4. Construction – contract documentation

4.1 INCORPORATION OF HIPIII GENERAL AND CONSTRUCTION CONSERVATION MEASURES

The HIP-III conservation measures are included in the attached plans. If a conservation measure cannot be met due to specific site constraints, a variance will be requested.

4.2 DESIGN – CONSTRUCTION PLAN SET

The attached preliminary design plans provide the basis for applying for environmental permits. During the future final design phase, final construction drawings will be prepared to include details and specifications for all project elements and construction activities in sufficient detail to facilitate a comprehensive and unambiguous contract, and govern competent and clean execution of project implementation.

4.3 LIST OF ALL PROPOSED PROJECT MATERIALS AND QUANTITIES

The preliminary design plans include tables listing project materials and quantities.

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

- Site access staging and sequencing plan
- Work area isolation and dewatering plan
- Erosion and pollution control plan
- Site reclamation and restoration plan

4.5 CALENDAR SCHEDULE FOR CONSTRUCTION/IMPLEMENTATION PROCEDURES

A final construction timeframe has not been determined. Although environmental conditions such as late snowmelt and runoff, or extreme precipitation causing soft ground, the construction start date and duration largely depends on the contractor's equipment, operators, and labor. Based on recent construction projects, in-water work window will be the full month of July. Significant portions of the project can be completed well outside of water.

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

To be completed in future design phases.

5. Monitoring and adaptive management plan

To be completed in future design phases.

6. References

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Cramer, Michelle. 2012. Stream Habitat Restoration Guidelines. Copublished by the Washington Departments of Fish and Wildlife, Natural Resources, Transportation and Ecology, Washington State Recreation and Conservation Office, Puget Sound Partnership, and the U.S. Fish and Wildlife Service. Olympia, Washington.

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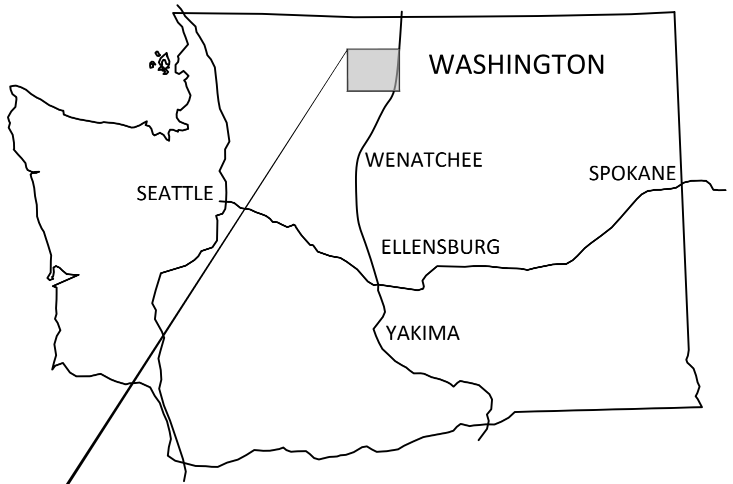
Appendix A: 30% Design Plans

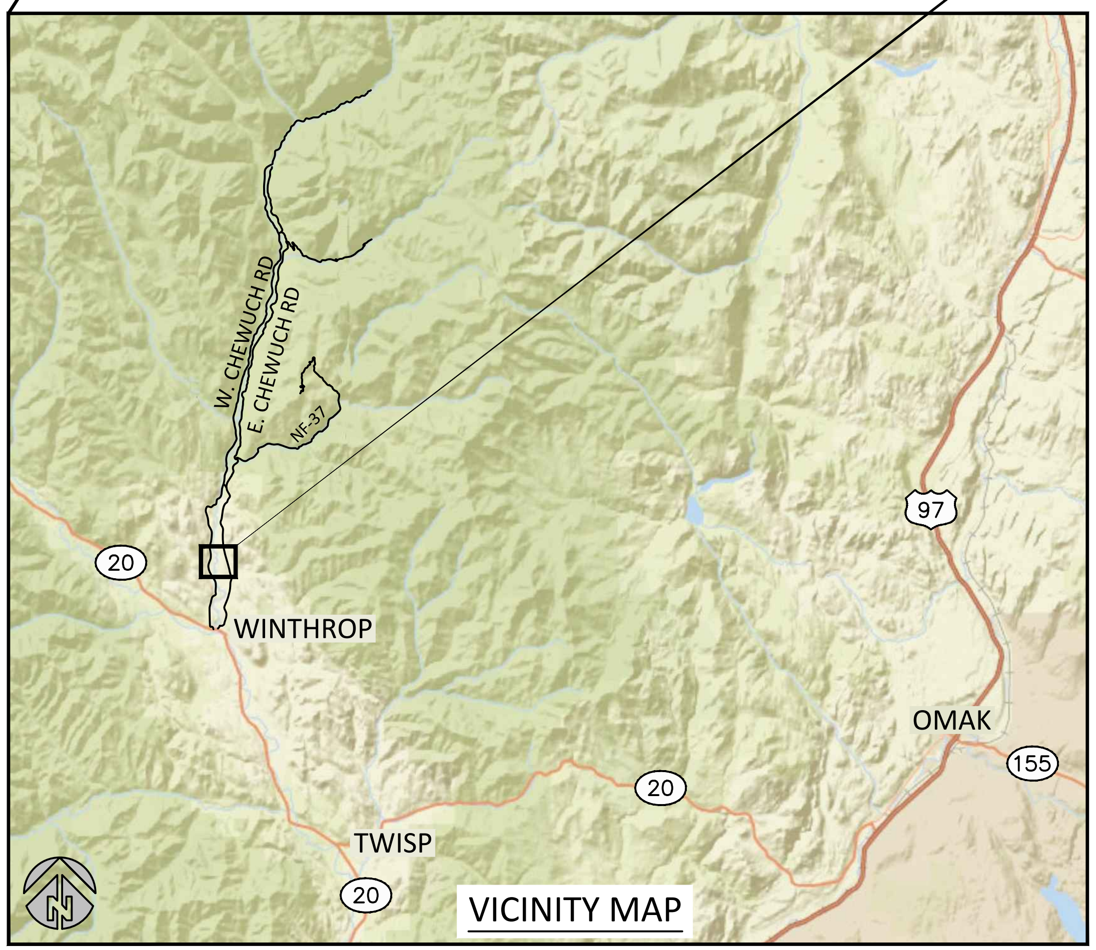
CHEWUCH RIVER MILE 4

FISH HABITAT ENHANCEMENT PROJECT

30% Design

YAKAMA NATION FISHERIES
2 JOHNSON LANE
WINTHROP WA, 98862



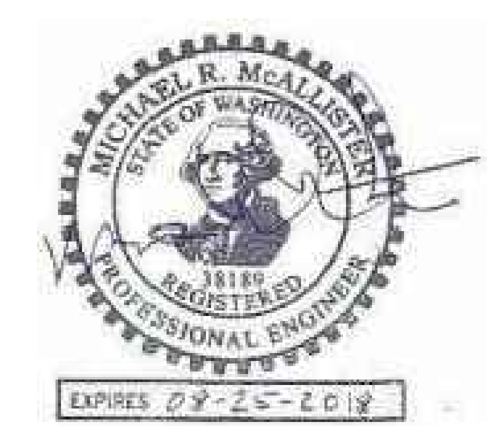


SITE LOCATION:

LATITUDE: 48°31'16"
LONGITUDE: -120°11'05"
OKANOGAN COUNTY, WASHINGTON

WATERBODY: CHEWUCH RIVER
TRIBUTARY OF: METHOW RIVER

SHEET LIST



NO.	BY	DATE	REVISION DESCRIPTION

MM, GS	MB	CB
DRAWN	DESIGNED	CHECKED
----	12/18/18	
APPROVED	DATE	PROJECT

YAKAMA NATION FISHERIES PROGRAM
CHEWUCH RIVER MILE 4.2
FISH HABITAT ENHANCEMENT

inter·fluve
501 Portway Avenue, Suite 101
Hood River, OR 97031
541.386.9003
www.interfluve.com

TITLE SHEET

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IT IS STRONGLY SUGGESTED THAT THE CONTRACTOR ATTEND A PRE-BID SITE MEETING.

THE CONTRACTOR SHALL ATTEND A PRE-CONSTRUCTION MEETING WITH THE OWNER AND OWNER'S REPRESENTATIVE PRIOR TO BEGINNING CONSTRUCTION.

ALL WORK SHALL CONFORM TO THE 2014 EDITIONS OF STANDARD PLANS AND SPECIFICATIONS OF THE WASHINGTON STATE DEPARTMENT OF TRANSPORTATION (WSDOT), AND LOCAL STANDARDS UNLESS INDICATED OTHERWISE BY THE CONTRACT DOCUMENTS. IN CASE OF A CONFLICT BETWEEN THE REGULATORY STANDARDS OR SPECIFICATIONS, THE MORE STRINGENT WILL PREVAIL.

BPA HIP III

THIS PROJECT WAS DESIGNED IN ACCORDANCE WITH THE BPA HABITAT IMPROVEMENT PROGRAM, PROGRAMMATIC BIOLOGICAL OPINION (HIP III). HIP III GENERAL CONSERVATION MEASURES (CMs) ARE INCLUDED ON SHEETS 3 AND 4. SITE SPECIFIC DIRECTION IS INCLUDED IN THE FOLLOWING GENERAL NOTES. ANY VARIANCES FROM HIP III CMs WILL BE REQUESTED BY OWNER. IN CASE OF A CONFLICT BETWEEN THE REGULATORY STANDARDS OR SPECIFICATIONS, LOCAL REGULATIONS, OR OTHER CONTRACT DOCUMENTATION, THE MORE STRINGENT WILL PREVAIL, UNLESS SPECIFIED IN WRITING BY THE OWNER.

EXISTING DATA

TOPOGRAPHIC SURVEY COLLECTED BY INTER-FLUVE, INC. BY RTK GPS AND TOTAL STATION IN 2017-18. REFERENCED TO NAD83 WASHINGTON STATE PLANE, NORTH ZONE US FEET NAVD 88.

CULTURAL RESOURCES

IF YOUR WORK BRINGS YOU INTO CONTACT WITH ANY OF THE FOLLOWING CULTURAL RESOURCES:

-NATIVE AMERICAN CULTURAL ARTIFACTS (EXAMPLE: FLAKES, ARROWHEADS, STONE TOOLS, BONE TOOLS, POTTERY, ETC.)

-HISTORIC ERA ARTIFACTS (EXAMPLE: BUILDING FOUNDATIONS, HOMESTEADS, SHIPWRECKS, MINING CAMPS, ETC.)

-HUMAN SKELETAL REMAINS AND BONE FRAGMENTS

YOU MUST IMMEDIATELY DISCONTINUE ALL GROUND-DISTURBING ACTIVITY. DO NOT TOUCH OR MOVE THE OBJECTS AND MAINTAIN THE CONFIDENTIALITY OF THE SITE. FOLLOW THE PROCEDURES LISTED IN THE BPA INADVERTENT DISCOVERY PROCEDURE AND AWAIT FURTHER DIRECTION FROM BPA'S CULTURAL RESOURCES STAFF.

INVASIVE SPECIES CONTROL

THE FOLLOWING MEASURES WILL BE FOLLOWED TO AVOID INTRODUCTION OF INVASIVE PLANTS AND NOXIOUS WEEDS INTO PROJECT AREAS:

PRIOR TO ENTERING THE SITE, ALL VEHICLES AND EQUIPMENT SHALL BE POWER WASHED, ALLOWED TO FULLY DRY, AND INSPECTED TO MAKE SURE NO PLANTS, SOIL, OR OTHER ORGANIC MATERIAL ADHERES TO THE SURFACE.

LIVE TREES

ALL TREES NOT MARKED FOR REMOVAL SHALL BE PRESERVED AND UNDISTURBED. CONSTRUCTION ACTIVITY SHALL NOT DEBARK OR DAMAGE LIVE TREES.

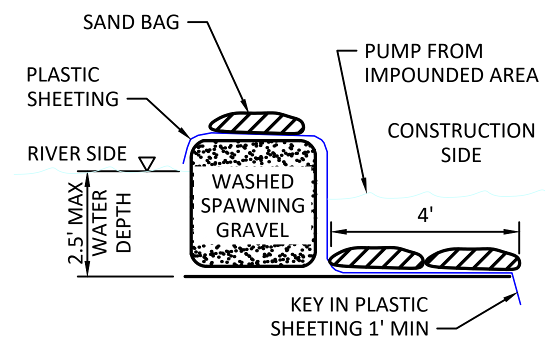
KEEP OUT OF DRIP LINE OF ALL PRESERVED EXISTING TREES.

ALL SAPLING AND TREES TO BE REMOVED FOR ACCESS WILL BE APPROVED AND CLEARLY MARKED BY THE OWNER'S REPRESENTATIVE.

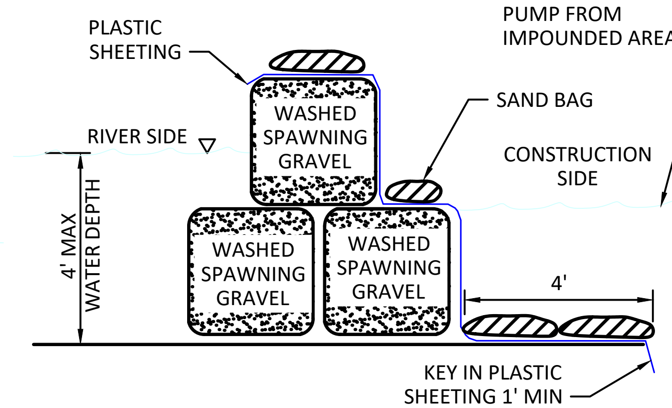
ALL TREES REMOVED WITHIN CLEARING LIMITS SHALL BE REMOVED WHOLE WITH ROOTS INTACT AND UTILIZED IN THE CHANNEL CONSTRUCTION AS DIRECTED BY OWNER'S REPRESENTATIVE.

ABBREVIATIONS

APPROX	APPROXIMATE	INV	INVERT
CY	CUBIC YARDS	LWM	LARGE WOODY MATERIAL
°	DEGREES	MAX	MAXIMUM
DIA or ø	DIAMETER	MIN	MINIMUM
DBH	DIAMETER AT BREAST HEIGHT	OHW	ORDINARY HIGH WATER
EA	EACH	%	PERCENT
EL or ELEV	ELEVATION	RMx	RIVER MILE x
ESC	EROSION AND SEDIMENT CONTROL	STA	STATION
EXIST	EXISTING	TBD	TO BE DETERMINED
FT or '	FEET	TYP	TYPICAL
FTR	FULLY THREADED ROD	VERT	VERTICAL
HORIZ	HORIZONTAL	WSE	WATER SURFACE ELEVATION
IN or "	INCH	YR	YEAR



SINGLE LAYER COFFERDAM
(WATER DEPTH LESS THAN 2.5')



STACKED BULK BAG COFFERDAM
(WATER DEPTH GREATER THAN 2.5')

TEMPORARY COFFERDAM DETAILS

NOT TO SCALE

COFFERDAM NOTES:

1. BULKBAG COFFERDAM IS A PRE-APPROVED METHOD OF ISOLATING CONSTRUCTION WATER FROM THE WATERWAY. ALTERNATE COFFERDAM MATERIALS AND CONFIGURATIONS MAY BE ALLOWED BUT SHALL NOT BE IMPLEMENTED WITHOUT REVIEW AND APPROVAL BY THE OWNER. CONTRACTOR SHALL PROVIDE SHOP DRAWINGS AND/OR VENDOR CUT SHEETS FOR SUBSTITUTIONS.
2. BULKBAG COFFERDAM SHALL BE CONSTRUCTED OF SEVERAL UNITS OF BULK BAGS FILLED WITH WASHED SPAWNING GRAVEL, AND ABUTTED SIDE BY SIDE TO CREATE A ROW THAT ISOLATES THE CONSTRUCTION SITE FROM THE RIVER.
3. IF WATER DEPTH EXCEEDS 85% OF THE BULK BAG HEIGHT, AN ADDITIONAL TOP ROW OF BULKBAGS SHALL BE INSTALLED, SUPPORTED BY TWO BOTTOM ROWS OF BULK BAGS.
4. BULKBAG COFFERDAM SHALL BE SEALED BY COVERING THE COFFERDAM WITH PLASTIC SHEETING HELD IN PLACE BY STANDARD SANDBAGS PLACED IN ROWS ON TOP OF COFFERDAM, AND AT TOE OF COFFERDAM. THE PLASTIC SHEETING SHALL BE DRAPED ALONG THE CHANNEL BOTTOM ON THE WORK AREA SIDE OF THE COFFERDAM WITH OUTWARD EDGE OF SHEETING MINIMUM 4-FEET FROM TOE OF COFFERDAM. THE DRAPED PORTION OF PLASTIC SHEETING SHALL BE PINNED TO THE CHANNEL BED BY MINIMUM TWO ROWS OF STANDARD SANDBAGS.
5. THE OUTWARD EDGE OF PLASTIC SHEETING ON WORK AREA SIDE SHALL BE TOED INTO THE CHANNEL BED MINIMUM 1-FT. TOEING IN THE OUTWARD EDGE OF PLASTIC SHEETING SHALL OCCUR AFTER THE COFFERDAM IS CLOSED TO PREVENT TURBIDITY RELEASE TO THE WATERWAY.
6. IF POSSIBLE, THE COFFERDAM SHALL BE EXTENDED ONTO A GRAVEL BAR AND OUT OF THE WATER. IF THE END MUST BE TERMINATED AT THE RIVERBANK, THE COFFERDAM SHALL BE TIGHTLY SEALED TO THE GROUND BY PLASTIC SHEETING AND STANDARD SANDBAGS. MULTIPLE LAYERS OF SHEETING AND SANDBAGS MAY BE REQUIRED TO FORM A WATERTIGHT SEAL.
7. BULKBAGS SHALL BE WATERPROOF CUBE-SHAPED POLYPROPYLENE WOVEN FABRIC BAGS WITH FULLY OPEN TOP, FLAT BOTTOM, FOUR LOOPS, MINIMUM 2-TON WEIGHT CAPACITY, MINIMUM 5:1 SAFETY FACTOR.
8. PLASTIC SHEETING SHALL BE MINIMUM 6-MIL THICKNESS. ROLL LENGTH SHALL BE LONG ENOUGH TO ENSURE THAT ENTIRE LENGTH OF COFFERDAM WILL BE COVERED WITHOUT A SEAM. MINIMUM 12-FT WIDE ROLL SHALL BE USED FOR SINGLE LAYER BULK BAG COFFERDAM. MINIMUM 16-FT WIDE ROLL SHALL BE USED FOR 2-LAYER STACKED BULK BAG COFFERDAM.
9. CONTRACTOR SHALL PROVIDE PUMPING SUFFICIENT FOR A NET INFLOW TO THE WORK AREA, AND DISCHARGE TURBID WATER TO UPLAND FLOODPLAIN.
10. BULKBAG COFFERDAM SHALL BE COMPLETELY REMOVED AFTER CONSTRUCTION IS COMPLETED AND TURBIDITY HAS BEEN REMOVED. UPON OWNER'S REQUEST, SOME BULK BAGS WILL BE OPENED AND ENCLOSED SPAWNING GRAVEL APPLIED TO THE RIVER.
11. IF NECESSARY, GAPS BETWEEN BULKBAGS SHALL BE FILLED WITH WASHED GRAVEL TO SEAL AND IMPROVE COFFER DAM SEAL. DISPOSAL OF ROCK WASH SHALL BE DETERMINED BY OWNER.

NO.	BY	DATE	REVISION DESCRIPTION

MM, GS	MB	CB
DRAWN	DESIGNED	CHECKED
----	12/18/18	
APPROVED	DATE	PROJECT

YAKAMA NATION FISHERIES PROGRAM
CHEWUCH RIVER MILE 4.2
FISH HABITAT ENHANCEMENT

inter·fluve
501 Portway Avenue, Suite 101
Hood River, OR 97031
541.386.9003
www.interfluve.com

GENERAL NOTES

HIP 3 GENERAL AQUATIC CONSERVATION MEASURES APPLICABLE TO ALL ACTIONS

THE ACTIVITIES COVERED UNDER THE HIPIII ARE INTENDED TO PROTECT AND RESTORE FISH AND WILDLIFE HABITAT WITH LONG-TERM BENEFITS TO ESA-LISTED SPECIES. TO MINIMIZE THESE SHORT-TERM ADVERSE EFFECTS AND MAKE THEM PREDICTABLE FOR THE PURPOSES OF PROGRAMMATIC ANALYSIS, BPA WILL INCLUDE IN ALL PROJECTS IMPLEMENTED UNDER THIS HIP III PROPOSED ACTION THE FOLLOWING GENERAL CONSERVATION MEASURES (DEVELOPED IN COORDINATION WITH USFWS AND NMFS).

PROJECT DESIGN AND SITE PREPARATION.

1) STATE AND FEDERAL PERMITS. ALL APPLICABLE REGULATORY PERMITS AND OFFICIAL PROJECT AUTHORIZATIONS WILL BE OBTAINED BEFORE PROJECT IMPLEMENTATION. THESE PERMITS AND AUTHORIZATIONS INCLUDE, BUT ARE NOT LIMITED TO, NATIONAL ENVIRONMENTAL POLICY ACT, NATIONAL HISTORIC PRESERVATION ACT, AND THE APPROPRIATE STATE AGENCY REMOVAL AND FILL PERMIT, USACE CLEAN WATER ACT (CWA) 404 PERMITS, AND CWA SECTION 401 WATER QUALITY CERTIFICATIONS.

2) TIMING OF IN-WATER WORK. APPROPRIATE STATE (OREGON DEPARTMENT OF FISH AND WILDLIFE (ODFW), WASHINGTON DEPARTMENT OF FISH AND WILDLIFE (WDFW), IDAHO DEPARTMENT OF FISH AND GAME (IDFG), AND MONTANA FISH WILDLIFE AND PARKS (MFWP)) GUIDELINES FOR TIMING OF IN-WATER WORK WINDOWS (IWW) WILL BE FOLLOWED.

A) BULL TROUT - WHILE UTILIZING THE APPROPRIATE STATE DESIGNATED IN-WATER WORK PERIOD WILL LESSEN THE RISK TO BULL TROUT, THIS ALONE MAY NOT BE SUFFICIENT TO ADEQUATELY PROTECT LOCAL BULL TROUT POPULATIONS. THIS IS ESPECIALLY TRUE IF WORK IS OCCURRING IN SPAWNING AND REARING AREAS BECAUSE EGGS, ALEVIN, AND FRY ARE IN THE SUBSTRATE OR CLOSELY ASSOCIATED HABITATS NEARLY YEAR ROUND. SOME AREAS MAY NOT HAVE DESIGNATED IN-WATER WORK WINDOWS FOR BULL TROUT OR IF THEY DO, THEY MAY CONFLICT WITH WORK WINDOWS FOR SALMON AND STEELHEAD. IF THIS IS THE CASE, OR IF PROPOSED WORK IS TO OCCUR WITHIN BULL TROUT SPAWNING AND REARING HABITATS, PROJECT PROPONENTS WILL CONTACT THE APPROPRIATE USFWS FIELD OFFICE TO INSURE THAT ALL REASONABLE IMPLEMENTATION MEASURES ARE CONSIDERED AND AN APPROPRIATE IN-WATER WORK WINDOW IS BEING USED TO MINIMIZE PROJECT EFFECTS.

B) LAMPREY - THE PROJECT SPONSOR AND/OR THEIR CONTRACTORS WILL AVOID WORKING IN STREAM OR RIVER CHANNELS THAT CONTAIN PACIFIC LAMPREY FROM MARCH 1 TO JULY 1 IN LOW TO MID ELEVATION REACHES (<5,000 FEET). IN HIGH ELEVATION REACHES (>5,000 FEET), THE PROJECT SPONSOR WILL AVOID WORKING IN STREAM OR RIVER CHANNELS FROM MARCH 1 TO AUGUST 1. IF EITHER TIMEFRAME IS INCOMPATIBLE WITH OTHER OBJECTIVES, THE AREA WILL BE SURVEYED FOR NESTS AND LAMPREY PRESENCE, AND AVOIDED IF POSSIBLE. IF LAMPREYS ARE KNOWN TO EXIST, THE PROJECT SPONSOR WILL UTILIZE DEWATERING AND SALVAGE PROCEDURES OUTLINED IN US FISH AND WILDLIFE SERVICE BEST MANAGEMENT PRACTICES TO MINIMIZE ADVERSE EFFECTS TO PACIFIC LAMPREY (2010).

C) EXCEPTIONS TO ODFW, WDFW, MFWP, OR IDFG IN-WATER WORK WINDOWS WILL BE REQUESTED THROUGH THE VARIANCE PROCESS (PAGE 2).

3) CONTAMINANTS. THE PROJECT SPONSOR WILL COMPLETE A SITE ASSESSMENT WITH THE FOLLOWING ELEMENTS TO IDENTIFY THE TYPE, QUANTITY, AND EXTENT OF ANY POTENTIAL CONTAMINATION FOR ANY ACTION THAT INVOLVES EXCAVATION OF MORE THAN 20 CUBIC YARDS OF MATERIAL:

A) A REVIEW OF AVAILABLE RECORDS, SUCH AS FORMER SITE USE, BUILDING PLANS, AND RECORDS OF ANY PRIOR CONTAMINATION EVENTS;

B) A SITE VISIT TO INSPECT THE AREAS USED FOR VARIOUS INDUSTRIAL PROCESSES AND THE CONDITION OF THE PROPERTY;

C) INTERVIEWS WITH KNOWLEDGEABLE PEOPLE, SUCH AS SITE OWNERS, OPERATORS, AND OCCUPANTS, NEIGHBORS, OR LOCAL GOVERNMENT OFFICIALS; AND

D) A SUMMARY, STORED WITH THE PROJECT FILE THAT INCLUDES AN ASSESSMENT OF THE LIKELIHOOD THAT CONTAMINANTS ARE PRESENT AT THE SITE, BASED ON ITEMS 4(A) THROUGH 4(C).

4) SITE LAYOUT AND FLAGGING. PRIOR TO CONSTRUCTION. THE ACTION AREA WILL BE CLEARLY FLAGGED TO IDENTIFY THE FOLLOWING:

A) SENSITIVE RESOURCE AREAS, SUCH AS AREAS BELOW ORDINARY HIGH WATER, SPAWNING AREAS, SPRINGS, AND WETLANDS;

B) EQUIPMENT ENTRY AND EXIT POINTS;

C) ROAD AND STREAM CROSSING ALIGNMENTS;

D) STAGING, STORAGE, AND STOCKPILE AREAS; AND

E) NO-SPRAY AREAS AND BUFFERS.

5) TEMPORARY ACCESS ROADS AND PATHS.

A) EXISTING ACCESS ROADS AND PATHS WILL BE PREFERENTIALLY USED WHENEVER REASONABLE, AND THE NUMBER AND LENGTH OF TEMPORARY ACCESS ROADS AND PATHS THROUGH RIPARIAN AREAS AND FLOODPLAINS WILL BE MINIMIZED TO LESSEN SOIL DISTURBANCE AND COMPACTION, AND IMPACTS TO VEGETATION.

B) TEMPORARY ACCESS ROADS AND PATHS WILL NOT BE BUILT ON SLOPES WHERE GRADE, SOIL, OR OTHER FEATURES SUGGEST A LIKELIHOOD OF EXCESSIVE EROSION OR FAILURE. IF SLOPES ARE STEEPER THAN 30%, THEN THE ROAD WILL BE DESIGNED BY A CIVIL ENGINEER WITH EXPERIENCE IN STEEP ROAD DESIGN.

C) THE REMOVAL OF RIPARIAN VEGETATION DURING CONSTRUCTION OF TEMPORARY ACCESS ROADS WILL BE MINIMIZED. WHEN TEMPORARY VEGETATION REMOVAL IS REQUIRED, VEGETATION WILL BE CUT AT GROUND LEVEL (NOT GRUBBED).

D) AT PROJECT COMPLETION, ALL TEMPORARY ACCESS ROADS AND PATHS WILL BE OBLITERATED, AND THE SOIL WILL BE STABILIZED AND REVEGETATED. ROAD AND PATH OBLITERATION REFERS TO THE MOST COMPREHENSIVE DEGREE OF DECOMMISSIONING AND INVOLVES DECOMPACTING THE SURFACE AND DITCH, PULLING THE FILL MATERIAL ONTO THE RUNNING SURFACE, AND RESHAPING TO MATCH THE ORIGINAL CONTOUR.

E) TEMPORARY ROADS AND PATHS IN WET AREAS OR AREAS PRONE TO FLOODING WILL BE OBLITERATED BY THE END OF THE IN-WATER WORK WINDOW.

6) TEMPORARY STREAM CROSSINGS.

A) EXISTING STREAM CROSSINGS WILL BE PREFERENTIALLY USED WHENEVER REASONABLE, AND THE NUMBER OF TEMPORARY STREAM CROSSINGS WILL BE MINIMIZED.

B) TEMPORARY BRIDGES AND CULVERTS WILL BE INSTALLED TO ALLOW FOR EQUIPMENT AND VEHICLE CROSSING OVER PERENNIAL STREAMS DURING CONSTRUCTION. TREATED WOOD SHALL NOT BE USED ON TEMPORARY BRIDGE CROSSINGS OR IN LOCATIONS IN CONTACT WITH OR OVER WATER.

C) EQUIPMENT AND VEHICLES WILL CROSS THE STREAM IN THE WET ONLY WHERE:

I. THE STREAMBED IS BEDROCK; OR

II. MATS OR OFF-SITE LOGS ARE PLACED IN THE STREAM AND USED AS A CROSSING.

D) VEHICLES AND MACHINERY WILL CROSS STREAMS AT RIGHT ANGLES TO THE MAIN CHANNEL WHEREVER POSSIBLE.

E) THE LOCATION OF THE TEMPORARY CROSSING WILL AVOID AREAS THAT MAY INCREASE THE RISK OF CHANNEL RE-ROUTING OR AVULSION.

F) POTENTIAL SPAWNING HABITAT (I.E., POOL TAILOUTS) AND POOLS WILL BE AVOIDED TO THE MAXIMUM EXTENT POSSIBLE.

G) NO STREAM CROSSINGS WILL OCCUR AT ACTIVE SPAWNING SITES, WHEN HOLDING ADULT LISTED FISH ARE PRESENT, OR WHEN EGGS OR ALEVINS ARE IN THE GRAVEL. THE APPROPRIATE STATE FISH AND WILDLIFE AGENCY WILL BE CONTACTED FOR SPECIFIC TIMING INFORMATION.

H) AFTER PROJECT COMPLETION, TEMPORARY STREAM CROSSINGS WILL BE OBLITERATED AND THE STREAM CHANNEL AND BANKS RESTORED.

7) STAGING, STORAGE, AND STOCKPILE AREAS.

A) STAGING AREAS (USED FOR CONSTRUCTION EQUIPMENT STORAGE, VEHICLE STORAGE, FUELING, SERVICING, AND HAZARDOUS MATERIAL STORAGE) WILL BE 150 FEET OR MORE FROM ANY NATURAL WATER BODY OR WETLAND, OR ON AN ADJACENT, ESTABLISHED ROAD AREA IN A LOCATION AND MANNER THAT WILL PRECLUDE EROSION INTO OR CONTAMINATION OF THE STREAM OR FLOODPLAIN.

B) NATURAL MATERIALS USED FOR IMPLEMENTATION OF AQUATIC RESTORATION, SUCH AS LARGE WOOD, GRAVEL, AND BOULDERS, MAY BE STAGED WITHIN THE 100-YEAR FLOODPLAIN.

C) ANY LARGE WOOD, TOPSOIL, AND NATIVE CHANNEL MATERIAL DISPLACED BY CONSTRUCTION WILL BE STOCKPILED FOR USE DURING SITE RESTORATION AT A SPECIFICALLY IDENTIFIED AND FLAGGED AREA.

D) ANY MATERIAL NOT USED IN RESTORATION, AND NOT NATIVE TO THE FLOODPLAIN, WILL BE REMOVED TO A LOCATION OUTSIDE OF THE 100-YEAR FLOODPLAIN FOR DISPOSAL.

8) EQUIPMENT. MECHANIZED EQUIPMENT AND VEHICLES WILL BE SELECTED, OPERATED, AND MAINTAINED IN A MANNER THAT MINIMIZES ADVERSE EFFECTS ON THE ENVIRONMENT (E.G., MINIMALLY-SIZED, LOW PRESSURE TIRES; MINIMAL HARD-TURN PATHS FOR TRACKED VEHICLES; TEMPORARY MATS OR PLATES WITHIN WET AREAS OR ON SENSITIVE SOILS). ALL VEHICLES AND OTHER MECHANIZED EQUIPMENT WILL BE:

A) STORED, FUELED, AND MAINTAINED IN A VEHICLE STAGING AREA PLACED 150 FEET OR MORE FROM ANY NATURAL WATER BODY OR WETLAND OR ON AN ADJACENT, ESTABLISHED ROAD AREA;

B) REFUELED IN A VEHICLE STAGING AREA PLACED 150 FEET OR MORE FROM A NATURAL WATERBODY OR WETLAND, OR IN AN ISOLATED HARD ZONE, SUCH AS A PAVED PARKING LOT OR ADJACENT, ESTABLISHED ROAD (THIS MEASURE APPLIES ONLY TO GAS-POWERED EQUIPMENT WITH TANKS LARGER THAN 5 GALLONS);

C) BIODEGRADABLE LUBRICANTS AND FLUIDS SHALL BE USED ON EQUIPMENT OPERATING IN AND ADJACENT TO THE STREAM CHANNEL AND LIVE WATER.

D) INSPECTED DAILY FOR FLUID LEAKS BEFORE LEAVING THE VEHICLE STAGING AREA FOR OPERATION WITHIN 150 FEET OF ANY NATURAL WATER BODY OR WETLAND; AND

E) THOROUGHLY CLEANED BEFORE OPERATION BELOW ORDINARY HIGH WATER, AND AS OFTEN AS NECESSARY DURING OPERATION, TO REMAIN GREASE FREE.

9) EROSION CONTROL. EROSION CONTROL MEASURES WILL BE PREPARED AND CARRIED OUT, COMMENSURATE IN SCOPE WITH THE ACTION, THAT MAY INCLUDE THE FOLLOWING:

A) TEMPORARY EROSION CONTROLS.

I. TEMPORARY EROSION CONTROLS WILL BE IN PLACE BEFORE ANY SIGNIFICANT ALTERATION OF THE ACTION SITE AND APPROPRIATELY INSTALLED DOWNSLOPE OF PROJECT ACTIVITY WITHIN THE RIPARIAN BUFFER AREA UNTIL SITE REHABILITATION IS COMPLETE.

II. IF THERE IS A POTENTIAL FOR ERODED SEDIMENT TO ENTER THE STREAM, SEDIMENT BARRIERS WILL BE INSTALLED AND MAINTAINED FOR THE DURATION OF PROJECT IMPLEMENTATION.

III. TEMPORARY EROSION CONTROL MEASURES MAY INCLUDE FIBER WATTLES, SILT FENCES, JUTE MATTING, WOOD FIBER MULCH AND SOIL BINDER, OR GEOTEXTILES AND GEOSYNTHETIC FABRIC.

IV. SOIL STABILIZATION UTILIZING WOOD FIBER MULCH AND TACKIFIER (HYDRO-APPLIED) MAY BE USED TO REDUCE EROSION OF BARE SOIL IF THE MATERIALS ARE NOXIOUS WEED FREE AND NONTOXIC TO AQUATIC AND TERRESTRIAL ANIMALS, SOIL MICROORGANISMS, AND VEGETATION. SEDIMENT WILL BE REMOVED FROM EROSION CONTROLS ONCE IT HAS REACHED 1/3 OF THE EXPOSED HEIGHT OF THE CONTROL.

IIV. ONCE THE SITE IS STABILIZED AFTER CONSTRUCTION, TEMPORARY EROSION CONTROL MEASURES WILL BE REMOVED.

B) EMERGENCY EROSION CONTROLS. THE FOLLOWING MATERIALS FOR EMERGENCY EROSION CONTROL WILL BE AVAILABLE AT THE WORK SITE:

I. A SUPPLY OF SEDIMENT CONTROL MATERIALS; AND

II. AN OIL-ABSORBING FLOATING BOOM WHENEVER SURFACE WATER IS PRESENT.

10) DUST ABATEMENT. THE PROJECT SPONSOR WILL DETERMINE THE APPROPRIATE DUST CONTROL MEASURES BY CONSIDERING SOIL TYPE, EQUIPMENT USAGE, PREVAILING WIND DIRECTION, AND THE EFFECTS CAUSED BY OTHER EROSION AND SEDIMENT CONTROL MEASURES. IN ADDITION, THE FOLLOWING CRITERIA WILL BE FOLLOWED:

A) WORK WILL BE SEQUENCED AND SCHEDULED TO REDUCE EXPOSED BARE SOIL SUBJECT TO WIND EROSION.

B) DUST-ABATEMENT ADDITIVES AND STABILIZATION CHEMICALS (TYPICALLY MAGNESIUM CHLORIDE, CALCIUM CHLORIDE SALTS, OR LIGNINSULFONATE) WILL NOT BE APPLIED WITHIN 25 FEET OF WATER OR A STREAM CHANNEL AND WILL BE APPLIED SO AS TO MINIMIZE THE LIKELIHOOD THAT THEY WILL ENTER STREAMS. APPLICATIONS OF LIGNINSULFONATE WILL BE LIMITED TO A MAXIMUM RATE OF 0.5 GALLONS PER SQUARE YARD OF ROAD SURFACE, ASSUMING A 50:50 (LIGNINSULFONATE TO WATER) SOLUTION.

C) APPLICATION OF DUST ABATEMENT CHEMICALS WILL BE AVOIDED DURING OR JUST BEFORE WET WEATHER, AND AT STREAM CROSSINGS OR OTHER AREAS THAT COULD RESULT IN UNFILTERED DELIVERY OF THE DUST ABATEMENT MATERIALS TO A WATERBODY (TYPICALLY THESE WOULD BE AREAS WITHIN 25 FEET OF A WATERBODY OR STREAM CHANNEL; DISTANCES MAY BE GREATER WHERE VEGETATION IS SPARSE OR SLOPES ARE STEEP).

D) SPILL CONTAINMENT EQUIPMENT WILL BE AVAILABLE DURING APPLICATION OF DUST ABATEMENT CHEMICALS.

E) PETROLEUM-BASED PRODUCTS WILL NOT BE USED FOR DUST ABATEMENT.

11) SPILL PREVENTION, CONTROL, AND COUNTER MEASURES. THE USE OF MECHANIZED MACHINERY INCREASES THE RISK FOR ACCIDENTAL SPILLS OF FUEL, LUBRICANTS, HYDRAULIC FLUID, OR OTHER CONTAMINANTS INTO THE RIPARIAN ZONE OR DIRECTLY INTO THE WATER. ADDITIONALLY, UNCURED CONCRETE AND FORM MATERIALS ADJACENT TO THE ACTIVE STREAM CHANNEL MAY RESULT IN ACCIDENTAL DISCHARGE INTO THE WATER. THESE CONTAMINANTS CAN DEGRADE HABITAT, AND INJURE OR KILL AQUATIC FOOD ORGANISMS AND ESA-LISTED SPECIES. THE PROJECT SPONSOR WILL ADHERE TO THE FOLLOWING MEASURES:

A) A DESCRIPTION OF HAZARDOUS MATERIALS THAT WILL BE USED, INCLUDING INVENTORY, STORAGE, AND HANDLING PROCEDURES WILL BE AVAILABLE ON-SITE.

B) WRITTEN PROCEDURES FOR NOTIFYING ENVIRONMENTAL RESPONSE AGENCIES WILL BE POSTED AT THE WORK SITE.

C) SPILL CONTAINMENT KITS (INCLUDING INSTRUCTIONS FOR CLEANUP AND DISPOSAL) ADEQUATE FOR THE TYPES AND QUANTITY OF HAZARDOUS MATERIALS USED AT THE SITE WILL BE AVAILABLE AT THE WORK SITE.

D) WORKERS WILL BE TRAINED IN SPILL CONTAINMENT PROCEDURES AND WILL BE INFORMED OF THE LOCATION OF SPILL CONTAINMENT KITS.

E) ANY WASTE LIQUIDS GENERATED AT THE STAGING AREAS WILL BE TEMPORARILY STORED UNDER AN IMPERVIOUS COVER, SUCH AS A TARPAULIN, UNTIL THEY CAN BE PROPERLY TRANSPORTED TO AND DISPOSED OF AT A FACILITY THAT IS APPROVED FOR RECEIPT OF HAZARDOUS MATERIALS.

WORK AREA ISOLATION & FISH SALVAGE.

ANY WORK AREA WITHIN THE WETTED CHANNEL WILL BE ISOLATED FROM THE ACTIVE STREAM WHENEVER ESA-LISTED FISH ARE REASONABLY CERTAIN TO BE PRESENT, OR IF THE WORK AREA IS LESS THAN 300-FEET UPSTREAM FROM KNOWN SPAWNING HABITATS. WHEN WORK AREA ISOLATION IS REQUIRED, DESIGN PLANS WILL INCLUDE ALL ISOLATION ELEMENTS, FISH RELEASE AREAS, AND, WHEN A PUMP IS USED TO DEWATER THE ISOLATION AREA AND FISH ARE PRESENT, A FISH SCREEN THAT MEETS NMFS'S FISH SCREEN CRITERIA (NMFS 2011, OR MOST CURRENT). WORK AREA ISOLATION AND FISH CAPTURE ACTIVITIES WILL OCCUR DURING PERIODS OF THE COOLEST AIR AND WATER TEMPERATURES POSSIBLE, NORMALLY EARLY IN THE MORNING VERSUS LATE IN THE DAY, AND DURING CONDITIONS APPROPRIATE TO MINIMIZE STRESS AND DEATH OF SPECIES PRESENT.

- NATIONAL MARINE FISHERIES SERVICE. 2011. ANADROMOUS SALMONID PASSAGE FACILITY DESIGN. NORTHWEST REGION. AVAILABLE ONLINE AT:
HTTP://WWW.NWR.NOAA.GOV/SALMON-HYDROPOWER/FERC/UPLOAD/FISH-PASSAGE-DESIGN.PDF
- U.S. FISH AND WILDLIFE SERVICE. 2010. BEST MANAGEMENT PRACTICES TO MINIMIZE ADVERSE EFFECTS TO PACIFIC LAMPREY.
HTTP://WWW.FWS.GOV/PACIFIC/FISHERIES/SPHABCON/LAMPREY/PDF/BEST%20MANAGEMENT%20PRACTICES%20FOR%20PACIFIC%20LAMPREY%20APRIL%202010%20VERSION.PDF

FOR SALVAGE OPERATIONS IN KNOWN BULL TROUT SPAWNING AND REARING HABITAT, ELECTROFISHING SHALL ONLY OCCUR FROM MAY 1 TO JULY 31. NO ELECTROFISHING WILL OCCUR IN ANY BULL TROUT OCCUPIED HABITAT AFTER AUGUST 15. BULL TROUT ARE VERY TEMPERATURE SENSITIVE AND GENERALLY SHOULD NOT BE ELECTROSHOCKED OR OTHERWISE HANDLED WHEN TEMPERATURES EXCEED 15 DEGREES CELSIUS. SALVAGE ACTIVITIES SHOULD TAKE PLACE DURING PERIODS OF THE COOLEST AIR AND WATER TEMPERATURES POSSIBLE, NORMALLY EARLY IN THE MORNING VERSUS LATE IN THE DAY, AND DURING CONDITIONS APPROPRIATE TO MINIMIZE STRESS TO FISH SPECIES PRESENT.

SALVAGE OPERATIONS WILL FOLLOW THE ORDERING, METHODOLOGIES, AND CONSERVATION MEASURES SPECIFIED BELOW IN STEPS 1 THROUGH 6. STEPS 1 AND 2 WILL BE IMPLEMENTED FOR ALL PROJECTS WHERE WORK AREA ISOLATION IS NECESSARY ACCORDING TO CONDITIONS ABOVE. ELECTROFISHING (STEP 3) CAN BE IMPLEMENTED TO ENSURE ALL FISH HAVE BEEN REMOVED FOLLOWING STEPS 1 AND 2, OR WHEN OTHER MEANS OF FISH CAPTURE MAY NOT BE FEASIBLE OR EFFECTIVE. DEWATERING AND REWATERING (STEPS 4 AND 5) WILL BE IMPLEMENTED UNLESS WETTED IN-STREAM WORK IS DEEMED TO BE MINIMALLY HARMFUL TO FISH, AND IS BENEFICIAL TO OTHER AQUATIC SPECIES. DEWATERING WILL NOT BE CONDUCTED IN AREAS KNOWN TO BE OCCUPIED BY LAMPREY, UNLESS LAMPREYS ARE SALVAGED USING GUIDANCE SET FORTH IN US FISH AND WILDLIFE SERVICE (2010)3.

1) ISOLATE.

A) BLOCK NETS WILL BE INSTALLED AT UPSTREAM AND DOWNSTREAM LOCATIONS AND MAINTAINED IN A SECURED POSITION TO EXCLUDE FISH FROM ENTERING THE PROJECT AREA.

B) BLOCK NETS WILL BE SECURED TO THE STREAM CHANNEL BED AND BANKS UNTIL FISH CAPTURE AND TRANSPORT ACTIVITIES ARE COMPLETE. BLOCK NETS MAY BE LEFT IN PLACE FOR THE DURATION OF THE PROJECT TO EXCLUDE FISH.

C) IF BLOCK NETS REMAIN IN PLACE MORE THAN ONE DAY, THE NETS WILL BE MONITORED AT LEAST DAILY TO ENSURE THEY ARE SECURED TO THE BANKS AND FREE OF ORGANIC ACCUMULATION. IF THE PROJECT IS WITHIN BULL TROUT SPAWNING AND REARING HABITAT, THE BLOCK NETS MUST BE CHECKED EVERY FOUR HOURS FOR FISH IMPINGEMENT ON THE NET. LESS FREQUENT INTERVALS MUST BE APPROVED THROUGH A VARIANCE REQUEST.

D) NETS WILL BE MONITORED HOURLY ANYTIME THERE IS INSTREAM DISTURBANCE.

2) SALVAGE. AS DESCRIBED BELOW, FISH TRAPPED WITHIN THE ISOLATED WORK AREA WILL BE CAPTURED TO MINIMIZE THE RISK OF INJURY, THEN RELEASED AT A SAFE SITE:

A) REMOVE AS MANY FISH AS POSSIBLE PRIOR TO DEWATERING.

B) DURING DEWATERING, ANY REMAINING FISH WILL BE COLLECTED BY HAND OR DIP NETS.

C) SEINES WITH A MESH SIZE TO ENSURE CAPTURE OF THE RESIDING ESA-LISTED FISH WILL BE USED.

D) MINNOW TRAPS WILL BE LEFT IN PLACE OVERNIGHT AND USED IN CONJUNCTION WITH SEINING.

E) IF BUCKETS ARE USED TO TRANSPORT FISH:

I. THE TIME FISH ARE IN A TRANSPORT BUCKET WILL BE LIMITED, AND WILL BE RELEASED AS QUICKLY AS POSSIBLE;

II. THE NUMBER OF FISH WITHIN A BUCKET WILL BE LIMITED BASED ON SIZE, AND FISH WILL BE OF RELATIVELY COMPARABLE SIZE TO MINIMIZE PREDATION;

III. AERATORS FOR BUCKETS WILL BE USED OR THE BUCKET WATER WILL BE FREQUENTLY CHANGED WITH COLD CLEAR WATER AT 15 MINUTE OR MORE FREQUENT INTERVALS.

IV. BUCKETS WILL BE KEPT IN SHADED AREAS OR WILL BE COVERED BY A CANOPY IN EXPOSED AREAS.

V. DEAD FISH WILL NOT BE STORED IN TRANSPORT BUCKETS, BUT WILL BE LEFT ON THE STREAM BANK TO AVOID MORTALITY COUNTING ERRORS.

F) AS RAPIDLY AS POSSIBLE (ESPECIALLY FOR TEMPERATURE-SENSITIVE BULL TROUT), FISH WILL BE RELEASED IN AN AREA THAT PROVIDES ADEQUATE COVER AND FLOW REFUGE. UPSTREAM RELEASE IS GENERALLY PREFERRED, BUT FISH RELEASED DOWNSTREAM WILL BE SUFFICIENTLY OUTSIDE OF THE INFLUENCE OF CONSTRUCTION.

G) SALVAGE WILL BE SUPERVISED BY A QUALIFIED FISHERIES BIOLOGIST EXPERIENCED WITH WORK AREA ISOLATION AND COMPETENT TO ENSURE THE SAFE HANDLING OF ALL FISH.

3) ELECTROFISHING. ELECTROFISHING WILL BE USED ONLY AFTER OTHER SALVAGE METHODS HAVE BEEN EMPLOYED OR WHEN OTHER MEANS OF FISH CAPTURE ARE DETERMINED TO NOT BE FEASIBLE OR EFFECTIVE. IF ELECTROFISHING WILL BE USED TO CAPTURE FISH FOR SALVAGE, THE SALVAGE OPERATION WILL BE LED BY AN EXPERIENCED FISHERIES BIOLOGIST AND THE FOLLOWING GUIDELINES WILL BE FOLLOWED:

A) THE NMFS'S ELECTROFISHING GUIDELINES (NMFS 2000).

B) ONLY DIRECT CURRENT (DC) OR PULSED DIRECT CURRENT (PDC) WILL BE USED AND CONDUCTIVITY MUST BE TESTED.

I. IF CONDUCTIVITY IS LESS THAN 100 MS, VOLTAGE RANGES FROM 900 TO 1100 WILL BE USED.

II. FOR CONDUCTIVITY RANGES BETWEEN 100 TO 300 MS, VOLTAGE RANGES WILL BE 500 TO 800.

III. FOR CONDUCTIVITY GREATER THAN 300 MS, VOLTAGE WILL BE LESS THAN 400.

C) ELECTROFISHING WILL BEGIN WITH A MINIMUM PULSE WIDTH AND RECOMMENDED VOLTAGE AND THEN GRADUALLY INCREASE TO THE POINT WHERE FISH ARE IMMOBILIZED.

D) THE ANODE WILL NOT INTENTIONALLY CONTACT FISH.

E) ELECTROFISHING SHALL NOT BE CONDUCTED WHEN THE WATER CONDITIONS ARE TURBID AND VISIBILITY IS POOR. THIS CONDITION MAY BE EXPERIENCED WHEN THE SAMPLER CANNOT SEE THE STREAM BOTTOM IN ONE FOOT OF WATER.

F) IF MORTALITY OR OBVIOUS INJURY (DEFINED AS DARK BANDS ON THE BODY, SPINAL DEFORMATIONS, DE-SCALING OF 25% OR MORE OF BODY, AND TORPIDITY OR INABILITY TO MAINTAIN UPRIGHT ATTITUDE AFTER SUFFICIENT RECOVERY TIME) OCCURS DURING ELECTROFISHING, OPERATIONS WILL BE IMMEDIATELY DISCONTINUED, MACHINE SETTINGS, WATER TEMPERATURE AND CONDUCTIVITY CHECKED, AND PROCEDURES ADJUSTED OR ELECTROFISHING POSTPONED TO REDUCE MORTALITY.

4) DEWATER. DEWATERING, WHEN NECESSARY, WILL BE CONDUCTED OVER A SUFFICIENT PERIOD OF TIME TO ALLOW SPECIES TO NATURALLY MIGRATE OUT OF THE WORK AREA AND WILL BE LIMITED TO THE SHORTEST LINEAR EXTENT PRACTICABLE.

A) DIVERSION AROUND THE CONSTRUCTION SITE MAY BE ACCOMPLISHED WITH A COFFER DAM AND A BY-PASS CULVERT OR PIPE, OR A LINED, NON-ERODIBLE DIVERSION DITCH. WHERE GRAVITY FEED IS NOT POSSIBLE, A PUMP MAY BE USED, BUT MUST BE OPERATED IN SUCH A WAY AS TO AVOID REPETITIVE DEWATERING AND REWATERING OF THE SITE. IMPOUNDMENT BEHIND THE COFFERDAM MUST OCCUR SLOWLY THROUGH THE TRANSITION, WHILE CONSTANT FLOW IS DELIVERED TO THE DOWNSTREAM REACHES.

B) ALL PUMPS WILL HAVE FISH SCREENS TO AVOID JUVENILE FISH IMPINGEMENT OR ENTRAINMENT, AND WILL BE OPERATED IN ACCORDANCE WITH NMFS'S CURRENT FISH SCREEN CRITERIA (NMFS 20114, OR MOST RECENT VERSION). IF THE PUMPING RATE EXCEEDS 3 CUBIC FEET SECOND (CFS), A NMFS HYDRO FISH PASSAGE REVIEW WILL BE NECESSARY.

C) DISSIPATION OF FLOW ENERGY AT THE BYPASS OUTFLOW WILL BE PROVIDED TO PREVENT DAMAGE TO RIPARIAN VEGETATION OR STREAM CHANNEL.

D) SAFE REENTRY OF FISH INTO THE STREAM CHANNEL WILL BE PROVIDED, PREFERABLY INTO POOL HABITAT WITH COVER, IF THE DIVERSION ALLOWS FOR DOWNSTREAM FISH PASSAGE.

E) SEEPAGE WATER WILL BE PUMPED TO A TEMPORARY STORAGE AND TREATMENT SITE OR INTO UPLAND AREAS TO ALLOW WATER TO PERCOLATE THROUGH SOIL OR TO FILTER THROUGH VEGETATION PRIOR TO REENTERING THE STREAM CHANNEL.

4 NATIONAL MARINE FISHERIES SERVICE. 2011. ANADROMOUS SALMONID PASSAGE FACILITY DESIGN. NORTHWEST REGION. AVAILABLE ONLINE AT:
HTTP://WWW.NWR.NOAA.GOV/SALMON-HYDROPOWER/FERC/UPLOAD/FISH-PASSAGE-DESIGN.PDF

5) SALVAGE NOTICE. MONITORING AND RECORDING OF FISH PRESENCE, HANDLING, AND MORTALITY MUST OCCUR DURING THE DURATION OF THE ISOLATION, SALVAGE, ELECTROFISHING, DEWATERING, AND REWATERING OPERATIONS. ONCE OPERATIONS ARE COMPLETED, A SALVAGE REPORT WILL DOCUMENT PROCEDURES USED, ANY FISH INJURIES OR DEATHS (INCLUDING NUMBERS OF FISH AFFECTED), AND CAUSES OF ANY DEATHS.

CONSTRUCTION AND POST-CONSTRUCTION CONSERVATION MEASURES.

1) FISH PASSAGE. FISH PASSAGE WILL BE PROVIDED FOR ANY ADULT OR JUVENILE FISH LIKELY TO BE PRESENT IN THE ACTION AREA DURING CONSTRUCTION, UNLESS PASSAGE DID NOT EXIST BEFORE CONSTRUCTION OR THE STREAM IS NATURALLY IMPASSABLE AT THE TIME OF CONSTRUCTION. IF THE PROVISION OF TEMPORARY FISH PASSAGE DURING CONSTRUCTION WILL INCREASE NEGATIVE EFFECTS ON AQUATIC SPECIES OF INTEREST OR THEIR HABITAT, A VARIANCE CAN BE REQUESTED FROM THE NMFS BRANCH CHIEF AND THE FWS FIELD OFFICE SUPERVISOR. PERTINENT INFORMATION, SUCH AS THE SPECIES AFFECTED, LENGTH OF STREAM REACH AFFECTED, PROPOSED TIME FOR THE PASSAGE BARRIER, AND ALTERNATIVESCONSIDERED, WILL BE INCLUDED IN THE VARIANCE REQUEST.

2) CONSTRUCTION AND DISCHARGE WATER.

A) SURFACE WATER MAY BE DIVERTED TO MEET CONSTRUCTION NEEDS, BUT ONLY IF DEVELOPED SOURCES ARE UNAVAILABLE OR INADEQUATE.

B) DIVERSIONS WILL NOT EXCEED 10% OF THE AVAILABLE FLOW.

C) ALL CONSTRUCTION DISCHARGE WATER WILL BE COLLECTED AND TREATED USING THE BEST AVAILABLE TECHNOLOGY APPLICABLE TO SITE CONDITIONS.

D) TREATMENTS TO REMOVE DEBRIS, NUTRIENTS, SEDIMENT, PETROLEUM HYDROCARBONS, METALS AND OTHER POLLUTANTS LIKELY TO BE PRESENT WILL BE PROVIDED.

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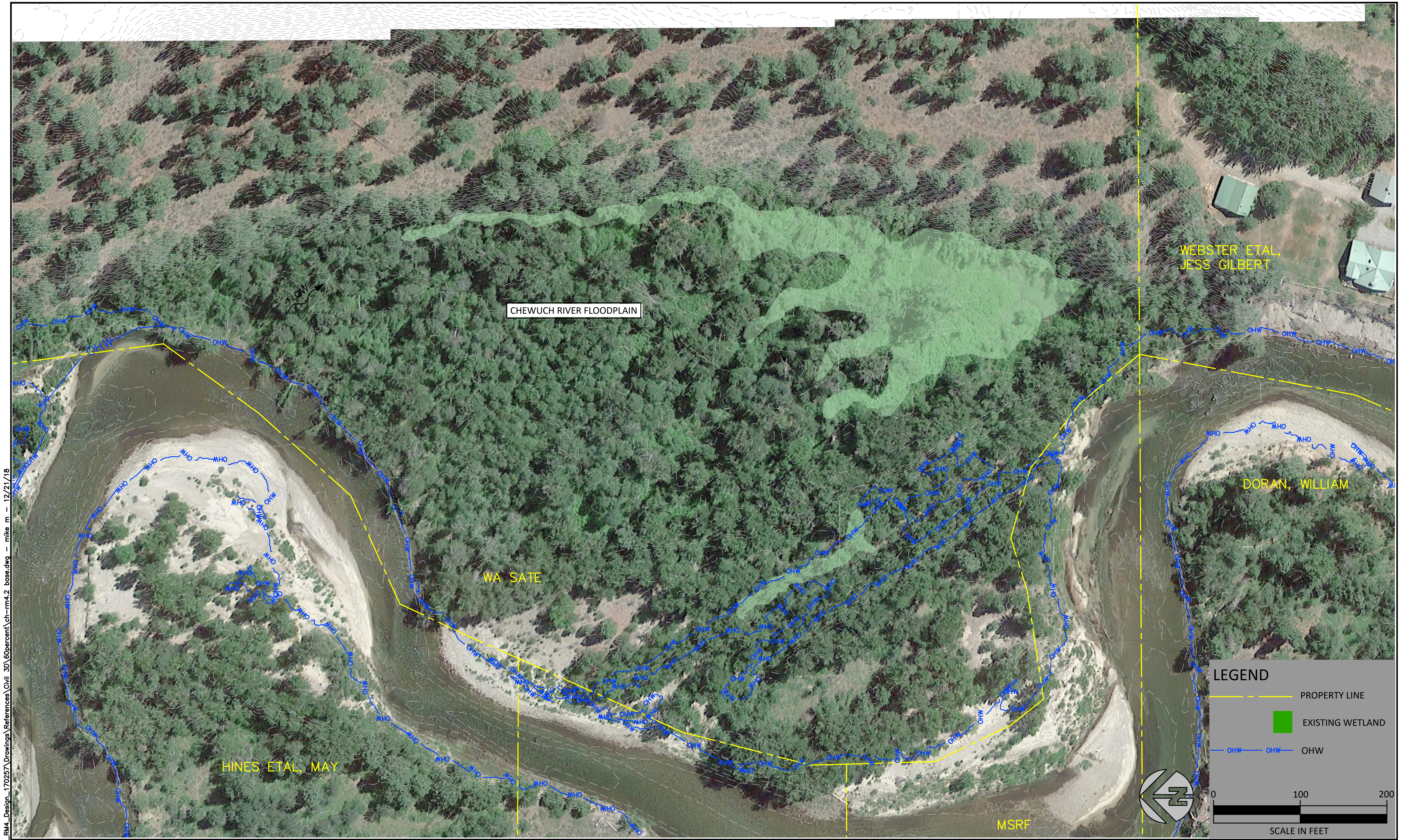
NO.	BY	DATE	REVISION DESCRIPTION

MM, GS (DRAWN) | MB (DESIGNED) | CB (CHECKED)
---- (APPROVED) | 12/18/18 (DATE) | PROJECT

YAKAMA NATION FISHERIES PROGRAM
CHEWUCH RIVER MILE 4.2
FISH HABITAT ENHANCEMENT

inter-fluve
501 Portway Avenue, Suite 101
Hood River, OR 97031
541.386.9003
www.interfluve.com

HIP-III GENERAL NOTES (2 OF 2)



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DRAWN	DESIGNED	CHECKED
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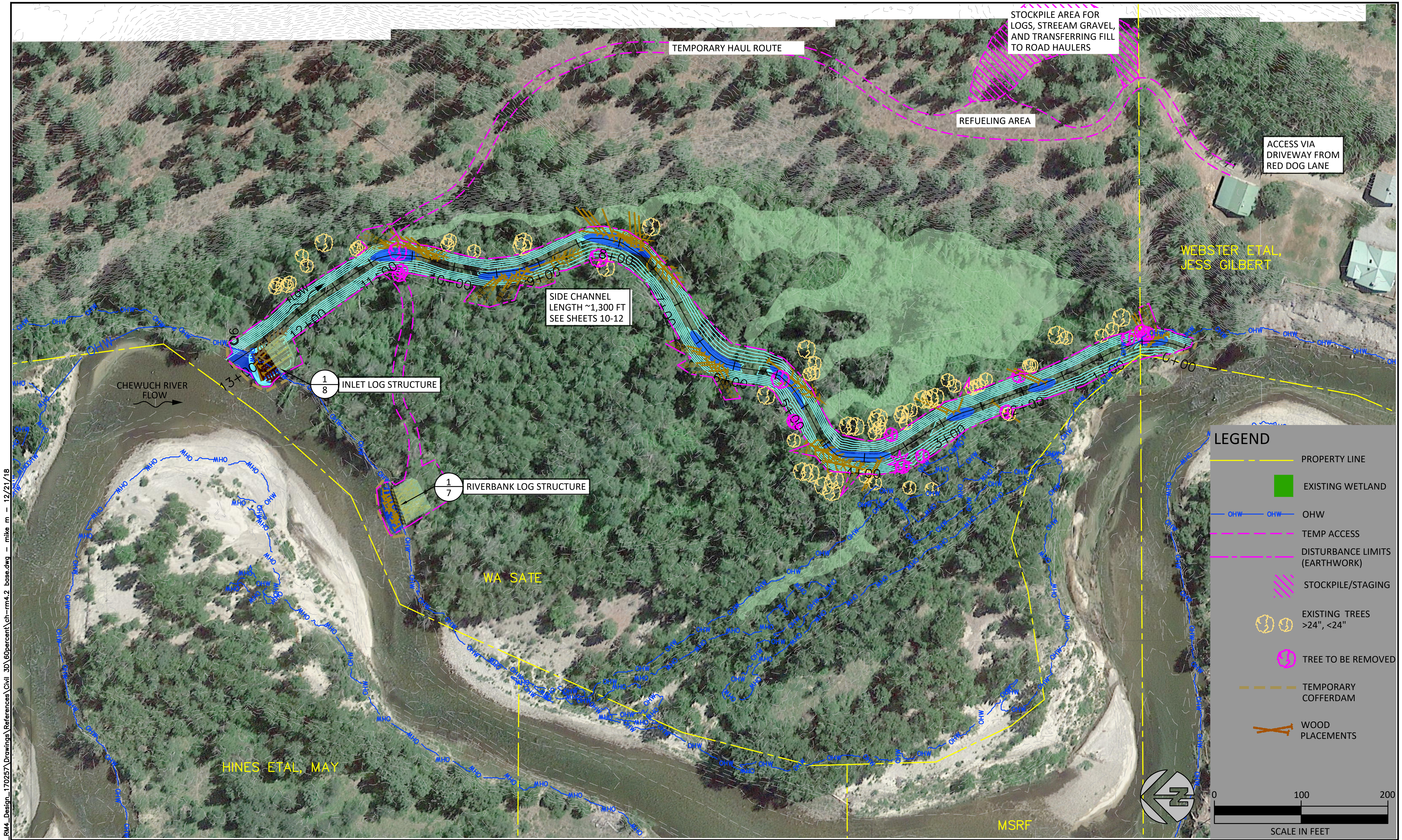
PROJECT SITE
EXISTING CONDITIONS

SHEET
5 OF 13



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YAKAMA NATION FISHERIES PROGRAM
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FISH HABITAT ENHANCEMENT

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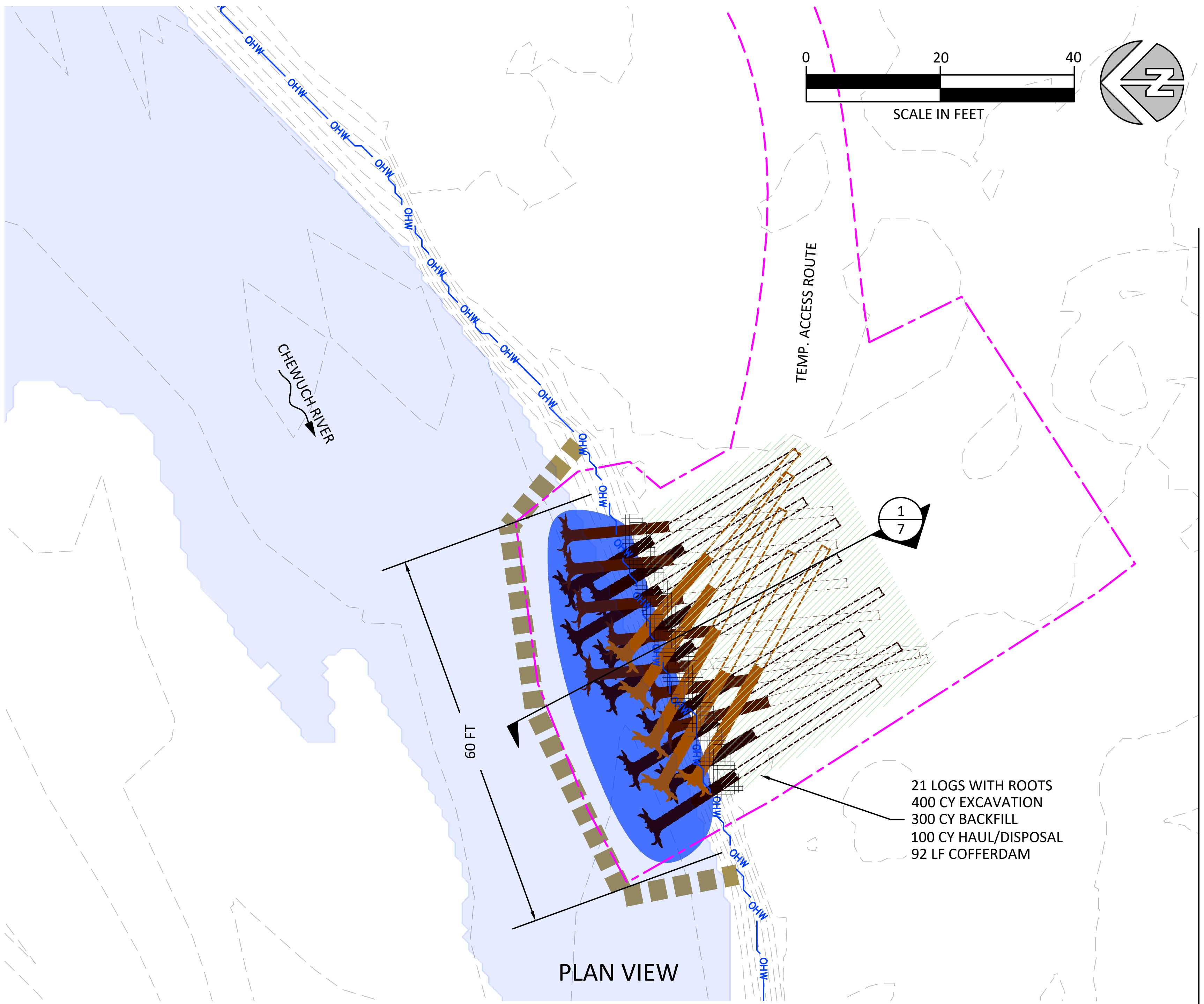
PROJECT SITE
DESIGN OVERVIEW

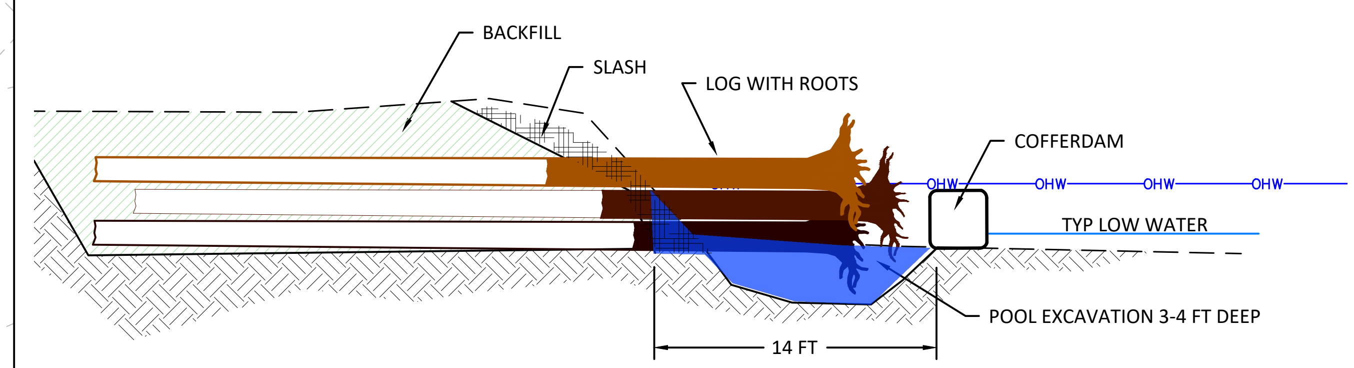
SHEET
6 OF 13



PLAN VIEW

LEGEND

- ACCESS
- DISTURBANCE LIMITS (EARTHWORK)
- COFFERDAM
- ORDINARY HIGH WATER (OHW)
- TYPICAL LOW WATER
- EXCAVATION BELOW OHW
- LOG BURIAL AREA



1/7 SECTION VIEW - PARTIALLY BURIED LOG STRUCTURE

LOG NOTES

1. LOG LOCATIONS, SIZE, AND ALIGNMENTS DEPICTED HERE ARE TYPICAL. SOME ADJUSTMENTS IN THE FIELD MAY OCCUR BASED ON ACTUAL MATERIALS.
2. SHURBS AND SLASH GENERATED FROM SITE ACCESS SHALL BE INCORPORATED INTO THE STRUCTURES AS SLASH. INSTALL SLASH LOOSELY BETWEEN LOGS NEAR THE WATERWARD EDGE OF THE STRUCTURE. DO NOT BURY SLASH.

JURISDICTIONAL AREA IMPACTS

ACTIVITY	IMPACT LOCATION	DURATION OF IMPACT	VOLUME OF MATERIAL PLACED OR REMOVAL	LENGTH (LF) OF IMPACT
LARGE WOOD PLACEMENT	WATER	PERMANENT	6 CY PLACED	56 LF
POOL EXCAVATION	WATER	PERMANENT	90 CY REMOVED	60 LF (800 SF)
COFFERDAM	WATER	TEMPORARY (2 DAYS)	–	70 LF

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NO.	BY	DATE	REVISION DESCRIPTION

MM, GS DRAWN | MB DESIGNED | CB CHECKED
---- APPROVED | 12/18/18 DATE | PROJECT

YAKAMA NATION FISHERIES PROGRAM
CHEWUCH RIVER MILE 4.2
FISH HABITAT ENHANCEMENT

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Hood River, OR 97031
541.386.9003
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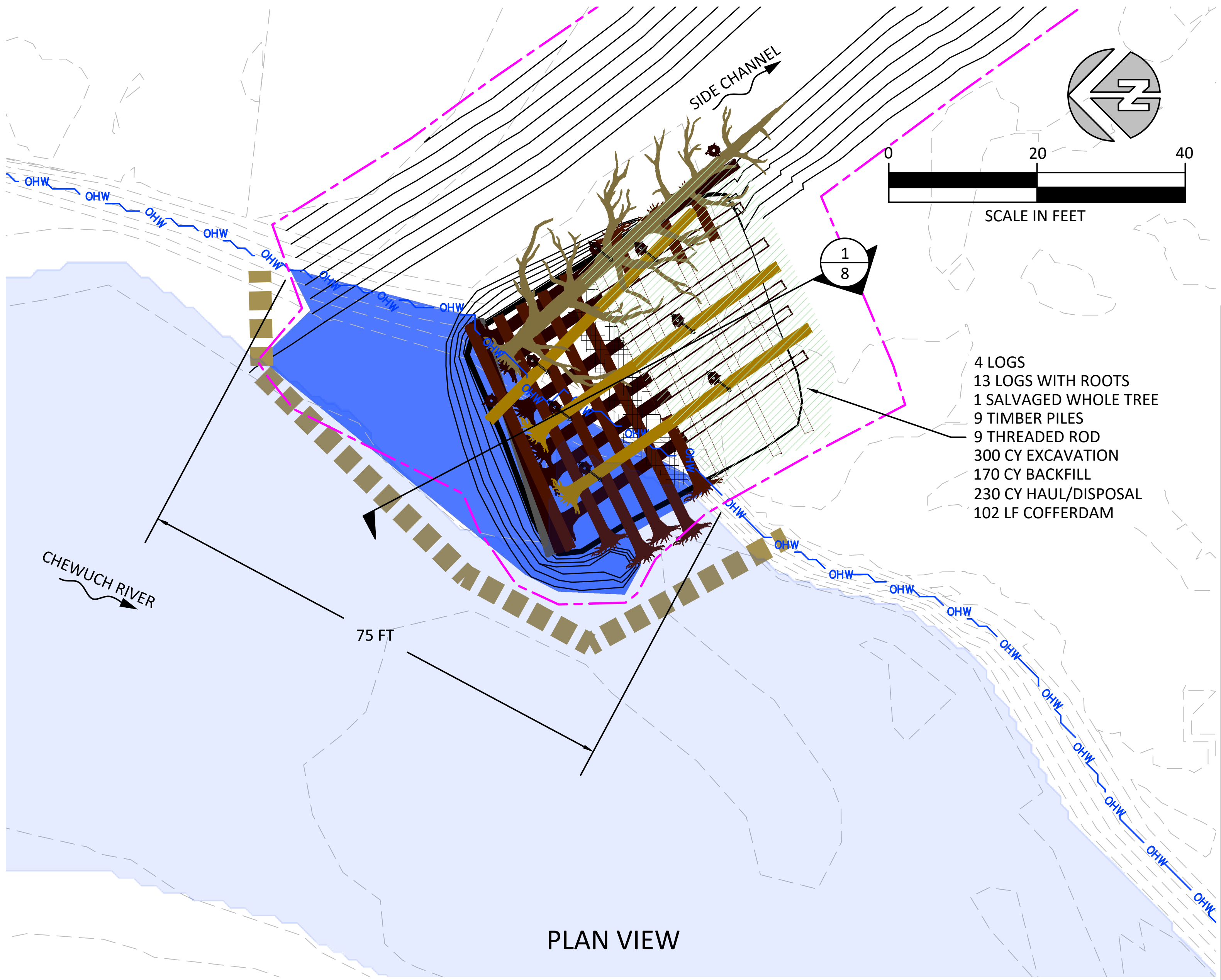
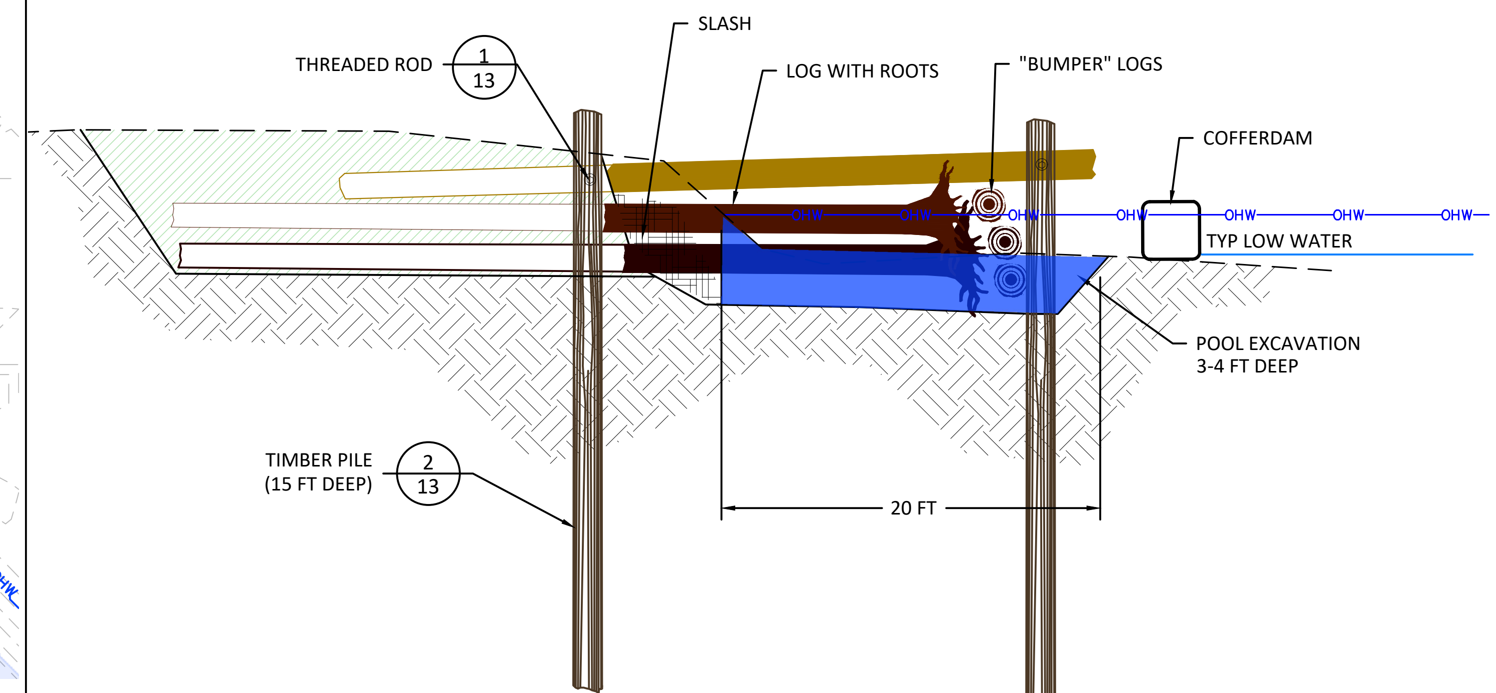
RIVERBANK LOG STRUCTURE



PLAN VIEW

LEGEND

- ACCESS
- DISTURBANCE LIMITS (EARTHWORK)
- COFFERDAM
- ORDINARY HIGH WATER (OHW)
- TYPICAL LOW WATER
- EXCAVATION BELOW OHW
- LOG BURIAL AREA



1/8 SECTION VIEW - INLET LOG STRUCTURE

JURISDICTIONAL AREA IMPACTS				
ACTIVITY	IMPACT LOCATION	DURATION OF IMPACT	VOLUME OF MATERIAL PLACED OR REMOVAL	LENGTH (LF) OF IMPACT
LARGE WOOD PLACEMENT	WATER	PERMANENT	10 CY PLACED	40 LF
EXCAVATION	WATER	PERMANENT	90 CY REMOVED	75 LF (1,200 SF)
COFFERDAM	WATER	TEMPORARY (30 DAYS)	1,400 SF	102 LF

LOG NOTES

1. LOG LOCATIONS, SIZE, AND ALIGNMENTS DEPICTED HERE ARE TYPICAL. SOME ADJUSTMENTS IN THE FIELD MAY OCCUR BASED ON ACTUAL MATERIALS.
2. SHURBS AND SLASH GENERATED FROM SITE ACCESS SHALL BE INCORPORATED INTO THE STRUCTURES AS SLASH. INSTALL SLASH LOOSELY BETWEEN LOGS NEAR THE WATERWARD EDGE OF THE STRUCTURE. DO NOT BURY SLASH.
3. VARY THE APPEARANCE OF TIMBER PILES BY INSTALLING THEM AT ANGLES AND WITH DIFFERENT TOP HEIGHTS. BREAK OR ROUGHEN THE TOP OF PILES FOR A NATURAL APPEARANCE. PILES SHALL BE INSTALLED BY VIBRATORY DRIVER. PILE DEPTH SHALL BE MINIMUM 15'. FINAL DEPTH TO BE DETERMINED BY PULLOUT TEST RESULTS.

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NO.	BY	DATE	REVISION DESCRIPTION

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YAKAMA NATION FISHERIES PROGRAM
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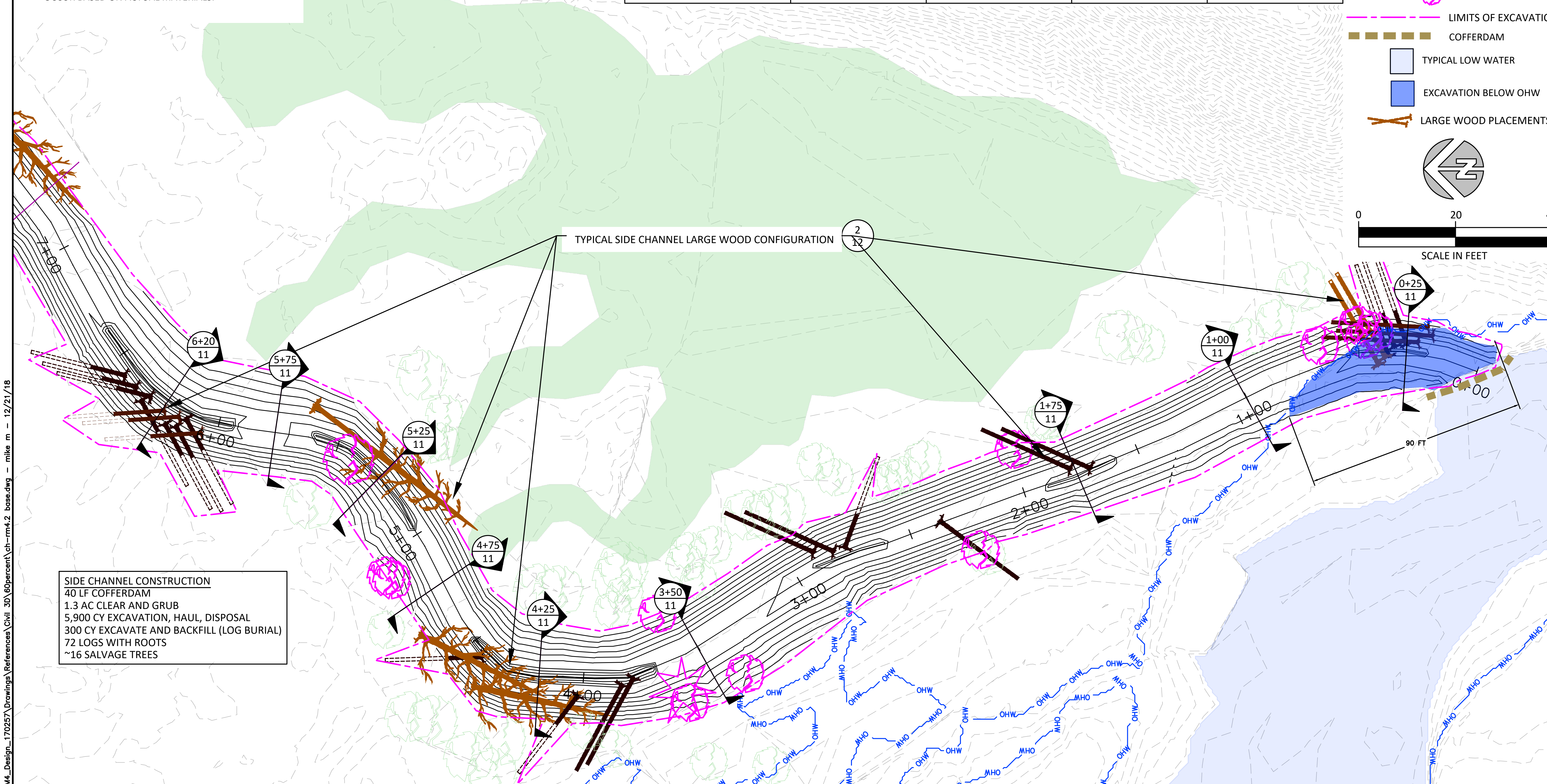
INLET LOG STRUCTURE

NOTES
1. PRESERVE TREES OUTSIDE OF THE LIMITS OF DISTURBANCE.
2. ALL TREES AND SHRUBS REMOVED FROM SIDE CHANNEL CONSTRUCTION AREA SHALL BE TEMPORARILY STORED ON FLOODPLAIN TO BE RE-USED AS SALVAGED TREES AND SLASH DURING CHANNEL CONSTRUCTION.
3. THE ACCESS ROUTE SHALL BE WITHIN THE CONSTRUCTION FOOTPRINT.
4. LOG LOCATIONS, SIZE, AND ALIGNMENTS DEPICTED HERE ARE TYPICAL. SOME ADJUSTMENTS IN THE FIELD MAY OCCUR BASED ON ACTUAL MATERIALS.

JURISDICTIONAL AREA IMPACTS (DOWNSTREAM END. SEE INLET LOG STRUCTURE FOR UPSTREAM IMPACTS)

ACTIVITY	IMPACT LOCATION	DURATION OF IMPACT	VOLUME OF MATERIAL PLACED OR REMOVAL	LENGTH (LF) OF IMPACT
LARGE WOOD PLACEMENT	WATER	PERMANENT	4 CY PLACED	40 LF
EXCAVATION	WATER	PERMANENT	166 CY REMOVED	90 LF (1,500 SF)
COFFERDAM	WATER	TEMPORARY (30 DAYS)	–	40 LF

LEGEND
- OHW — ORDINARY HIGH WATER (OHW)
- EXISTING WETLAND
- EXISTING TREES >24", <24"
- TREE TO BE REMOVED
- LIMITS OF EXCAVATION
- COFFERDAM
- TYPICAL LOW WATER
- EXCAVATION BELOW OHW
- LARGE WOOD PLACEMENTS



SIDE CHANNEL CONSTRUCTION
40 LF COFFERDAM
1.3 AC CLEAR AND GRUB
5,900 CY EXCAVATION, HAUL, DISPOSAL
300 CY EXCAVATE AND BACKFILL (LOG BURIAL)
72 LOGS WITH ROOTS
~16 SALVAGE TREES

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NO.	BY	DATE	REVISION DESCRIPTION

MM, GS DRAWN	MB DESIGNED	CB CHECKED
---- APPROVED	12/18/18 DATE	PROJECT

YAKAMA NATION FISHERIES PROGRAM
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SIDE CHANNEL PLAN VIEW
0+00 TO 7+00

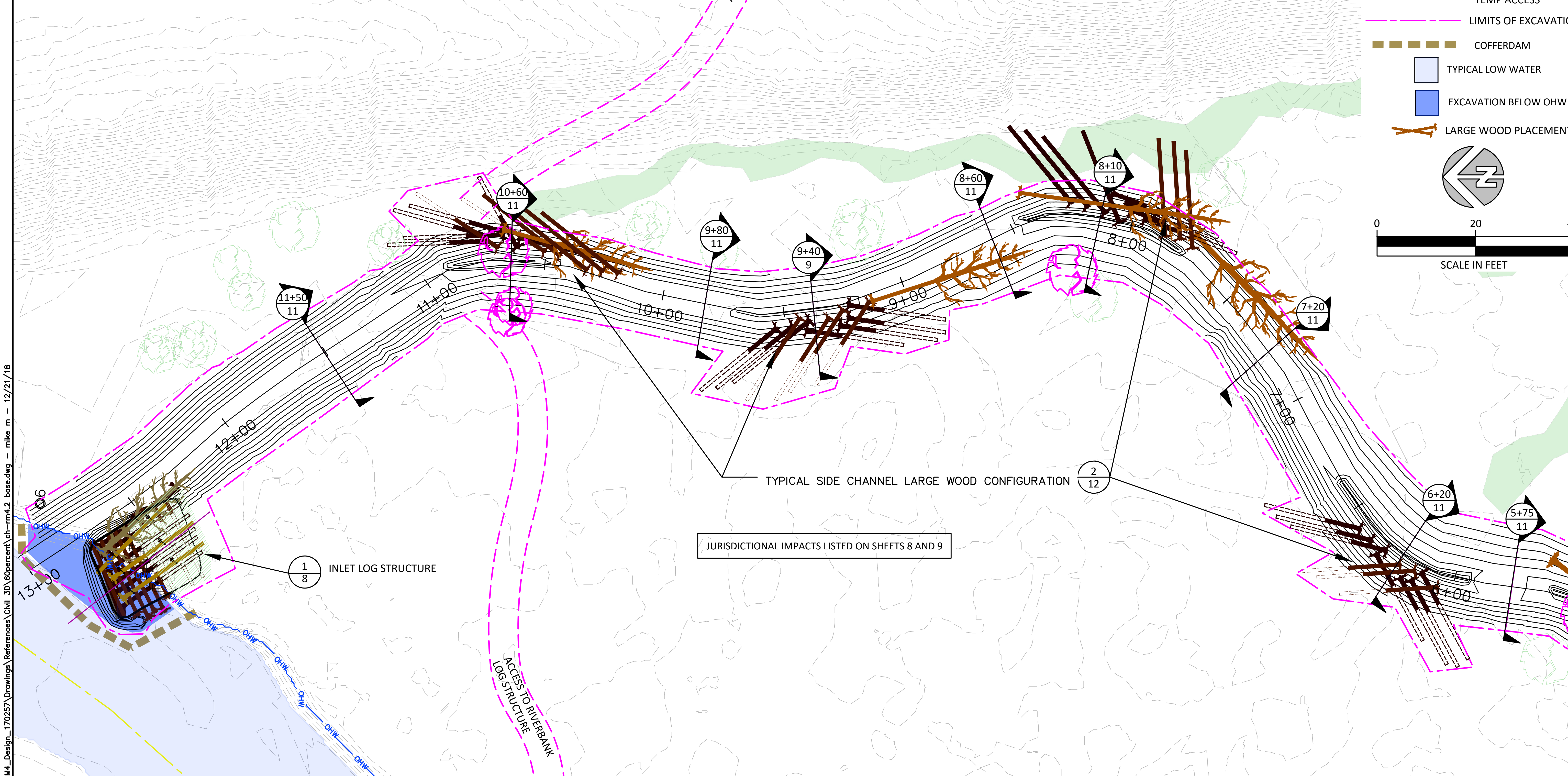
SHEET
9 OF 13

NOTES

1. PRESERVE TREES OUTSIDE OF THE LIMITS OF DISTURBANCE.
2. ALL TREES AND SHRUBS REMOVED FROM SIDE CHANNEL CONSTRUCTION AREA SHALL BE TEMPORARILY STORED ON FLOODPLAIN TO BE RE-USED AS SALVAGED TREES AND SLASH DURING CHANNEL CONSTRUCTION.
3. THE ACCESS ROUTE IS TYPICAL. ACCESS ROUTE WILL BE ADJUSTED IN FIELD TO MINIMIZE IMPACTS TO VEGETATION.
4. LOG LOCATIONS, SIZE, AND ALIGNMENTS DEPICTED HERE ARE TYPICAL. SOME ADJUSTMENTS IN THE FIELD MAY OCCUR BASED ON ACTUAL MATERIALS.

LEGEND

- OHW — ORDINARY HIGH WATER (OHW)
- EXISTING WETLAND
- EXISTING TREES >24", <24"
- TREE TO BE REMOVED
- TEMP ACCESS
- LIMITS OF EXCAVATION
- COFFERDAM
- TYPICAL LOW WATER
- EXCAVATION BELOW OHW
- LARGE WOOD PLACEMENTS



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NO.	BY	DATE	REVISION DESCRIPTION

DRAWN	DESIGNED	CHECKED
MM, GS	MB	CB
APPROVED	DATE	PROJECT
----	12/18/18	

YAKAMA NATION FISHERIES PROGRAM
CHEWUCH RIVER MILE 4.2
FISH HABITAT ENHANCEMENT

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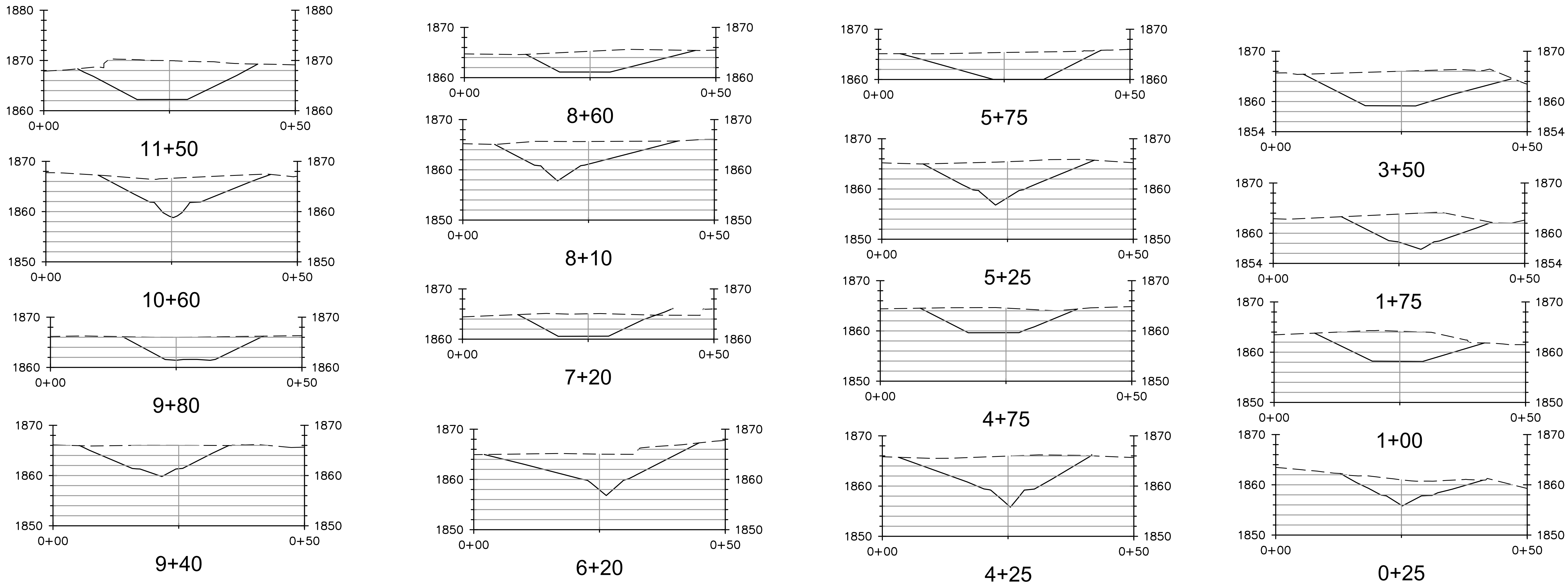
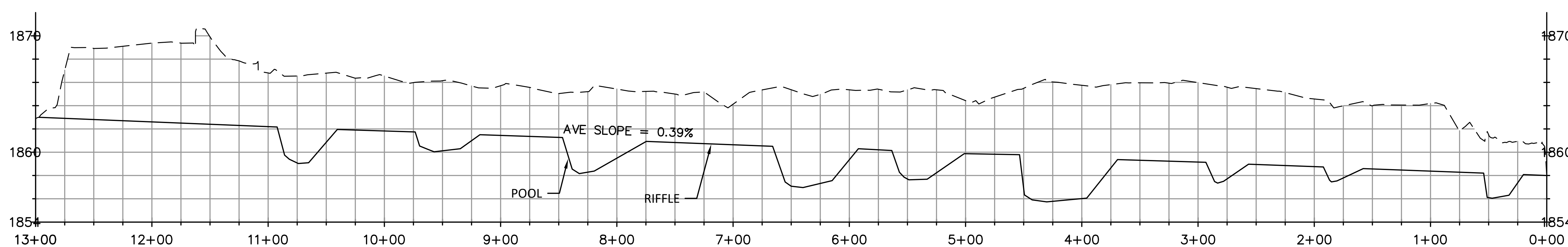
SIDE CHANNEL PLAN VIEW
7+00 TO 13+00

SHEET 10 OF 13



SECTION VIEWS



PROFILE VIEW – SIDE CHANNEL CENTERLINE

NO.	BY	DATE	REVISION DESCRIPTION

MM, GS	MB	CB
DRAWN	DESIGNED	CHECKED
----	12/18/18	
APPROVED	DATE	PROJECT

YAKAMA NATION FISHERIES PROGRAM
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SIDE CHANNEL PROFILE AND CROSS SECTIONS

SHEET 11 OF 13

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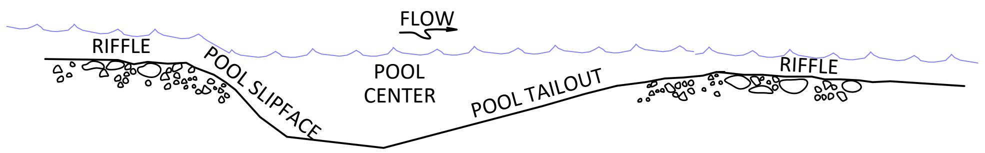
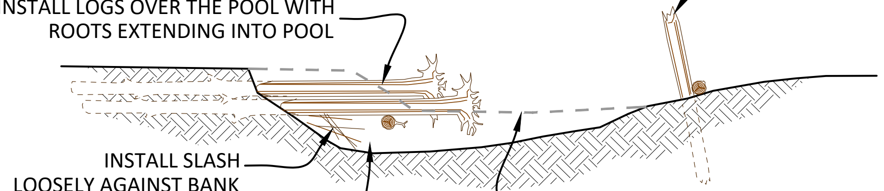


1/12 PROFILE VIEW - TYPICAL POOL AND RIFFLE

NOT TO SCALE



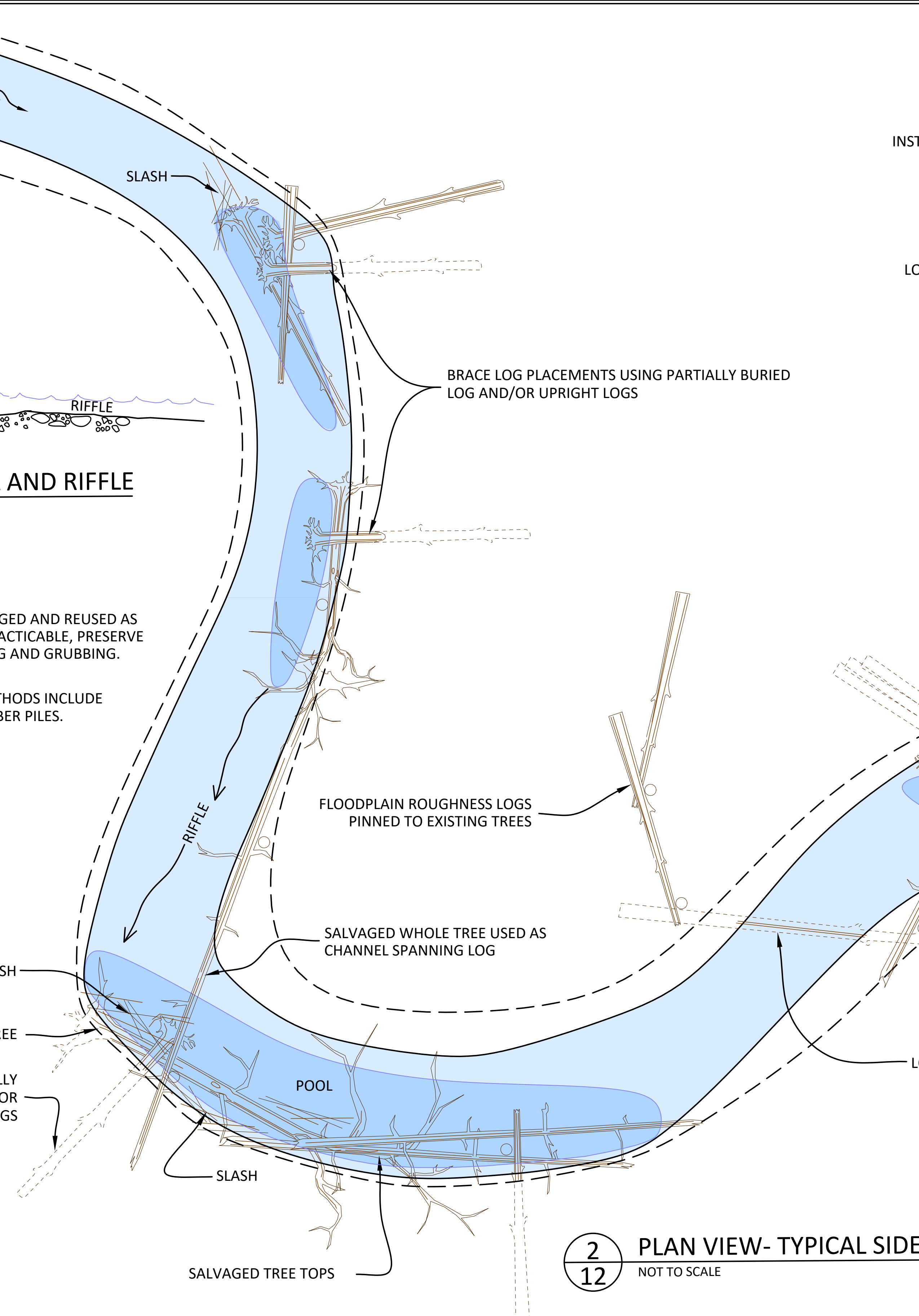
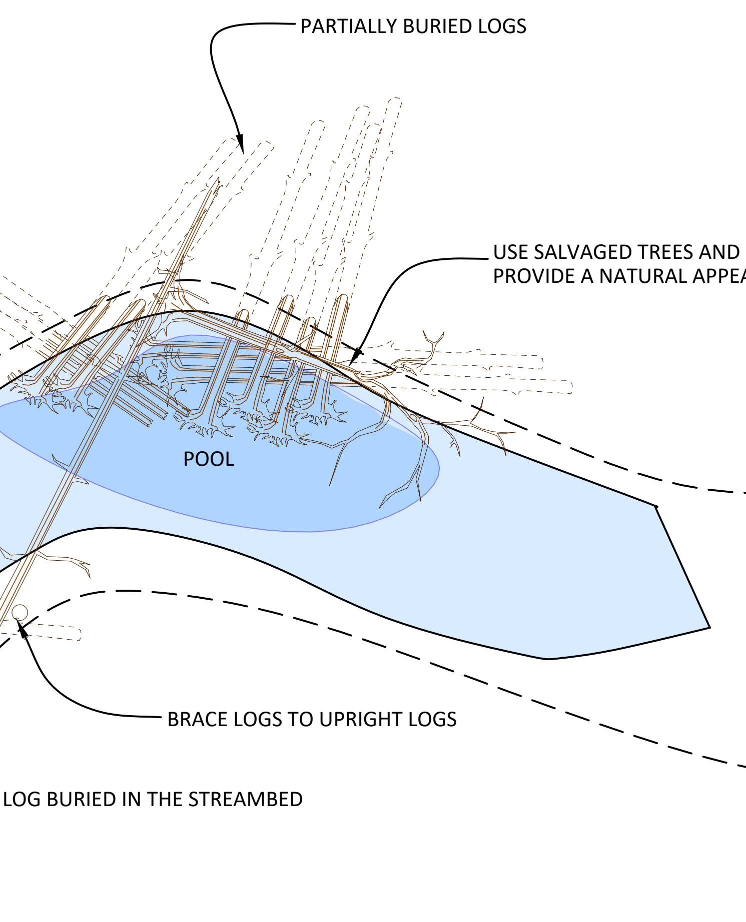
3/12 SECTION VIEW - TYPICAL POOL AND LWD

NOT TO SCALE

NOTES:

1. TREES AND SHRUBS WITHIN CLEARING LIMITS SHALL BE SALVAGED AND REUSED AS LOGS AND SLASH IN HABITAT STRUCTURES. TO THE EXTENT PRACTICABLE, PRESERVE BRANCHES AND ROOTS ON TREES REMOVED DURING CLEARING AND GRUBBING.

2. WOOD STRUCTURES SHALL BE STABILIZED. STABILIZATION METHODS INCLUDE PARTIAL BURIAL, BRACING AGAINST STANDING TREES, OR TIMBER PILES.

2/12 PLAN VIEW- TYPICAL SIDE CHANNEL LARGE WOOD CONFIGURATIONS

NOT TO SCALE

NO.	BY	DATE	REVISION DESCRIPTION

MM, GS (DRAWN) | MB (DESIGNED) | CB (CHECKED)
---- (APPROVED) | 12/18/18 (DATE) | (PROJECT)

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TYPICAL SECTIONS

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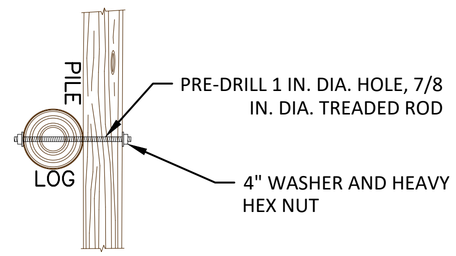
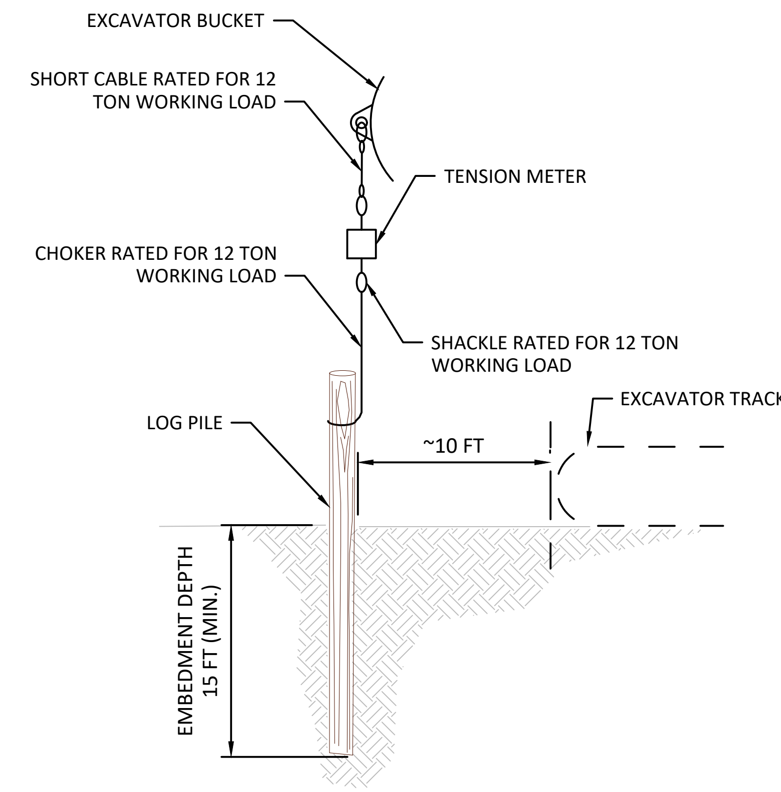


1/13 TYPICAL DETAIL
LOG–PILE CONNECTIONS
NOT TO SCALE

BOLTED CONNECTION NOTES

PIN LOGS TO LOGS
1. DRILL 1" DIA HOLE THROUGH LOGS.
2. INSERT 7/8" DIA THREADED ROD.
3. INSTALL STEEL PLATES AND HEAVY HEX NUTS. SECURE NUTS BY CHISELING THREADS OR MUSHROOMING EXPOSED ENDS OF ROD.
4. FILE OR GRIND OFF SHARP EDGES



2/13 TYPICAL DETAIL
PILE PULL OUT TEST
NOT TO SCALE

TIMBER PILE NOTES:

GENERAL

1. THE RESULTS OF ON-SITE PULLOUT TESTS WILL INFORM THE ENGINEER OF THE ACTUAL PERFORMANCE OF SUBSURFACE SOILS, WHICH WILL INFORM THE REQUIRED EMBEDMENT DEPTH. THE CONTRACTOR IS SOLEY RESPONSIBLE FOR SITE SAFETY .

RIGGING

1. RIGGING FOR PILE TESTING SHALL CONFORM TO THE TENSION SCALE MANUFACTURER'S RECOMMENDATIONS.
2. CHOKERS, CABLES AND AND SHACKLES SHALL HAVE MINIMUM WORKING LOAD RATING OF 12 TONS. FITTINGS SHALL BE SIZED ACCORDINGLY.

TESTING

1. TESTING OF PILES SHALL BE PERFORMED IN THE PRESENCE OF THE ENGINEER. UP TO FOUR LOAD TESTS SHALL BE APPLIED TO EACH TESTED PILE. EACH OF THE FOUR LOAD TESTS SHALL BE APPLIED TO THE PILE WITH A DIFFERENT INSTALLED DEPTH. PROOF TESTS SHALL BE MADE AT UP TO FOUR EMBEDMENT DEPTHS. DEPTHS SHALL BE DETERMINED IN THE FIELD. AS A GUIDELINE, TEST EMBEDMENT DEPTHS MIGHT INCLUDE 8 FT, 10 FT, 11 FT, AND 12 FT.
2. EACH PILE TEST SHALL HAVE UPWARD LOAD GRADUALLY INCREASED AND AS ALIGNED TO THE LONG AXIS OF THE PILE. RECORD THE PILE DIAMETER, EMBEDMENT DEPTH AND MAXIMUM FORCE REQUIRED TO MOVE THE PILE VERTICALLY APPROXIMATELY 1 INCH. THEN DRIVE THE PILE TO A NEW DEPTH. APPLY NEW LOAD AND RECORD MAX FORCE THAT CAUSES THE PILE TO MOVE VERTICALLY 1 INCH. REPEAT FOR THIRD AND FOURTH TEST.
3. EXCAVATOR SHALL BE NO CLOSER TO PILE THAN NEEDED TO GENERATE DESIRED LOADING. LIMIT COMPRESSIVE LOADING OF THE TRACKS ON THE GROUND BY DRIVING THE EXCAVATOR ONTO LOGS LAID ON THE GROUND TO DISTRIBUTE THE WEIGHT OVER A LARGER AREA.
4. UP TO 10% OF PRODUCTION PILINGS SHALL BE PROOF TESTED. IF RESULTS VARY MORE THAN 50% THEN IT SHOULD BE ANTICIPATED THAT UP TO 25% OF THE PRODUCTION PILINGS SHALL BE PROOF TESTED.
5. PILE EMBEDMENT DEPTH SPECIFIED IN THESE DRAWINGS MIGHT BE INCREASED AT NO ADDITIONAL COST TO THE OWNER PENDING PULL OUT TEST RESULTS . ASSUMED RESISTANCE IS 20,000 POUNDS. IF TESTING REVEALS FIELD PULLOUT RESISTANCE VALUES THAT ARE LESS THAN THE ASSUMED VALUES, PILES MAY BE REQUIRED TO BE DRIVEN UP TO 5 FT DEEPER THAN INDICATED IN PLANS.

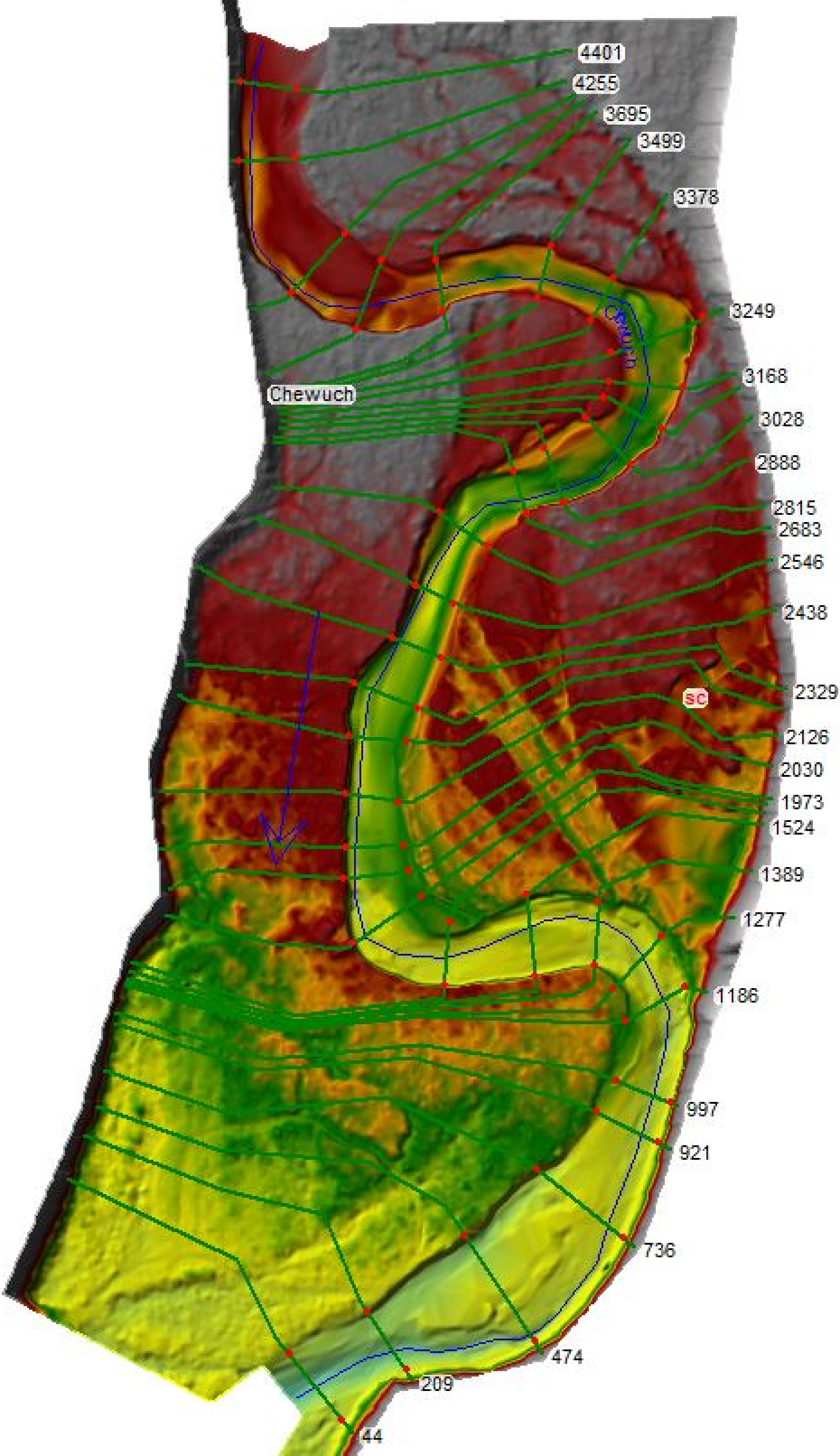
Appendix B: Hydraulic Model Output

HEC-RAS Profile: 8531 cfs Q100

Reach	River Sta	Profile	Plan	Q Total	W.S. Elev
				(cfs)	(ft)
Chewuch	4401	8531 cfs Q100	Existing	8531.00	1873.81
Chewuch	4401	8531 cfs Q100	Proposed	8531.00	1873.77
Chewuch	4255	8531 cfs Q100	Existing	8531.00	1873.55
Chewuch	4255	8531 cfs Q100	Proposed	8531.00	1873.50
Chewuch	3982	8531 cfs Q100	Existing	8531.00	1873.27
Chewuch	3982	8531 cfs Q100	Proposed	8531.00	1873.21
Chewuch	3843	8531 cfs Q100	Existing	8531.00	1873.08
Chewuch	3843	8531 cfs Q100	Proposed	8531.00	1873.01
Chewuch	3695	8531 cfs Q100	Existing	8531.00	1872.77
Chewuch	3695	8531 cfs Q100	Proposed	8531.00	1872.67
Chewuch	3499	8531 cfs Q100	Existing	8531.00	1871.88
Chewuch	3499	8531 cfs Q100	Proposed	8531.00	1871.68
Chewuch	3378	8531 cfs Q100	Existing	8531.00	1871.53
Chewuch	3378	8531 cfs Q100	Proposed	8531.00	1871.19
Chewuch	3249	8531 cfs Q100	Existing	8531.00	1871.63
Chewuch	3249	8531 cfs Q100	Proposed	8531.00	1871.31
Chewuch	3168	8531 cfs Q100	Existing	8531.00	1871.30
Chewuch	3168	8531 cfs Q100	Proposed	8531.00	1870.84
Chewuch-Mid	3107	8531 cfs Q100	Existing	7738.87	1871.12
Chewuch-Mid	3107	8531 cfs Q100	Proposed	7058.64	1870.77
Chewuch-Mid	3028	8531 cfs Q100	Existing	7738.87	1870.97
Chewuch-Mid	3028	8531 cfs Q100	Proposed	7058.64	1870.62
Chewuch-Mid	2888	8531 cfs Q100	Existing	7738.87	1870.69
Chewuch-Mid	2888	8531 cfs Q100	Proposed	7058.64	1870.33
Chewuch-Mid	2815	8531 cfs Q100	Existing	7738.87	1870.21
Chewuch-Mid	2815	8531 cfs Q100	Proposed	7058.64	1869.87
Chewuch-Mid	2683	8531 cfs Q100	Existing	7738.87	1869.21
Chewuch-Mid	2683	8531 cfs Q100	Proposed	7058.64	1868.90
Chewuch-Mid	2546	8531 cfs Q100	Existing	7738.87	1868.00
Chewuch-Mid	2546	8531 cfs Q100	Proposed	7058.64	1867.68
Chewuch-Mid	2438	8531 cfs Q100	Existing	7738.87	1867.83
Chewuch-Mid	2438	8531 cfs Q100	Proposed	7058.64	1867.64
Chewuch-Mid	2329	8531 cfs Q100	Existing	7738.87	1867.70
Chewuch-Mid	2329	8531 cfs Q100	Proposed	7058.64	1867.51

HEC-RAS Profile: 8531 cfs Q100 (Continued)

Reach	River Sta	Profile	Plan	Q Total	W.S. Elev
				(cfs)	(ft)
Chewuch-Mid	2237	8531 cfs Q100	Existing	7738.87	1867.26
Chewuch-Mid	2237	8531 cfs Q100	Proposed	7058.64	1867.10
Chewuch-Mid	2126	8531 cfs Q100	Existing	7738.87	1866.91
Chewuch-Mid	2126	8531 cfs Q100	Proposed	7058.64	1866.77
Chewuch-Mid	2030	8531 cfs Q100	Existing	7738.87	1866.78
Chewuch-Mid	2030	8531 cfs Q100	Proposed	7058.64	1866.65
Chewuch-Mid	1973	8531 cfs Q100	Existing	7738.87	1866.42
Chewuch-Mid	1973	8531 cfs Q100	Proposed	7058.64	1866.37
Chewuch-Mid	1858	8531 cfs Q100	Existing	7738.87	1866.53
Chewuch-Mid	1858	8531 cfs Q100	Proposed	7058.64	1866.47
Chewuch-Mid	1692	8531 cfs Q100	Existing	7738.87	1866.40
Chewuch-Mid	1692	8531 cfs Q100	Proposed	7058.64	1866.35
Chewuch-Mid	1524	8531 cfs Q100	Existing	7738.87	1866.24
Chewuch-Mid	1524	8531 cfs Q100	Proposed	7058.64	1866.22
Chewuch-Mid	1389	8531 cfs Q100	Existing	7738.87	1865.97
Chewuch-Mid	1389	8531 cfs Q100	Proposed	7058.64	1866.01
Chewuch-Mid	1285	8531 cfs Q100	Existing	7738.87	1865.90
Chewuch-Mid	1285	8531 cfs Q100	Proposed	7058.64	1865.94
Chewuch-DS	1186	8531 cfs Q100	Existing	8531.00	1865.72
Chewuch-DS	1186	8531 cfs Q100	Proposed	8531.00	1865.73
Chewuch-DS	997	8531 cfs Q100	Existing	8531.00	1862.59
Chewuch-DS	997	8531 cfs Q100	Proposed	8531.00	1862.59
Chewuch-DS	921	8531 cfs Q100	Existing	8531.00	1862.78
Chewuch-DS	921	8531 cfs Q100	Proposed	8531.00	1862.78
Chewuch-DS	736	8531 cfs Q100	Existing	8531.00	1861.02
Chewuch-DS	736	8531 cfs Q100	Proposed	8531.00	1861.02
Chewuch-DS	474	8531 cfs Q100	Existing	8531.00	1860.43
Chewuch-DS	474	8531 cfs Q100	Proposed	8531.00	1860.43
Chewuch-DS	209	8531 cfs Q100	Existing	8531.00	1858.86
Chewuch-DS	209	8531 cfs Q100	Proposed	8531.00	1858.86
Chewuch-DS	44	8531 cfs Q100	Existing	8531.00	1858.15
Chewuch-DS	44	8531 cfs Q100	Proposed	8531.00	1858.15



4401
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Chewuch
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2815
2683
2546
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1524
1389
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1186
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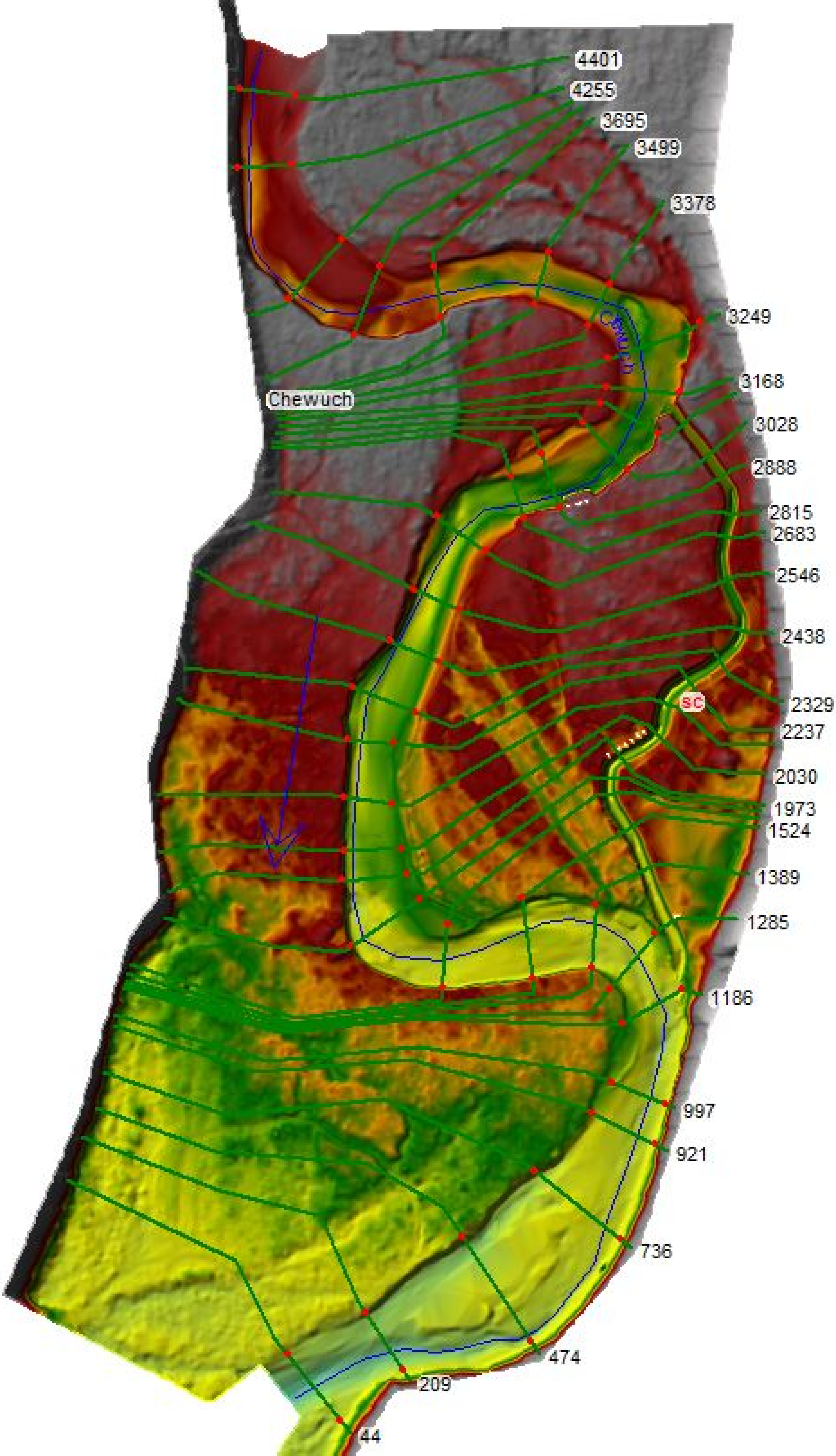
209
44



4401
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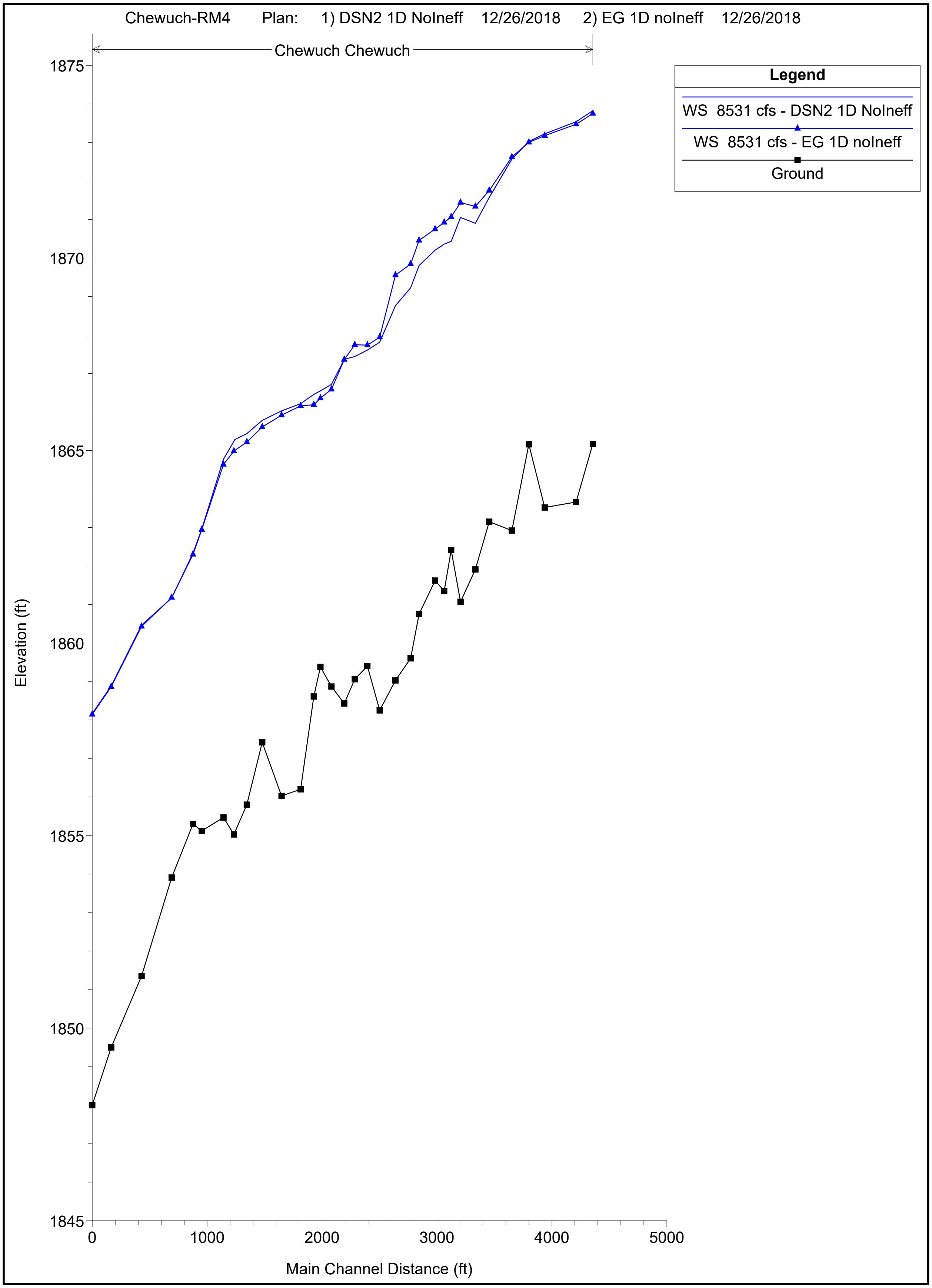
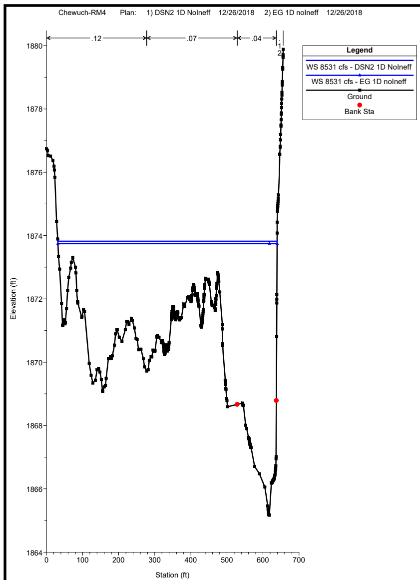
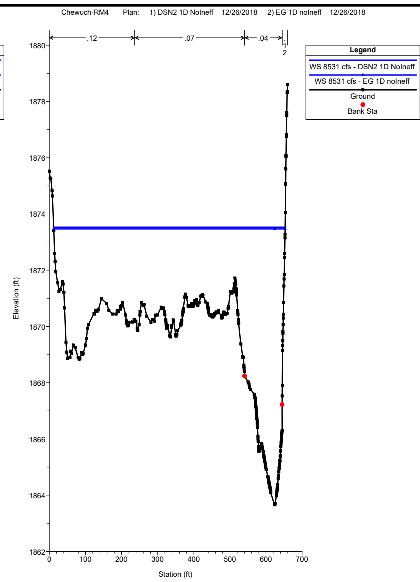


Chewuch-RM4 Plan: 1) DSN2 1D NoIneff 12/26/2018 2) EG 1D noIneff 12/26/2018
Chewuch Chewuch
Legend
WS 8531 cfs - DSN2 1D NoIneff
WS 8531 cfs - EG 1D noIneff
Ground
Elevation (ft)
1875
1870
1865
1860
1855
1850
1845
0
1000
2000
3000
4000
5000
Main Channel Distance (ft)


Chewuch-RM4 Plan: 1) DSN2 1D Nolneff 12/26/2018 2) EG 1D nolneff 12/26/2018
.12
.07
.04
Legend
WS 8531 cfs - DSN2 1D Nolneff
WS 8531 cfs - EG 1D nolneff
Ground
Bank Sta
Elevation (ft)
Station (ft)


Chewuch-RM4 Plan: 1) DSN2 1D Nolneff 12/26/2018 2) EG 1D nolneff 12/26/2018
.12
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Legend
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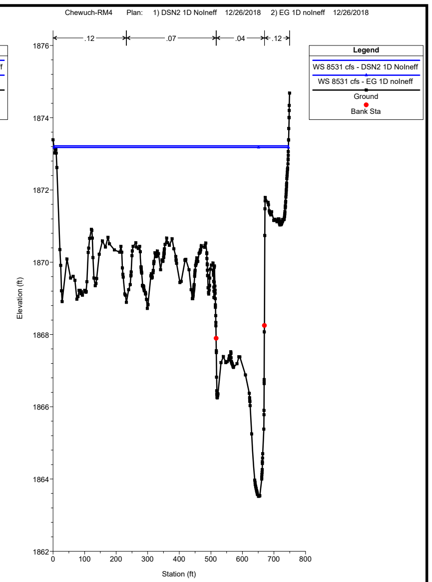
WS 8531 cfs - EG 1D nolneff
Ground
Bank Sta
Elevation (ft)
Station (ft)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WS 8531 cfs - EG 1D nolneff
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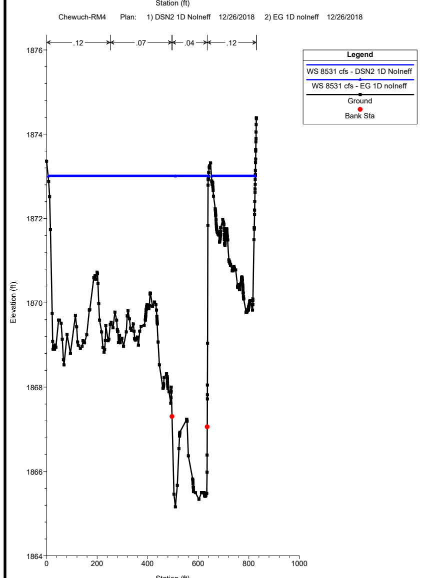
Elevation (ft)
Station (ft)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Elevation (ft)
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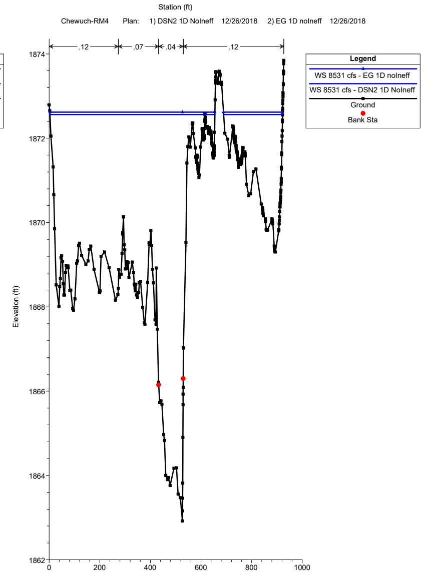
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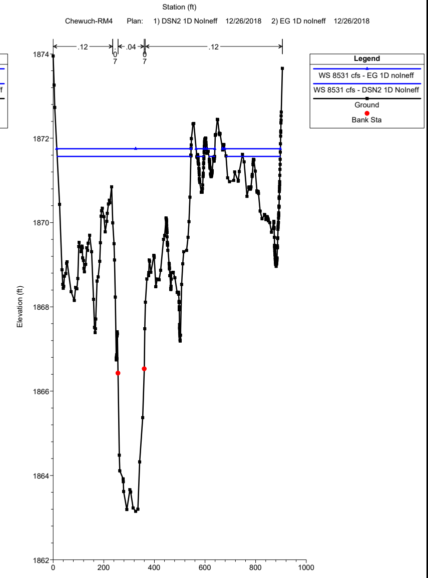
Elevation (ft)
Station (ft)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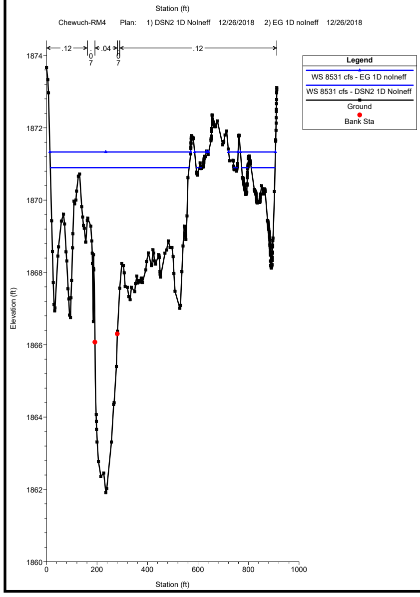
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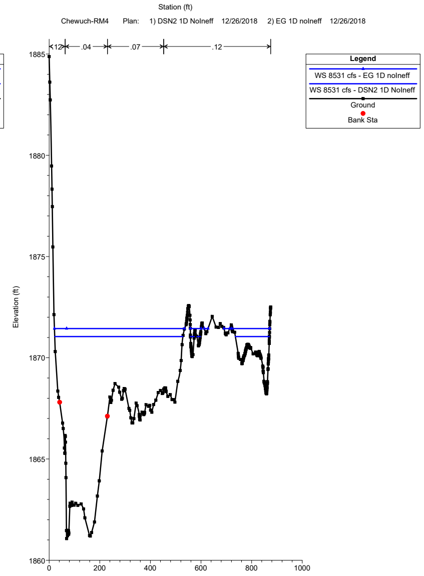
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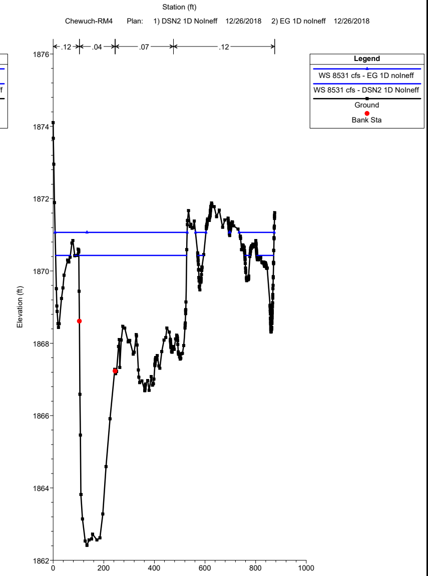
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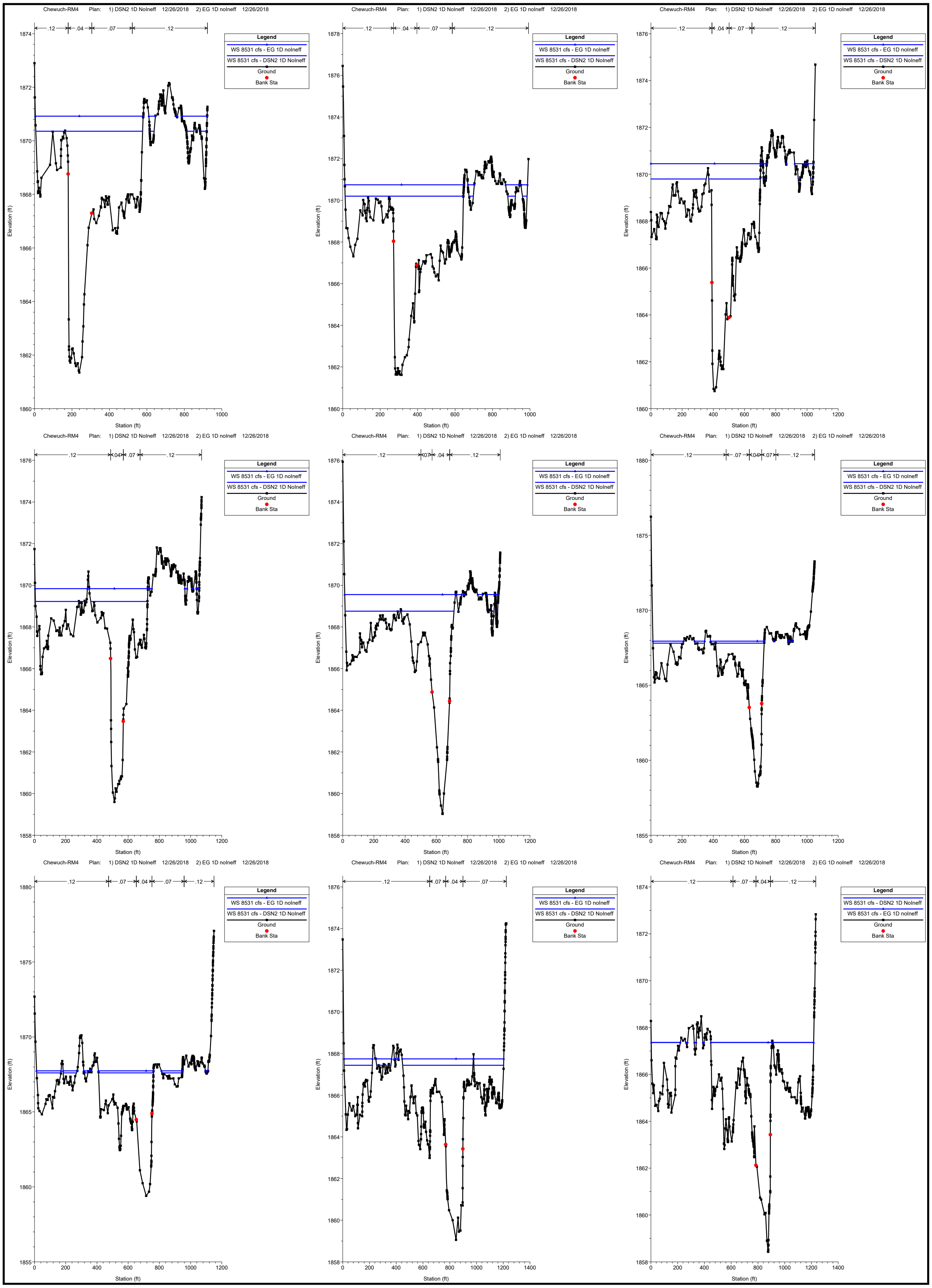

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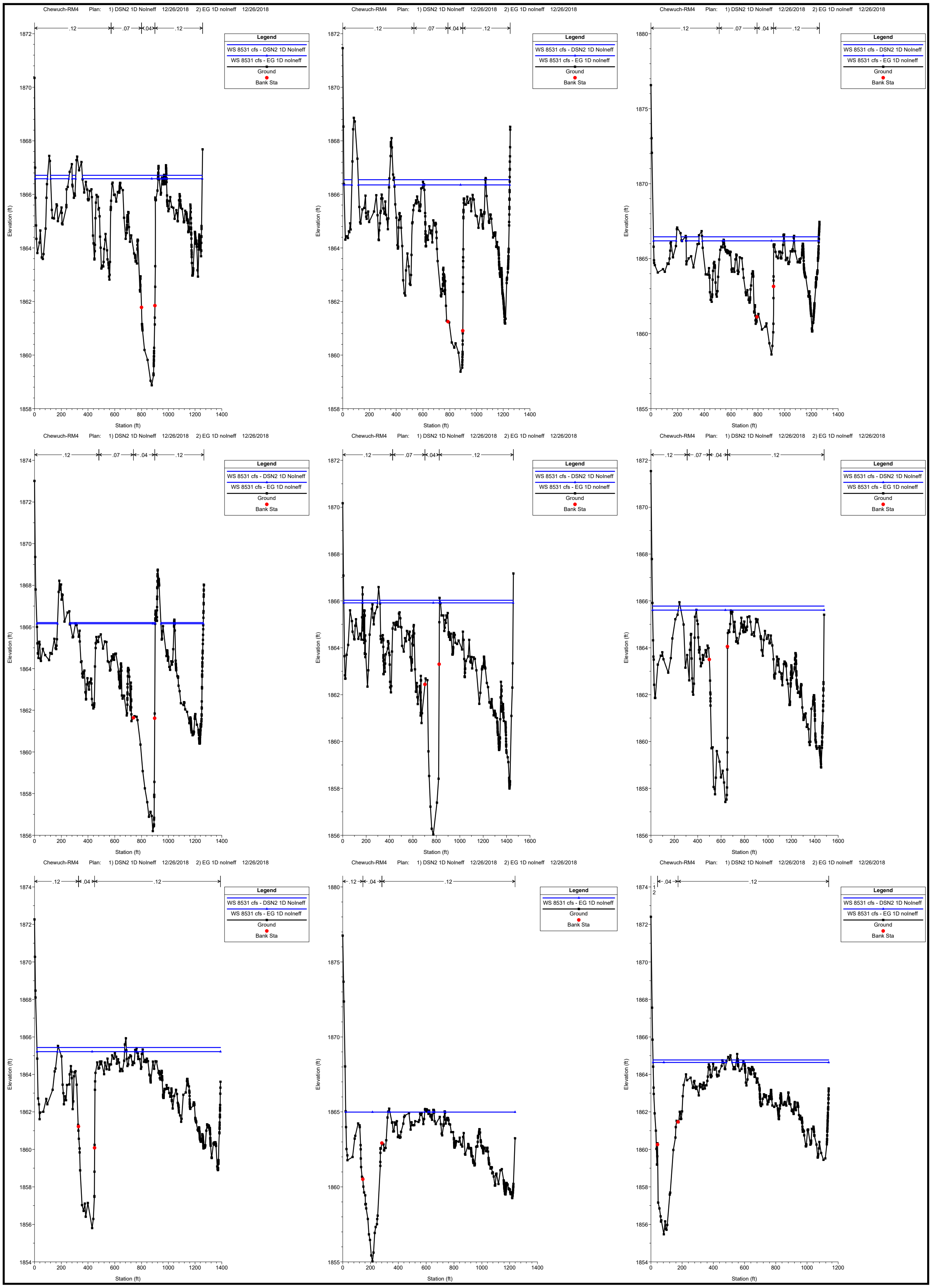

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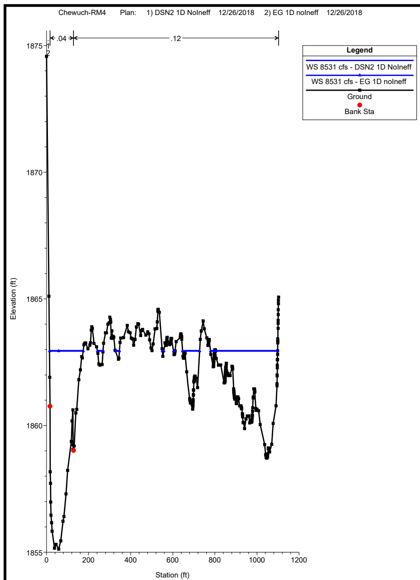
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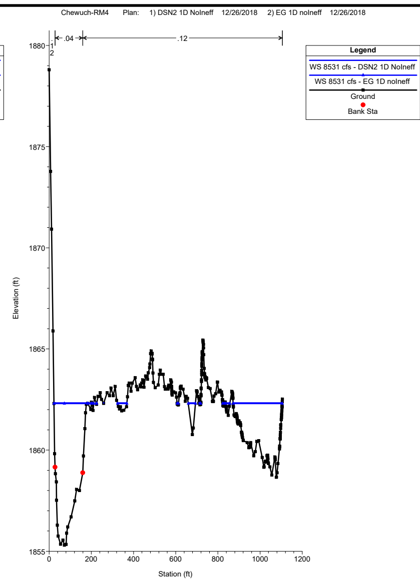
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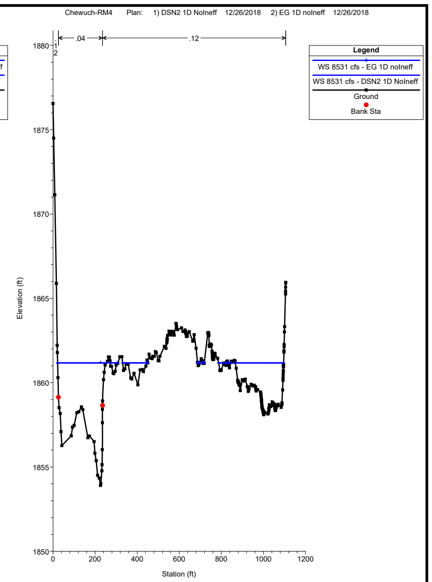
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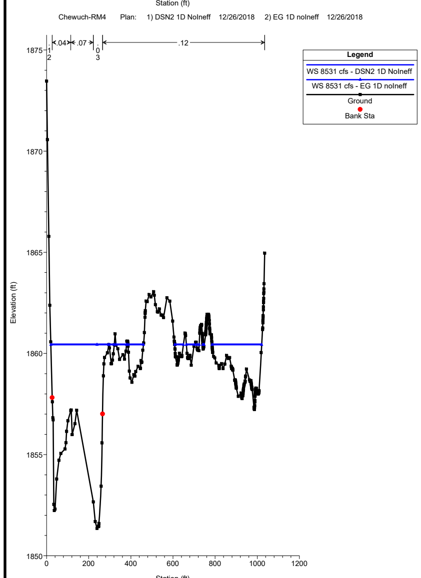
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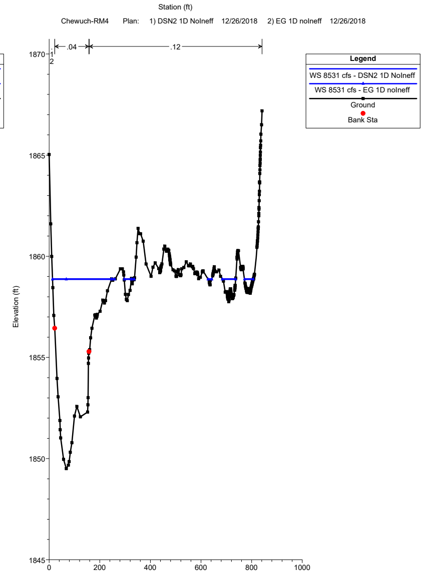
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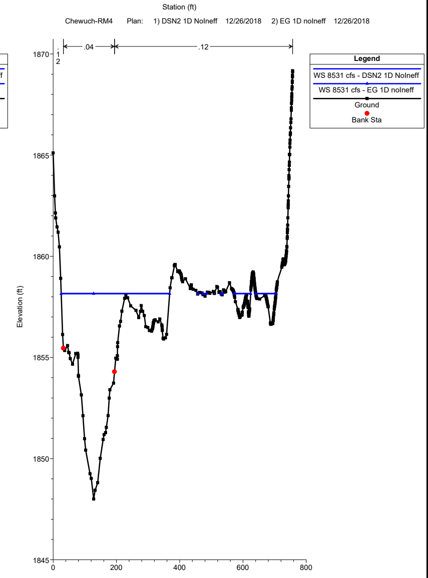
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