Beaver Creek Reach 5

15 PERCENT CONCEPT DESIGN REPORT AND ALTERNATIVES DRAWINGS

Yakama Nation Fisheries

TETRA TECH

May 2017

BEAVER CREEK REACH 5

15 PERCENT CONCEPT DESIGN REPORT

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May 2017

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1. PROJECT BACKGROUND

The Yakama Nation Upper Columbia Habitat Restoration Program is focused on implementing science-based restoration projects in the upper Columbia River Basin that benefit Endangered Species Act (ESA)-listed fish species including ESA-listed (Endangered) Chinook salmon (*Oncorhynchus tshawytscha*) and ESA-listed (Threatened) steelhead (*O. mykiss*) and bull trout (*Salvelinus confluentus*). Habitat restoration priorities, objectives, and treatments are guided by the Upper Columbia Habitat Restoration Framework, under the Recovery Plan (UCSRB 2007) and the revised Biological Strategy (UCRTT 2014).

The Beaver Creek Reach Assessment (Tetra Tech 2017) describes the physical conditions as well as the biological and ecological impairments throughout the lower Beaver Creek drainage from river mile (RM) 0 to 11. It also presents a comprehensive restoration strategy for addressing ecological concerns (also known as limiting factors) to support recovery of ESA-listed salmonids and non-listed species in the upper Columbia River Basin. It provides the technical basis to identify and conceptually develop potential restoration project areas that will improve habitat and river processes. The restoration strategy presented in the Beaver Creek Reach Assessment involves a project ranking and evaluation process, according to restoration objectives, feasibility, and logistical factors, for potential project areas in each of the seven delineated reaches (Tetra Tech 2017).

As demonstrated in the reach assessment analyses and Reach-based Ecosystem Indicator (REI) evaluation (Tetra Tech 2017), the current condition of Beaver Creek is severely impaired. The channel is incised in many areas, has limited floodplain connectivity, and lacks channel complexity, habitat diversity, and cover. In order to restore impaired natural process and address ecological concerns, structural elements are needed in Beaver Creek that retain sediment and mobile wood, and create the hydraulic conditions necessary to aggrade the channel bed so that natural geomorphic processes of bank erosion, channel migration, floodplain inundation, and flood attenuation can occur.

The Beaver Creek Reach 5 Project (Project) is intended to benefit ESA-listed steelhead by addressing the priority ecological concerns for Beaver Creek identified in the Revised Biological Strategy (UCRTT 2014). The Project was selected to be advanced to the restoration design phase because of its high potential for restoration, public ownership, and distance from infrastructure. The Project area includes Beaver Creek and its associated floodplains between approximately RM 7.0 and RM 9.5, Piper Creek from Upper Beaver Creek Road to its confluence with Beaver Creek near RM 8.0, and a culvert on Beaver Creek at the NF-4225 Road crossing at approximately RM 9.5 (see Figure 1-1). The Project is located on properties owned by the Washington Department of Fish and Wildlife (WDFW) and the U.S. Fish and Wildlife Service (USFWS); there is a property owned by the U.S. Department of Agriculture Forest Service (USFS) at approximately RM 8.6 but no Project actions are proposed for this property, at this time.

This 15 Percent Concept Design Report describes the Project background, including regional goals and objectives, Project goals and objectives, and design criteria; the site conditions and baseline analyses, including the site surveys, geomorphology, hydrology, fish use and habitat conditions, and vegetation (Section 2); and an overview of the 15 Percent Concept Design Alternatives (Section 3), which are attached as Appendix A.

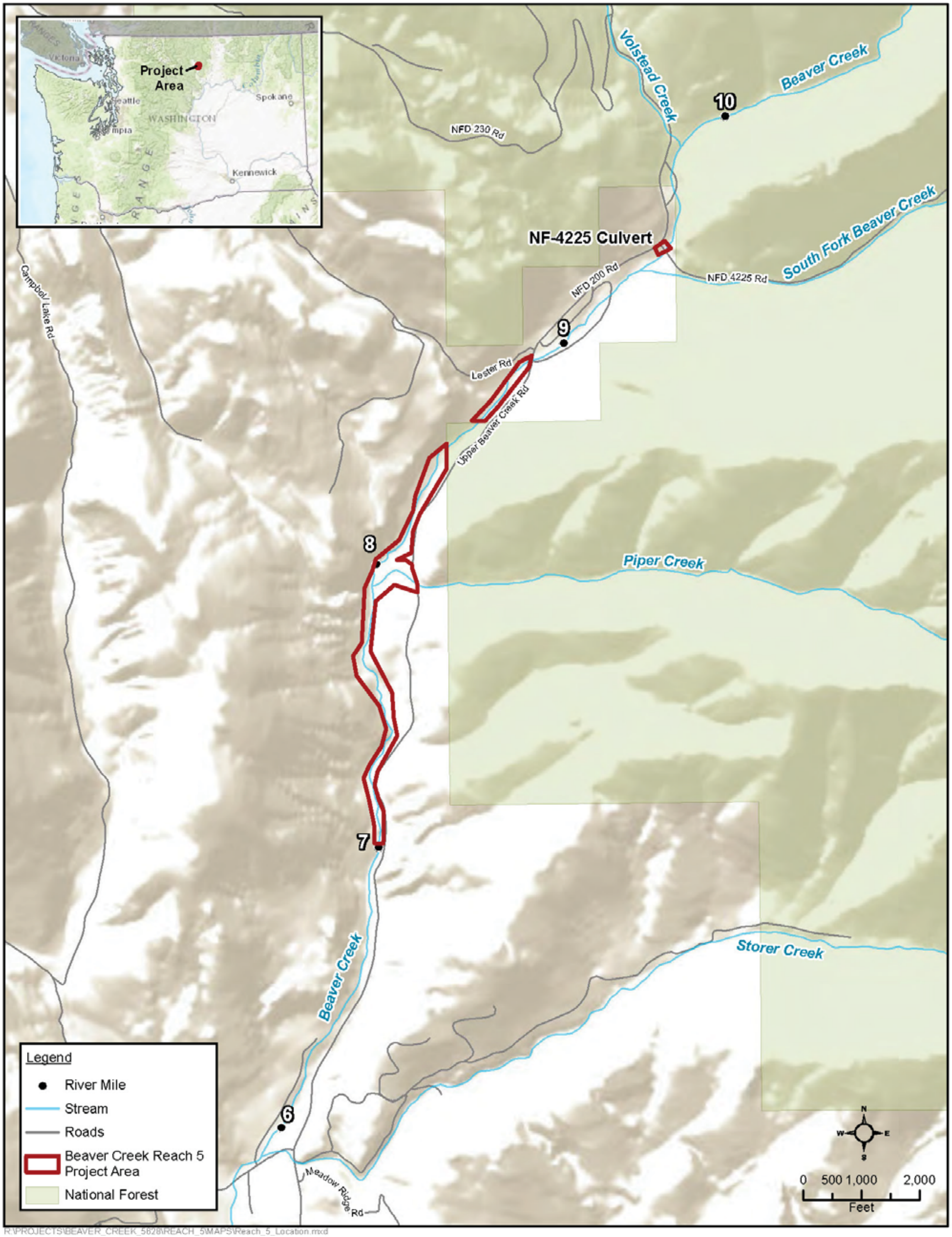

Figure 1-1. Project Location Map–Beaver Creek Reach 5

1.1 Regional Goals and Objectives

Key recovery planning efforts that have addressed conditions in the Beaver Creek drainage, as part of the Methow Subbasin, include the Methow Subbasin Plan (NPCC 2005), the Upper Columbia Spring Chinook Salmon and Steelhead Recovery Plan (Recovery Plan; UCSRB 2007), the Recovery Plan for the Coterminous United States Population of Bull Trout (USFWS 2015a), and the revised Biological Strategy (UCRTT 2014). Additionally, in 2012, tribes and state and federal agencies signed the Conservation Agreement for Pacific Lamprey, which was developed "to promote implementation of conservation measures for Pacific Lamprey in Alaska, Washington, Oregon, Idaho, and California" (USFWS 2012).

The Recovery Plan established regional objectives for habitat restoration along streams that currently support or may support ESA-listed salmonids (UCSRB 2007). The following short-term objectives, long-term objectives, and general recovery actions identified in the Recovery Plan support the development of the restoration strategy in the Beaver Creek Reach Assessment (Tetra Tech 2017).

Short-Term Objectives

- Protect existing areas where high ecological integrity and natural ecosystem processes persist.
- Restore connectivity (access) throughout the historical range where feasible and practical for each listed species.
- Protect and restore water quality where feasible and practical within natural constraints.
- Increase habitat diversity in the short term by adding instream structures (e.g., large woody debris [LWD], rocks, etc.) where appropriate.
- Protect and restore riparian habitat along spawning and rearing streams and identify long-term opportunities for riparian habitat enhancement.
- Protect and restore floodplain function and reconnection, off-channel habitat, and channel migration processes where appropriate and identify long-term opportunities for enhancing these conditions.
- Restore natural sediment delivery processes by improving road network, restoring natural floodplain connectivity, riparian health, natural bank erosion, and wood recruitment.

Long-Term Objectives

- Protect areas with high ecological integrity and natural ecosystem processes.
- Maintain connectivity through the range of the listed species where feasible and practical.
- Protect and restore water quality where feasible and practical within natural constraints.
- Protect and restore off-channel and riparian habitat.
- Increase habitat diversity by rebuilding, maintaining, and adding instream structures (e.g., LWD, rocks, etc.) where long-term channel form and function efforts are not feasible.
- Reduce sediment recruitment where feasible and practical within natural constraints.
- Reduce the abundance and distribution of non-native species that compete and interbreed with or prey on listed species in spawning, rearing, and migration areas.

While the Recovery Plan outlined above was also intended to address bull trout, in September 2015 the USFWS published an updated Recovery Plan (USFWS 2015a). This includes a Mid-Columbia Recovery Unit

Implementation Plan for Bull Trout (Mid-Columbia Recovery Unit Implementation Plan) (USFWS 2015b), within which the Methow Subbasin is one of 24 bull trout core areas.

The revised Biological Strategy (UCRTT 2014) provides specific support and guidance on implementing the 2007 Recovery Plan described above. In the revised Biological Strategy, Beaver Creek is designated as a Priority 2 area (on scale of 1 to 4) within the Methow River Subbasin. Restoration priority action types include increasing instream flow and restoring natural geomorphic processes such as channel migration, floodplain interaction, and sediment transport (UCRTT 2014). Specific actions are recommended for improving these functions in the Revised Biological Strategy. These include (in priority order):

1) Water quantity – Increase stream flow through irrigation practice improvements and water leases/purchases.
2) Channel structure and form – Address roads and dikes.
3) Habitat quantity – Remove or modify instream diversion structures to maintain effective fish passage at the Beatty diversion, replace Stokes Ranch culvert (~ RM 3.0).
4) Riparian Condition – Plant riparian vegetation to restore adequate riparian buffer, increase LWD recruitment and retention, livestock exclusion fencing in riparian areas, implement Respect the River Program (20 acres on USFS land, 40 acres on WDFW land).
5) Sediment – Perform road management, reduction, and maintenance to restore sediment and large wood recruitment rates within riparian and upland areas, in particular around WDFW and USFS campgrounds.
6) Injury and Mortality – Replace or properly modify diversion screens to meet fish passage standards.
7) Species interactions – Reduce or eliminate brook trout.

The strategy also identified specific priority ecological concerns for the Beaver Creek, in priority order: 1) water quantity (decreased water quantity), 2) channel structure and form (bed and channel form), 3) habitat quantity (anthropogenic barriers – need to maintain passage), 4) riparian restoration (condition), 5) sediment (increased sedimentation, 6) injury and mortality (mechanical injury), and 7) species interactions (introduced species that compete and or predate on native fish) (UCRTT 2014). The UCRTT ranked Beaver Creek as a priority 2 for restoration in the Biological Strategy (UCRTT 2013). The priority actions for Beaver Creek include increasing instream flow and restoring natural geo-fluvial processes such as channel migration, floodplain interaction, and sediment transport.

1.2 Project Goals and Objectives

The goal of the Project is to benefit ESA-listed steelhead and bull trout, and address the priority ecological concerns for the Beaver Creek identified in the Revised Biological Strategy (UCRTT 2014).

Objectives identified for the Project include:

- Improve instream and off-channel habitat for juvenile steelhead and bull trout;
- Increase spawning habitat for steelhead and bull trout;
- Increase floodplain connectivity;
- Promote natural geomorphic and habitat forming processes;

- Improve riparian vegetation condition to provide shade and promote large tree growth for future recruitment;
- Increase complex pools; and
- Increase hydraulic diversity.

The Project includes the majority of Reach 5, and includes all or parts of four project areas identified in the Beaver Creek Reach Assessment (Tetra Tech 2017). The Project area is wood deficient, has suffered riparian impacts from recent fires, is incised with limited lateral migration, and has limited floodplain connectivity. There are also multiple relic channel scars and disconnected side channels in this reach. The restoration strategy for the Project focuses on installing large wood habitat structures to increase pool frequency and quality, reconnect relic side channels and alcoves, and retain mobile sediment and wood to aggrade the streambed, reduce channel incision, and enhance floodplain connectivity in areas where the restoration of natural channel function does not pose a risk to infrastructure.

1.3 Design Criteria

Design criteria, by definition, are specific, measurable attributes of project components that have been developed to meet project objectives and that serve as measurable benchmarks for individual components of a project design (Miller and Skidmore 2003). Design criteria can be categorized as performance criteria, which define what a project will achieve and the duration of benefits; or prescriptive criteria, which define how the project will be undertaken. Applicable performance and prescriptive engineering design criteria have been developed that are intended to ensure that the engineering design meets Project objectives and maintains compliance with applicable codes, standards, and established criteria.

- Habitat and Geomorphology Criteria:
    - Increase floodplain inundation at lower flows (preferably at annual or bankfull flows) in locations where infrastructure is not present.
    - Install stable LWD structures in Beaver Creek where infrastructure is not present to:
        - Restore natural geomorphic processes;
        - Increase floodplain hydraulic connection;
        - Improve connection with existing wetlands;
        - Capture fine sediment and mobile LWD;
        - Increase sorting/retention of spawning gravels;
        - Increase pool frequency and complexity;
        - Aggrade the channel;
        - Reconnect relic high-flow channels, side channels, and backwater alcoves; and
        - Provide immediate fish habitat.
    - Assess Piper Creek and NF-4225 culverts for function and debris/sediment transport.
    - Assess realigning lower section of Piper Creek to decrease sediment transport, promote wetland development, and increase alluvial fan channel stability.

- Increase channel length and off-channel habitat through the removal of artificial fill associated with a historical stream crossing near Lester Road.
- Create structures that will permit perennial fish passage.

- Revegetation:
  - Jumpstart natural recovery processes with revegetation.
  - Preserve existing vegetation wherever possible, and replant or reuse disturbed vegetation.
  - All disturbed areas will be reseeded and replanted with native vegetation.
  - Assess grazing management or exclusion.
- Risk Criteria:
  - Do not increase risks of flooding or erosion to roads, bridges, culverts, irrigation diversions, and other public or private infrastructure.
  - Maintain or increase conveyance at the existing bridge on Upper Beaver Creek Road at RM 8.9.
  - Provide adequate stability for LWD structures.
  - Avoid impacts to the Parmley Diversion.
  - Assess impacts to the Ecology gaging station.
  - No work is to be performed on the USFS property. Inundation on this property may be increased where it does not impact existing infrastructure.
  - Consider impacts of winter ice.
  - Assess post-fire hydrologic and sediment regime design implications and potential safety factors.
- Construction Criteria:
  - Permitting pathways and criteria will be determined at a future design stage.
  - During construction, all work shall employ standard and relevant erosion control best management practices and methods.
  - The in-water work window for Beaver Creek will be identified at a future design stage.
  - Access routes will minimize impacts to the stream and riparian vegetation.

2. SITE CONDITIONS AND BASELINE ANALYSES

This section describes the site survey and data collection, geomorphic setting, hydrology, fish use and habitat conditions, and vegetation.

2.1 Site Surveys and Data Collection

Topo-bathymetric light detection and ranging (LiDAR) data were acquired October 12 and 13, 2016, using traditional LiDAR and topo-bathymetric (or “green”) LiDAR collected simultaneously. While the traditional LiDAR laser pulses do not penetrate water surfaces, the topo-bathymetric sensor uses a narrow green beam laser that penetrates the water surface. The technical data report describing topo-bathymetric LiDAR acquisition, processing, and accuracy estimates is included as Appendix C of the Beaver Creek Reach Assessment (Tetra Tech 2017).

Field surveys for the Beaver Creek Reach Assessment (Tetra Tech 2017) were conducted between June 27 and July 1, 2016, to characterize current in-channel and riparian habitat, establish baseline conditions in Beaver Creek, and identify potential restoration opportunities. Specific attention was given during field surveys to making observations related to sediment transport and response conditions, channel incision and channel stability trends (erosion or aggradation), substrate characteristics (e.g., size, distribution, supply), the abundance and influence of instream wood, floodplain connectivity, the influence of human alterations, and the interaction of the stream with riparian ecological processes. The field habitat surveys were completed generally following the USFS Level II protocol (USFS 2016). Habitat units, also referred to as channel units, were mapped and data collected for each unit in the Survey Area. Habitat unit type, channel dimensions, and wood data were collected at every habitat unit throughout the Survey Area. More detailed data, including observations of substrate and riparian characteristics, fish cover, floodprone width, and Rosgen classification, were collected at 10 percent of the habitat units. Other important features such as side channels, tributary junctions, log jams, culverts, diversion structures, eroding or armored banks, or other points of interest were identified, documented, and their location mapped during field surveys. Sediment samples (pebble counts) were taken to document significant changes in bed sediment texture following the methods described in Bunte and Abt (2001). LWD in the Survey Area was inventoried in every habitat unit. Instream wood that was shorter than the size criteria in the USFS Level II protocol was inventoried separately. This wood was included because relatively small wood has the ability to provide important functions in Beaver Creek. Standing trees within the bankfull channel were not inventoried as LWD.

Topographic survey data for the Project were acquired between April 24 and 26, 2017. Data were acquired using Leica global positioning system (GPS) real-time kinematic (RTK) total stations. Three survey benchmarks (also known as control points) were established by collecting raw static GPS data for a minimum of 2 hours. Tetra Tech staff sent the data in to the Online Positioning User Service (OPUS) for postprocessing and conversion to the preferred coordinate system: North American Datum (NAD) 83, Washington State Plane, North Zone, horizontal projection, and to the North American Vertical Datum (NAVD) 88, using U.S. survey feet as the vertical projection. Topographic data collection focused on collecting stream waters edges, which at the time of the survey were estimated at very close to bankfull and will be used in aid in hydrology and hydraulic calculations. Data were also collected at the Piper Creek and USFS 4225 road culverts to determine their adequacy for sediment transport and fish passage. Other survey data collected included various land features such as irrigation diversions, fence lines, cattle guards, and stream gage station. In addition, detailed potential restoration actions, site photographs, and related notes were recorded on iPads.

2.2 Geomorphology

A comprehensive review of the geomorphology and geology of Beaver Creek is presented in the Beaver Creek Reach Assessment (Tetra Tech 2017); a summary of key elements is provided in this section.

2.2.1 Geomorphic Setting

The Beaver Creek drainage area is approximately 110 square miles (sq mi) on the eastern slopes of the Cascade Mountains in Okanogan County, entering the Methow River about 5 miles downstream from the town of Twisp, Washington. Beaver Creek has a length of 22.3 miles, and is fed by tributaries including Frazer, South Fork Beaver, Middle Fork Beaver, Lightning, and Blue Buck Creeks (Andonaegui 2000; USBR 2013a). The Beaver Creek drainage is within Water Resource Inventory Area (WRIA) 48 and the Middle Methow River watershed (10-digit Hydrologic Unit Code [HUC] 1702000806). The Beaver Creek drainage area includes the lower Beaver Creek subwatershed (12-digit HUC 170200080608; 48 sq mi), upper Beaver Creek subwatershed (12-digit HUC 170200080607; 35 sq mi), and South Fork Beaver Creek subwatershed (12-digit HUC 170200080606; 27 sq mi).

The geomorphic and habitat conditions in Beaver Creek are tightly coupled with the local geology and glacial history. The history of human disturbance and the role of land use practices has also had an impact on geomorphic conditions, particularly in reaches that are more sensitive to disturbance. Channelization has occurred in many parts of Beaver Creek that has reduced channel complexity and increased velocity, adversely impacting juvenile rearing areas. The landscape of the Beaver Creek valley today is a patchwork of deep glacial deposits and alluvium with isolated bedrock outcrops at the valley margins. As the glaciers retreated, the flows cut through the glacial deposits, creating terraces and stream channels consisting of poorly graded gravels mixed with silt, sands, cobbles, and boulders. This material is erosion resistant, resulting in the sandy soils that are the source of the fines found in Beaver Creek today (Anchor 2008).

2.2.2 Reach 5 Conditions

Reach-scale geomorphic conditions for the seven geomorphically delineated reaches are presented in the Beaver Creek Reach Assessment (Tetra Tech 2017); a summary of the Reach 5 geomorphic conditions is provided in this section. Metrics describing reach-scale characteristics of Reach 5 are contained in Table 2-1.

Table 2-1. Reach 5 Characteristics

Metric	Reach Characteristics
River Miles (mapped)	6.6 to 9.2
Valley Setting	U-shaped, terraced, moderately confined
Channel Morphology	Riffle-rapid
Migration Type	Irregular lateral
Rosgen Type	C3b
Gradient	3.0%
Sinuosity	1.15
Bankfull Width (feet)	25.5
Width-to-Depth Ratio	10
Floodprone Width (feet)	61
Entrenchment Ratio	2.39
Substrate (dominant (%), subdominant (%))	Cobble (54%), gravel (24%)
Bank Condition	Armored (1.3%), eroding (2.9%)
Floodplain Disconnected	60.9%
LWD (pieces/mile)	6.8
Jams (jams/mile)	5.0
Pools (pools/mile)	5.3
Unit Stream Power (watts/meter)	322
Habitat Units	Pool (5%), glide (2%), riffle (27%), rapid (65%), cascade (0%)
REI Score	22

The valley setting in Reach 5 is highly complex and includes a mosaic of glacial, colluvial, and alluvial landforms. The valley is moderately confined by a combination of glacial terraces, alluvial, fans and valley hillslopes. In particular, the Piper Creek alluvial fan and the large glacial terrace downstream of the fan confine Beaver Creek in Reach 5. Upstream of the Piper Creek confluence near RM 8.0, the valley is generally less confined but channel incision and roads limit floodplain connectivity. Floodplain connectivity and floodplain inundation in Reach 5 were evaluated based on the results from the hydraulic modeling and floodplain inundation mapping.

Hydraulic model outputs of water surface elevation, flow depth, and velocity were used to map floodplain inundation and evaluate floodplain connectivity for the 2-year, 10-year, and 100-year flood events. The inundation map series Figures B-2h through B-2j in Appendix B of the Beaver Creek Reach Assessment (Tetra Tech 2017) illustrate that floodplain connectivity and inundation are very limited in Reach 5.

Beaver Creek and its tributaries have naturally high quantities of fine sediments that have been exacerbated by past management activities such as timber harvesting, roads, and cattle grazing. Post-fire rates of erosion and sediment input to Beaver Creek were extremely high following the 2014 Carlton Complex Fire and the debris flows which occurred in response to a large convective thunderstorm shortly after the fire. Within Reach 5, Piper Creek has been highly unstable and contributing large quantities of sediment to Beaver Creek since the fire. Pebble counts and ocular substrate estimates were used to characterize the existing bed sediment size distributions in Reach 5. Table 2-2 and Figure 2-1 show the bed sediment size distribution as measured at a pebble count sample site near RM 7.6.

Table 2-2. Sediment Size Distribution in Reach 5

Sediment Size		Sediment Classes	
Distribution Statistic	Sediment Size (mm)	Sediment Size Class	Percent of Total
D_{16}	20	Sand/Silt/Clay	9%
D_{35}	56	Gravel	33%
D_{50}	78	Cobble	58%
D_{84}	150	Boulder	1%
D_{95}	190	Bedrock	0%

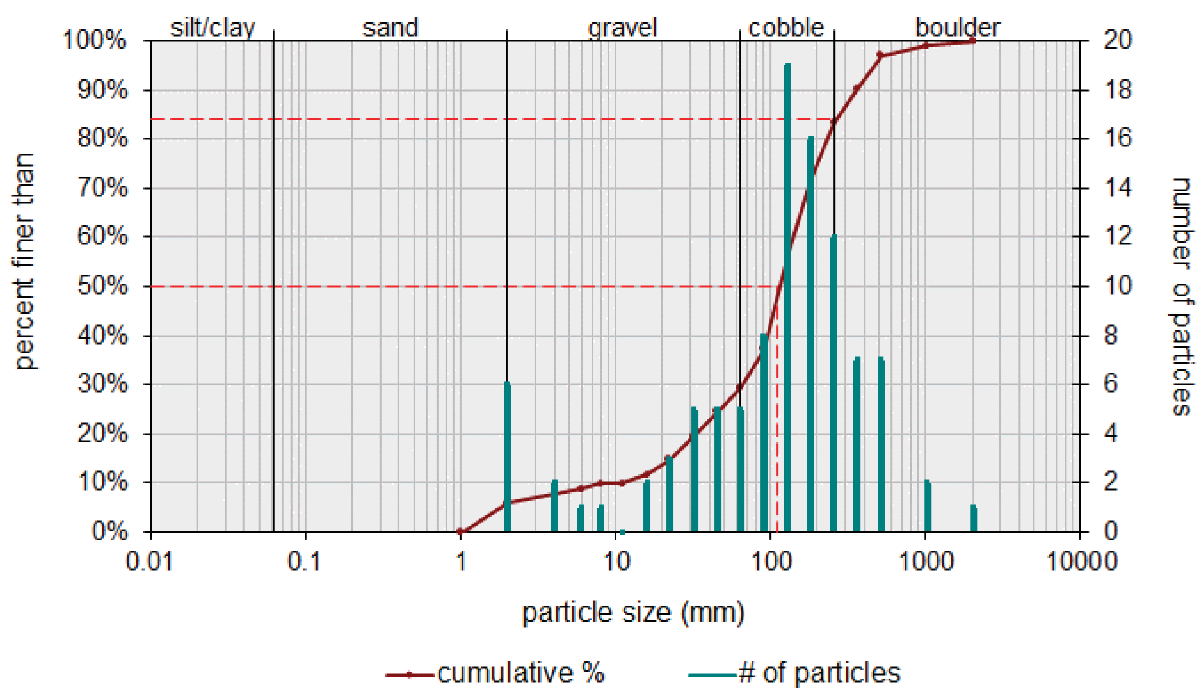

Figure 2-1. Pebble Count Grain Size Distribution in Reach 5

Sediment transport and hydraulic characteristics were calculated using hydraulic modeling results. The characteristics calculated included unit stream power, shear stress, threshold of motion grain size, (also referred to as incipient motion) and excess shear stress. Table 2-3 contains a summary of the sediment transport and hydraulic characteristics in Reach 5. The results indicate Reach 5 is a transport reach with relatively high transport potential and limited sediment storage potential, which is in agreement with the Beaver Creek Reach Assessment field observations (Tetra Tech 2017).

Table 2-3. Sediment Transport and Hydraulic Characteristics in Reach 5

Sediment Transport and Hydraulic Characteristics	Minimum	Maximum	Average
Shear Stress (Newtons per meter squared)	66	210	122
Unit Stream Power (watts per meter)	105	556	322
Threshold Grain Size (millimeters)	87	276	160
Excess Shear Stress Ratio	N/A	N/A	1.47

Instream wood within the bankfull channel within each habitat unit was inventoried during field surveys following the USFS Level II protocols (USFS 2016). The sizes of LWD that are referred to as qualifying and which were used to determine the LWD frequency in pieces per mile include medium (greater than 12 inches diameter and greater than 35 feet long) and large (greater than 20 inches diameter and greater than 35 feet long). The amount of qualifying LWD is 6.8 pieces per mile, which is well below the federal target of 20 pieces per mile (USFWS 1998) and the 42.5 pieces per mile estimate of Fox and Bolton (2007).

Instream wood that did not meet size criteria in the USFS Level II protocol was inventoried separately, and included small wood (6 to 12 inch diameter and greater than 10 feet length) and non-qualifying LWD (greater than 12 inch diameter and 10 to 35 feet length) that was not long enough to meet criteria since many of these pieces are large enough to function in Beaver Creek. Table 2-4 contains the quantity of instream wood by size class and the pieces per mile frequency of LWD and jams in Reach 5. As shown in Table 2-4, the amount of small wood is high in Reach 5 at 280 pieces and there are 5.0 jams per mile.

Table 2-4. Distribution of Instream Wood in Reach 5

LWD Size Class	Number of Pieces or Jams	Pieces or Jams per mile
Small (6 to 12 inch diameter and greater than 10 feet length)	280	100
Non-Qualifying (greater than 12 inch diameter and 10 to 35 feet length)	89	32
Qualifying (greater than 12 inch diameter and greater than 35 feet length)	19	6.8
Jams	14	5.0

Habitat units were inventoried during field surveys following the USFS (2016) Level II protocols. The slow water mainstem habitat units identified during surveys included scour pools, plunge pools, and dam pools. The fast water habitat units included glides (fast non-turbulent), riffles, rapids, and cascades. Side channels were also mapped and identified as slow water or fast water. Figure 2-2 shows the distribution of habitat units in Reach 5. This reach is dominated by rapid habitat units and has the lowest frequency of pools in the Beaver Creek Reach Assessment (Tetra Tech 2017). The presence of side-channel habitat units was limited in Reach 5. Relict channel scars are more prevalent in the upstream extent of the Project area, some of which appear to be disconnected by roads in the floodplain near RM 8.9.

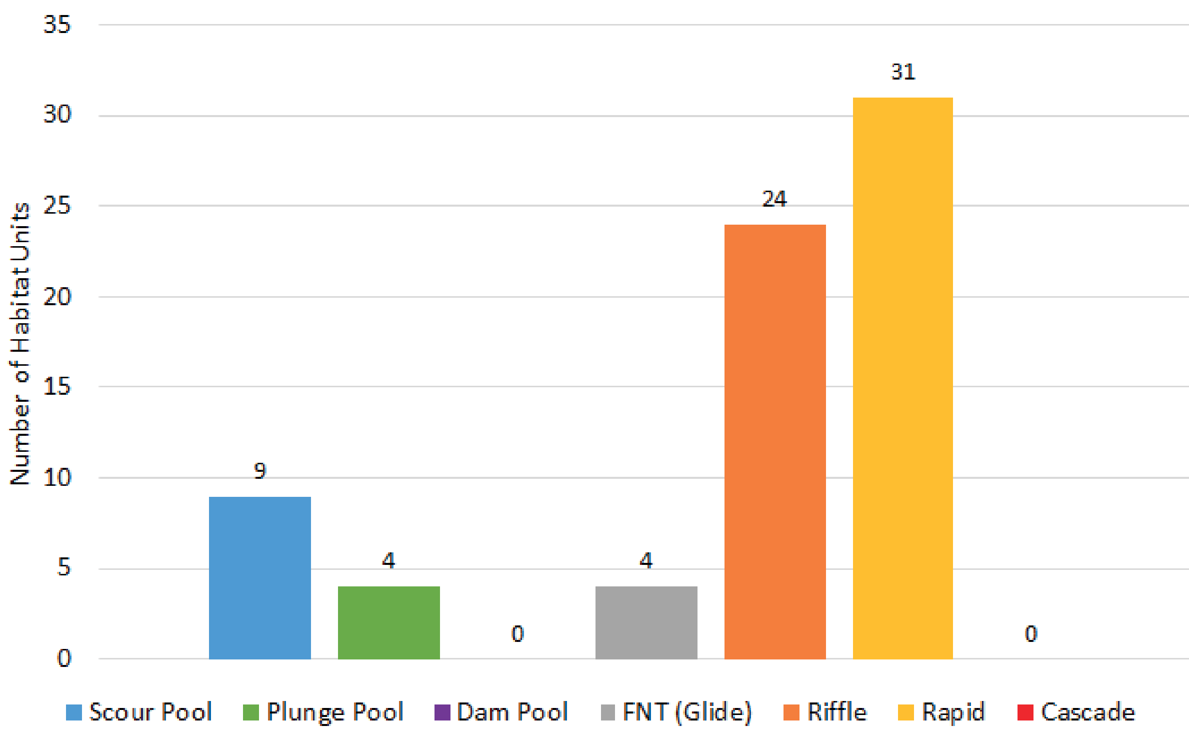

Figure 2-2. Distribution of Habitat Units in Reach 5

2.3 Hydrology

2.3.1 Existing Hydrology Information

Peak flow discharges typically occur in Beaver Creek during May and June driven by snowmelt runoff. Peak flows typically recede relatively quickly, returning to low-flow conditions from August to February. Major flood events occurred in 1894, 1942, 1948, 1957 and 1972 (Beck and Associates 1973). During the low-flow period, there are intermittent, short-duration, flow increases in response to storm events.

There are three inactive USGS gaging station locations on Beaver Creek: USGS 12449600, USGS 12449700, and USGS 12449710. The upstream gage (USGS 12449600) was located downstream of the South Fork Beaver Creek confluence at RM 9.0 and had the longest duration of operation from 1960 to 1978. The next gage downstream (USGS 12449700) was located near the Storer Creek confluence at RM 6.0 and was in operation from 1956 to 1961. The downstream gage (USGS 12449710) was located near the Methow Valley Highway (State Route [SR] 153) crossing and operated for a single water year from 2000 to 2001. USGS 12449600 and 12449700 bracket the Project area between RM 7.0 and 8.9, excluding the culvert crossing on NF-4225 Road.

Washington Department of Ecology's (Ecology) River and Stream Flow Monitoring Program has been operating two stream flow monitoring stations (ID 48F060 and ID 48F150) since April 2014. The upstream station (ID 48F150) is located downstream of the Lester Road crossing near Burns Canyon (Piper Creek confluence) at RM 8.2. The station has been operated since April 2014. The data collected at both gages thus far are not considered reliable due to highly dynamic post-fire conditions at gaging sites (Anderson 2017).

2.3.2 Hydrologic Analysis

Previous analyses performed a Log Pearson Type III analysis consistent with Bulletin 17B (USGS 1981) on the 20-year peak flow record for USGS 12449600 gage (Anchor 2008; USBR 2008). The USGS reported drainage area for the gage is approximately 62 sq mi, but StreamStats reports that the area is approximately 62.7 sq mi. This analysis does not include the flood event of 1957, but does include the 1972 event (USGS n.d.). The analysis performed by Anchor extended the gage record by transferring the short period of record from USGS 12449700 to the upstream gage using the drainage area ratio and regional exponent (Anchor 2008). By extending the record, the peak flow dataset includes the 1957 flood event.

Table 2-5 includes data from the Beaver Creek Reach Assessment (Tetra Tech 2017), which shows a comparison of peak discharge estimates at this gage location using a Log-Pearson Type III analysis (USGS 1981), drainage area gage-transfer methods (Anchor 2008), and regional regression equations (Sumioka et al. 1998). The extended gage record and the regional regression calculations produce very similar results. The event results of the shorter gage record, which do not include the 1957 event results, are less than the other two methods. These data are representative of the potential flows for the upstream end of the Project area.

Table 2-5. Comparison of Peak Discharge Estimates Downstream of the South Fork Beaver Creek Confluence RM 9.0

	USGS 12449600 Peak Discharge Estimates					
Estimation Method	2-year (cfs)	5-year (cfs)	10-year (cfs)	25-year (cfs)	50-year (cfs)	100-year (cfs)
Log-Pearson Type III[1/]	136	267	367	506	615	727
Revised Estimates including 1957 Flood Event[2/]	161	331	470	667	828	998
Regional Regression Equations[3/]	181	319	434	595	737	882

1/ Discharge calculated using the Log Pearson Type III analysis (USGS 1981). Results reported by USBR (2008) and Anchor (2008).
2/ Discharge calculated by revising Log Pearson Type III dataset. Results reported by Anchor (2008).
3/ Discharges calculated using regional regression equations (Mastin et al. 2016)
cfs = cubic feet per second

The Project area includes a tributary input from Piper Creek near RM 8.0. The Beaver Creek drainage area immediately upstream of the Piper Creek confluence is approximately 64.1 sq mi and the downstream extent of the Project area is approximately 67.5 sq mi (USGS n.d.). The difference in the drainage areas is approximately 3 square miles, so the influence of Piper Creek is minor. The hydrologic analysis will focus on flows at the downstream extent of the Project area. The values reported in Table 2-1 for the gage location can be transferred using the ratio of the drainage area using Equation 1 and regional exponent for regression from region 2 (Mastin et al. 2016).

$$Q_u = Q_g\left(\frac{A_u}{A_g}\right)^b \qquad \text{Equation 1}$$

Where,

Q_u is the peak discharge, in cubic feet per second, at the ungaged site for a given recurrence interval
Q_g is the peak discharge, in cubic feet per second, at the gaged site for a give recurrence interval
A_u is the drainage area, in square miles, at the ungaged site
A_g is the drainage area, in square miles, at the gaged site
b is the exponent of the drainage area variable in the regional regression equations

Table 2-6 reports the transferred peak flow data for the Project area downstream of Piper Creek. The table also reports the current regional regression results for the site along with the weighted regional regression results based on the 20-year gage data record as reported in the current regional regression report (Mastin et al. 2016).

Table 2-6. Peak Discharge Estimates Downstream of Piper Creek (RM 7.0)

	USGS 12449600 Peak Discharge Estimates					
Estimation Method	2-year (cfs)	5-year (cfs)	10-year (cfs)	25-year (cfs)	50-year (cfs)	100-year (cfs)
Log-Pearson Type III[1/]	145	285	391	538	654	772
Revised Estimates including 1957 Flood Event[2/]	172	353	501	709	880	1,060
Gage Transfer Regional Regression Equations[3/]	193	340	462	633	783	936
Regional Regression Equations[4/]	192	348	479	666	833	1,000
Weighted Regional Regression Equations[4/]	153	299	421	597	748	908

1/ Discharge calculated using gage transfer of Log Pearson Type III analysis (USGS 1981). Results reported by USBR (2008) and Anchor (2008).

2/ Discharge calculated by gage transfer of revised Log Pearson Type III analysis. Results reported by Anchor (2008).

3/ Discharge calculated by gage transfer methods from gage based on regression values (Mastin et al. 2016)

4/ Discharges calculated using regional regression equations (Mastin et al. 2016)

cfs = cubic feet per second

The historical gage record (1960 to 1978) is the primary method to estimate the average annual flow, baseflow, and bankfull discharge. A flow-duration analysis was performed for the Project site based on daily average flow data from USGS gage 12449600. A reasonable estimate of baseflow is the 95 percent exceedance flow, where this flow is exceeded 95 percent of the time. Table 2-7 tabulates this flow and the other low-flow analyses. The recurrence interval for the bankfull discharge is typically around 1.5 to 2 years but can range from 1 to 32 years (Hey 1997). The regional regression estimates for the 2-year flow is approximately 192 cubic feet per second (cfs). Bankfull discharge in snowmelt dominated basins typically occurs between 7 and 14 days per year (Wilkerson 2008). Based on the flow-duration analysis, 14 days per year would equate to an exceedance of approximately 3 to 4 percent. The corresponding flow range for this percentage is 203 to 271 cfs. Future hydraulic modeling can use bankfull indicator surveys to correlate this flow to the measured elevations along the channel.

Table 2-7. Low-Flow Discharge Estimates Downstream of Piper Creek (RM 7.0)

USGS 12449600 Peak Discharge Estimates	
Discharge Estimate	Flow (cfs)
Baseflow (95% Exceedance) [1/]	5
Average Annual Flow[2/]	21
Bankfull Flow[3/]	192
Bankfull Flow Range (3-4% Exceedance)[1/]	203 -271

1/ Discharge calculated using gage USGS 12449600 flow duration analysis for daily average flows (1960-1978)

2/ Discharge calculated using gage USGS 12449600 daily average flows (1960-1978)

3/ Discharge calculated using regional regression equations (Mastin et al. 2016)

cfs = cubic feet per second

2.3.3 Post-fire Hydrology

Peak flows have been shown to increase following fires, often substantially, with the magnitude of increase related to the burn severity, watershed characteristics, and post-fire infiltration and water repellency among other factors (Moody et al. 2013). The 2006 Tripod Complex Fire and the 2014 Carlton Complex Fire have had a major effect on Beaver Creek peak flood flows. The two fires combined burned the majority of the land in the Beaver Creek drainage (Watson and Crandall 2017), with the Tripod Complex Fire burning 51 percent (USBR 2013b) and the Carlton Complex Fire burning over 42 percent of the Beaver Creek drainage area (Johnson and Molesworth 2015). The USFS Hydrology Specialist Report estimated flood flows following the Tripod Complex Fire would increase by 153 percent. Assuming a direct correlation between percent area burned and flood flow increases, Beaver Creek flood flows should have flow increases of approximately 126 percent with a 42 percent burned area. A 2015 report for the Okanogan County Fires estimated increases in modeled 25-year 24-hour rainfall runoff events ranged from 137 percent to 478 percent (BAER 2015). These results are based on rainfall-runoff modeling, rather than instream gaged data. Rainfall recurrence intervals and streamflow recurrence intervals are not necessarily the same. Rainfall recurrence intervals are based on both the magnitude, or depth of rain, and the duration of the storm event, where streamflow recurrence intervals are based only on the magnitude of the instantaneous peak flow (USGS 2016). Rainfall evens and flood events are not directly correlated, and many factors can affect the runoff of a rainfall event and resulting magnitude of flow in the stream (USGS 2016).

The recovery time for increased peak flows can range from 3 to 10 years, or more, depending on the rate of recovery of soil conditions and the reestablishment of vegetation (Moody and Martin 2001). The Carlton Complex Fire occurred in 2014 and is likely still impacting the runoff hydrology of the drainage. With the additional years of recovery since 2014, the impacts to peak flows should be decreased. However, quantifying the amount of peak flow increases at this midpoint in the recovery process is difficult. A simple approach is to use the percent flow increase percentage of approximately 126 percent, based on the analysis of the Tripod Complex Fire correlated to percent area burned from the recent Carlton Complex Fire. The recent unweighted regional regression values are relatively similar to the revised Log-Pearson Type III results including the 1957 flood event. The data used for the revised Log Pearson Type III analysis are nearly 40 years old and may not represent current hydrologic conditions. For this reason, the recent regional regression values are proposed for future modeling efforts. Table 2-8 compares the regional regression values to values increased 126 percent to account for potential post-fire flood flow increases.

Table 2-8. Increased Peak Discharge Estimate Downstream of Piper Creek (RM 7.0)

			USGS 12449600 Peak Discharge Estimates			
Estimation Method	2-year (cfs)	5-year (cfs)	10-year (cfs)	25-year (cfs)	50-year (cfs)	100-year (cfs)
Regional Regression Equations[1/]	192	348	479	666	833	1,000
Increased Regional Regression Estimates	242	438	604	839	1050	1,260

1/ Discharges calculated using regional regression equations (Mastin et al. 2016)

2.4 Fish Use and Habitat Conditions

A comprehensive review of fish use and habitat conditions in Beaver Creek is presented in the Beaver Creek Reach Assessment (Tetra Tech 2017); a summary of key elements is provided in this section.

2.4.1 Fish Use

Beaver Creek is known to support summer steelhead, cutthroat trout (*O. clarkia*), and until recently a small population of bull trout in the upper reaches. In recent years, limited spring Chinook and coho (*O. kisutch*) salmon spawning has been observed in the lower reach near the mouth of the creek. Mountain whitefish (*Prosopium williamsoni*) and introduced brook trout (*Salvelinus fontinalis*) are known to be present in various areas of the Beaver Creek drainage (Andonaegui 2000; USBR 2013a). There are also a number of other non-anadromous species that are typical of higher elevation streams of the east slope Cascades including shorthead sculpin (*Cottus confuses*), smallmouth bass (*Micropterus dolomieu*), bridgelip sucker (*Catostomus columbianus*), and longnose dace (*Rhinichthys cataractae*) (USBR 2013a). Bridgelip sucker, longnose dace, and smallmouth bass have generally only been observed using the lower reaches of Beaver Creek. Pacific lamprey (*Entosphenus tridentatus*) have not been found in Beaver Creek fish surveys, though they were historically found in large numbers in the Methow River and there were no known barriers to their use of Beaver Creek before European settlement (NPCC 2005; WDFW 2011; Crandall 2016; Nelle et al. 2016).

Summer steelhead are a primary species of concern in Beaver Creek, and the stream is considered to contain important spawning and rearing habitat for this species (Peven 2003; Hopkins 2013). Steelhead use of Reach 5 includes all freshwater life stages, including both spawning and rearing. Adults migrate upstream to spawn between March and May (Weigel 2013). Steelhead redd counts from 2002 to 2011 indicate that the majority of spawning occurs downstream of Reach 5, but some spawning still occurs between RMs 5.8 to 9.0, at 0.6 redds/mile (Hopkins 2013). Steelhead spawning is likely limited due to channel confinement and course substrate. Although steelhead juvenile outmigration timing for the Methow Subbasin is typically estimated between April and June, research in Beaver Creek indicates that a portion of juveniles migrate out of the Beaver Creek drainage in fall, and that these fish were more successful returning as adults (USBR 2013a).

Bull trout are also a primary species of concern in Beaver Creek. Historically, both fluvial and resident populations of bull trout were present within the Beaver Creek drainage, including in the South Fork Beaver Creek and Blue Buck Creek (Andonaegui 2000; NPPC 2002). Current populations, however, are severely depressed and in some cases may be entirely replaced with brook trout (Andonaegui 2000). In Reach 5 bull trout presence would primarily occur during adult or juvenile migration. Bull trout use may have included possible low utilization for juvenile rearing, but may be water temperature limited. Surveys in 2007 indicated that the 2006 Tripod Complex Fire likely wiped out the population in Blue Buck Creek, whereas in 2004 surveys had previously identified 24 bull trout (USFS 2007). Following the Carlton Complex Fire, bull trout in Beaver Creek are considered to be functionally extirpated and have not been observed in surveys (ODFW and USFWS 2015).

2.4.2 Fish Habitat Conditions

As identified in the Beaver Creek Reach Assessment (Tetra Tech 2017) and reconfirmed during the topographic survey, the Project area has undergone significant anthropogenic impacts, including fire, diversions, grazing, road construction, and timber harvest. As described above in Section 2.2, the Project area is wood deficient, has suffered riparian impacts from recent fires, is incised with limited lateral migration, and has limited floodplain connectivity. Reach 5 has the lowest frequency of pools in the Reach Assessment Survey Area, and is dominated by rapid habitat units.

The reach-scale results of the REI analysis (Tetra Tech 2017) provide a summary of the reach conditions for 11 specific indicators. The indicators in Table 2-9 describe the high degree of impairment related to LWD, pools, and riparian condition (structure, disturbance and canopy cover) in Reach 5. The complete REI analysis is in Appendix D of the Beaver Creek Reach Assessment (Tetra Tech 2017).

Table 2-9. Reach-Based Ecosystem Indicator Ratings

Pathway	General Indicators	Specific Indicators	Rating Criteria[1/] Adequate	At Risk	Unacceptable	Reach 5 Rating
Habitat Assessment	Physical Barriers	Main Channel Barriers	No manmade barriers present in the mainstem that limit upstream or downstream fish passage at any flows	Manmade barriers present in the mainstem that prevent upstream or downstream migration at some flows that are biologically significant	Manmade barriers present in the mainstem that prevent upstream or downstream migration at multiple or all flows	Adequate
Habitat Quality	Substrate	Dominant substrate/ Fine sediment	Dominant Substrate is gravel or cobble (interstitial spaces clear), or embeddedness < 20%, <12% fines (<0.85mm) in spawning gravel or <12% surface fines of <6mm	Gravel and Cobble is subdominant, or if dominant, embeddedness is 20-30%; 12-17% fines (<0.85 mm) in spawning gravel or 12-20% surface fines of <6 mm	Bedrock, sand, silt, or small gravel dominant, or if gravel and cobble dominant, embeddedness > 30%; >17% fines (<0.85 mm) in spawning gravel or >20% surface fines of <6 mm	At Risk
	LWD	Pieces/mile at bankfull	>42.5 pieces/mile >12" dbh > 35' length; and adequate sources of woody debris available for both long- and short-term recruitment.	Current levels meet piece frequency standard for Adequate, but lacks potential sources from riparian areas for wood debris recruitment to maintain that standard	Does not meet standards for Adequate and lacks potential large woody material recruitment.	Unacceptable
	Pools	Pool frequency and quality	Pool frequency in a reach closely approximates criteria. Also, pools have good cover and cool water, and only minor reduction of pool volume by fine sediment	Pool frequency is similar to values in "adequate", but pools have inadequate cover/ temperature, and/or there has been a moderate reduction of pool volume by fine sediment	Pool frequency is considerably lower than values desired for "functioning appropriately"; also cover/temperature is inadequate, and there has been a major reduction of pool volume by fine sediment.	Unacceptable
	Off-Channel Habitat	Connectivity with main channel	Reach has ponds, oxbows, backwaters, and other low-energy off-channel areas with cover; similar to conditions that would be expected in the absence of human disturbance	Reach has some ponds, oxbows, backwaters, and other low-energy off-channel areas with cover; but availability or access is less than what would be expected in the absence of human disturbance	Reach has few or no ponds, oxbows, backwaters, or other off-channel areas relative to what would be expected in the absence of human disturbance.	At Risk
Channel	Dynamics	Floodplain connectivity	Floodplain areas are frequently hydrologically linked to main channel; overbank flows occur and maintain wetland functions, riparian vegetation and succession	Reduced linkage of wetlands, floodplains, and riparian areas to main channel; overbank flows are reduced relative to historical frequency, as evidenced by moderate degradation of wetland function, riparian vegetation/succession	Severe reduction in hydrologic connectivity between off-channel wetland, floodplain, and riparian areas; wetland extent drastically reduced and riparian vegetation/succession altered significantly	At Risk

Table 2-9. Reach-Based Ecosystem Indicator Ratings (continued)

Pathway	General Indicators	Specific Indicators	Rating Criteria[1/] Adequate	At Risk	Unacceptable	Reach 5 Rating
Channel (cont.)	Dynamics (cont.)	Bank stability/ Channel migration	Channel is migrating at or near natural rates.	Limited amount of channel migration is occurring at a faster/slower rate relative to natural rates, but significant change in channel width or planform is not detectable; large woody debris is still being recruited.	Little or no channel migration is occurring because of human actions preventing reworking of the floodplain and large woody debris recruitment; or channel migration is occurring at an accelerated rate such that channel width has a least doubled, possibly resulting in a channel planform change, and sediment supply has noticeably increased from bank erosion.	At Risk
		Vertical channel stability	No measurable trend of aggradation or incision and no visible change in channel planform.	Measurable trend of aggradation or incision that has the potential to but not yet caused disconnection of the floodplain or a visible change in channel planform (e.g., single thread to braided).	Enough incision that the floodplain and off-channel habitat areas have been disconnected; or, enough aggradation that a visible change in channel planform has occurred (e.g., single thread to braided).	Unacceptable
Riparian Vegetation	Condition	Structure	>80% species composition, seral stage, and structural complexity are consistent with potential native community.	50-80% species composition, seral stage, and structural complexity are consistent with potential native community.	<50% species composition, seral stage, and structural complexity are consistent with potential native community.	At Risk
		Disturbance (human)	>80% mature trees (medium-large) in the riparian buffer zone (defined as a 30 m belt along each bank) that are available for recruitment by the river via channel migration; <20% disturbance in the floodplain (e.g., agriculture, residential, roads, etc.); <2 mi/mi^2 road density in the floodplain.	50-80% mature trees (medium-large) in the riparian buffer zone (defined as a 30 m belt along each bank) that are available for recruitment by the river via channel migration; 20-50% disturbance in the floodplain (e.g., agriculture, residential, roads, etc.); 2-3 mi/mi2 road density in the floodplain.	<50% mature trees (medium-large) in the riparian buffer zone (defined as a 30 m belt along each bank) that are available for recruitment by the river via channel migration; >50% disturbance in the floodplain (e.g., agriculture, residential, roads, etc.); >3 mi/mi^2 road density in the floodplain.	At Risk
		Canopy cover	Trees and shrubs within one site potential tree height distance have >80% canopy cover that provides thermal shading to the river.	Trees and shrubs within one site potential tree height distance have 50-80% canopy cover that provides thermal shading to the river.	Trees and shrubs within one site potential tree height distance have <50% canopy cover that provides thermal shading to the river.	At Risk

2.5 Vegetation

Management practices including grazing, road construction, timber harvesting, and fires have led to significant changes to vegetation communities. An estimated 40 percent of riparian areas in Beaver Creek burned in the 2014 fire, with 16 percent of that rated as moderate to high severity (Johnson and Molesworth 2015). In general, riparian vegetation has been impacted throughout much of Reach 5, and riparian structure in that reach was ranked "at risk" in the REI analysis because fire related impacts to riparian vegetation structure that is less than would be expected in the absence of human alterations. Similarly, Reach 5 was rated "at risk" for disturbance because of some mature trees but also high road density within the historical floodplain. The canopy cover within 100 feet of the stream bank in Reach 5 averaged 53 percent, giving the reach a rating of "at risk" for that category as well. Of the eight habitat units in Reach 5 where vegetation data were collected, seven units were composed of small trees, shrubs and seedlings, or saplings and poles, and only one habitat unit was composed of large trees. Trees surveyed included a mix of hardwoods and conifers.

Observations during the April 2017 field survey indicate that riparian vegetation in the Project area consists of a mixed age classes of deciduous trees including red alder (*Alnus rubra*), black cottonwood (*Populus trichocarpa*), water birch (*Betula occidentalis*), choke cherry (*Prunus virginiana*), and a few small patches of aspen (*Populus tremuloides*). Conifers are also common and consist of mixed age classes of Douglas-fir (*Pseudotsuga menziesii*) and ponderosa pine (*Pinus ponderosa*) that occur in large patches throughout the reach. Shrubs include red-osier dogwood (*Cornus sericea*), and dense clumps of wild rose (*Rosa* sp.) that appear to be invigorated by the recent fires. A botanical and rare plant survey will be conducted to classify the stand composition and develop vegetation restoration objectives for the Project.

3. 15 PERCENT CONCEPT DESIGN ALTERNATIVES

Restoration opportunities were identified during the field surveys conducted for the Beaver Creek Reach Assessment between June 27 and July 1, 2016, during the topographic survey on April 24 and 26, 2017, and on subsequent site planning visits on April 28, 2017.

Subsequent to these surveys, flows caused by a storm between May 4 and May 5, 2017, created a debris jam and subsequent channel avulsion adjacent to a past restoration project near the Batie Diversion at approximately RM 6.3, downstream of the Project. The elevated flows and debris jam washed out a section of Upper Beaver Creek Road and a number of power poles, as well as caused impacts to the Batie Diversion and a cabin. The storm flows also appear to have created channel changes within the Project area, including at the Parmley Diversion near the downstream end of the Project. Further surveys and analyses are planned for July and August 2017 to evaluate the changed conditions.

The 15 Percent Concept Design Alternatives Drawings (Appendix A) were developed based on the design criteria in Section 1.3, using information collected during the surveys and site visit described previously and the analyses in the Beaver Creek Reach Assessment (Tetra Tech 2017). The topographical data in the 15 Percent Concept Design Alternatives Drawings are from the 2016 topo-bathymetric LiDAR surface.

Proposed actions in the 15 Percent Concept Design Alternatives include:

- Adding stable LWD structures in the stream channel to increase pool frequency and quality, retain mobile sediment and wood to aggrade the streambed and reduce channel incision, and reconnect side channels, alcoves, and adjacent floodplains to create hydraulic diversity and dissipate energy;
- Augmenting existing infrastructure protection rip-rap with large wood to improve margin-based habitat conditions;

- Reconnecting relic channels to increase habitat diversity and complexity, pool frequency and quality, and retain mobile sediment and wood; and
- Creating backwater alcoves with added wood to increase habitat diversity and complexity, and improve off-channel habitat for juvenile rearing.

There are currently no proposed actions at the Piper Creek and NF-4225 culverts. The Piper Creek culvert has been recently replaced with a 3-foot corrugated metal pipe culvert and no immediate restoration actions are proposed. The NF-4225 culvert at the time of survey had 4 feet of clearance from the water surface to crown of culvert, and the recommendation is to increase maintenance activities with no immediate restoration actions proposed. Continued observation of the performance of both culverts for function and debris/sediment transport is recommended, and future design stages may incorporate restoration actions at one or both locations.

Specific proposed design elements include the following, with locations provided by approximate engineering Station (Sta.):

- LWD structure and boulder additions:
    - Ballasted LWD revetments to protect infrastructure at Sta. 10+00, 15+00, 24+00, and 105+00.
    - Existing wood jams to be supplemented with LWD at Sta. 17+50, 22+50, 23+50, 29+50, 36+50, 47+00, 49+50, and 61+50.
    - Channel-spanning LWD structures to add habitat complexity, channel roughness, and sediment sorting at Sta. 18+00, 26+00, 29+50, 34+00, 40+00, 42+00, 46+00, 49+00, 51+00, 54+00, 63+00, 64+50, 67+50, and 95+50.
    - Stable LWD structures to activate relic side channels at Sta. 24+00, 28+00, 34+00, and 105+00, each with side channel LWD to provide habitat complexity, channel roughness, and sediment sorting.
    - Bank LWD structures to create roughness and floodplain activation at Sta. 75+00 and 95+00.
    - Addition of boulders to existing habitat feature at Sta. 65+00.
- Side-channel and alcove reconnections:
    - Preparation of historical channel for future activation at Sta. 15+00.
    - High-flow side channel at Sta. 102+00, connecting under Upper Beaver Creek Road with a fish-passable structure, and LWD for habitat downstream of the road crossing.
    - Activation of backwater alcoves with LWD for habitat and cover at Sta. 21+00, 28+00, and 96+50
    - Remove existing road grade/levee at Sta. 104+00.
- Remeandering of the Piper Creek confluence to decrease sediment transport and increase alluvial fan channel stability.

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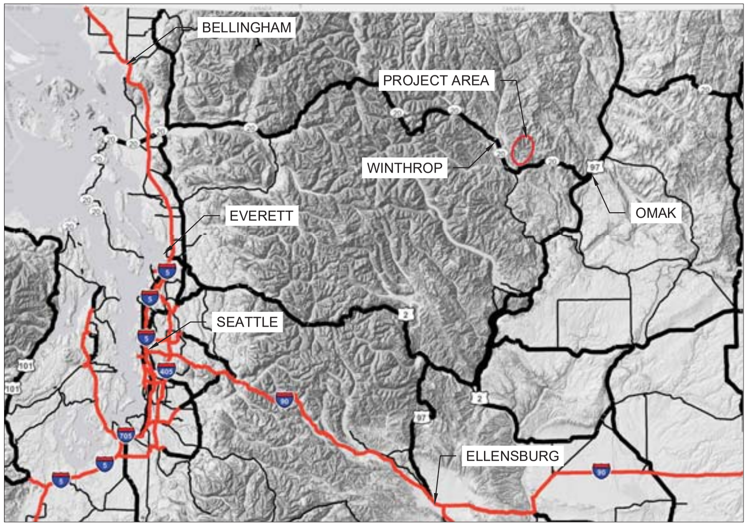
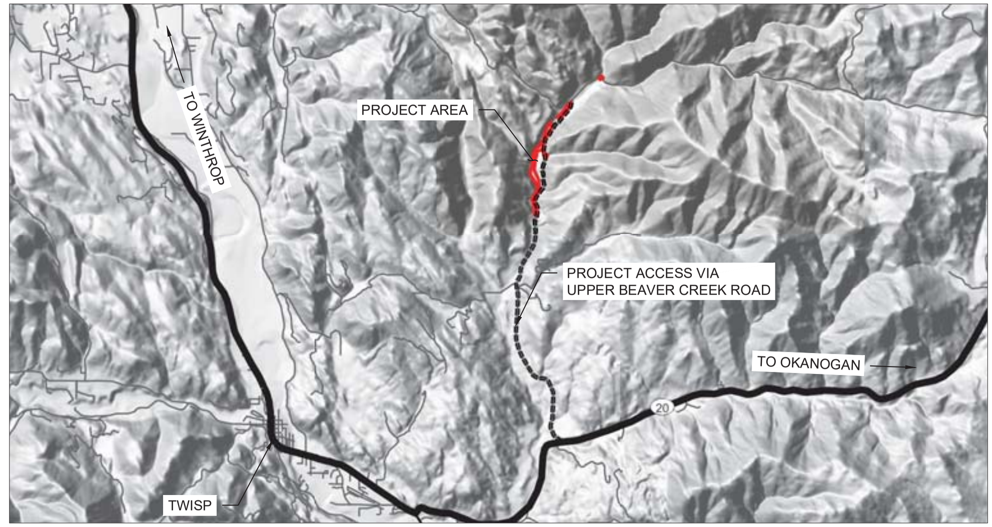
APPENDIX A

15 Percent Concept Design Alternatives Drawings

YAKAMA NATION FISHERIES
BEAVER CREEK REACH 5 DESIGN
15 PERCENT CONCEPT DESIGN ALTERNATIVES



LOCATION MAP
SCALE: NTS



VICINITY MAP
SCALE: 1" = 2 MILES

SHEET LIST

DWG #	TITLE
G-001	COVER SHEET
G-002	GENERAL NOTES
C-001	GENERAL OVERVIEW
C-002 - C-007	CONCEPT DESIGN - FULL RESTORATION
C-008	LWD CONSTRUCTION EXAMPLE
C-009	ALCOVE HABITAT CREATION EXAMPLE
C-010	SIDE CHANNEL CONNECTION EXAMPLE

TETRA TECH
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Bothell, Washington 98011
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Yakama Nation Fisheries

NOT FOR CONSTRUCTION

PLOTTED AS ANSI B (11" X 17"), PLAN SHEET FULL SIZE ANSI D (22" X 34")

REV.	DATE	REVISION DESCRIPTION	DRW	ENG	APP
A	4/12/17	15 PERCENT CONCEPT DESIGN	JSA	JSA	CB

YAKAMA NATION FISHERIES - BEAVER CREEK REACH 5 DESIGN

COVER SHEET

DWG. NO.: G-001
CREATED: 4/11/2017
SHEET: 1 of 12

ABBREVIATIONS

1H:1V	HORIZONTAL TO VERTICAL EXAGGERATION
%	PERCENT
BMP	BEST MANAGEMENT PRACTICES
CWA	CLEAN WATER ACT
DWG	DRAWING
EX.	EXISTING
FT, '	FOOT
IN, "	INCH
LT, (L)	LEFT
LWD	LARGE WOODY DEBRIS
NF-xxx	NATIONAL FOREST (USFS) SERVICE ROAD
NTS	NOT TO SCALE
OHW	ORDINARY HIGH WATER
RD	ROAD
RT, (R)	RIGHT
STA	STATION
TESC	TEMPORARY EROSION SEDIMENT CONTROL
TYP	TYPICAL
USFS	UNITIED STATES FOREST SERVICE
USFWS	UNITED STATES FISH AND WILDLIFE SERVICE
WDFW	WASHINGTON DEPARTMENT OF FISH AND WILDLIFE
XS	CROSS SECTION
YR	YEAR

CONSTRUCTION SEQUENCING:

1. CONSTRUCTION SEQUENCING TO BE DETERMINED AT LATER DESIGN STAGES.

GENERAL NOTES:

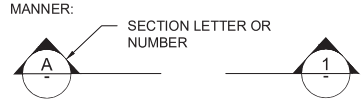
1. HORIZONTAL PROJECTION: NAD83 WASHINGTON STATE PLANES, NORTH ZONE, US FOOT.
2. VERTICAL PROJECTION: NAVD88.
3. PROJECT ALIGNMENT AND STATIONING FROM THE DRAFT BEAVER CREEK REACH ASSESSMENT (APRIL 2017) AND IS BASED ON 2015 AERIAL IMAGERY AND 2016 LiDAR TOPOGRAPHIC DATA.
4. PROPOSED PROJECT DESIGN, CONSTRUCTION ACTIVITIES, AND MATERIALS SUBJECT TO APPROVAL BY LANDOWNER.

GENERAL CONSTRUCTION NOTES:

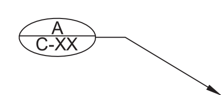
1. THE CONTRACTOR SHALL CONSTRUCT THE RESTORATION DESIGN ELEMENTS IN ACCORDANCE WITH THE PLANS STAMPED "ISSUED FOR CONSTRUCTION". THESE PLANS WILL BE PROVIDED TO THE CONTRACTOR BY THE CONTRACTING AGENCY PRIOR TO CONSTRUCTION. WORK SHALL NOT BE DONE WITHOUT THE CURRENT SET OF APPROVED CONSTRUCTION PLANS.
2. CONTRACTOR SHALL CONTACT THE NORTHWEST UTILITY NOTIFICATION CENTER 1-800-424-5555 (OR 811) BEFORE ANY EXCAVATION WORK BEGINS.
3. THE CONTRACTOR SHALL PURSUE WORK IN A CONTINUOUS AND EFFICIENT MANNER TO ENSURE TIMELY COMPLETION OF THE PROJECT.
4. ALL WORK WITHIN THE ACTIVE CHANNEL SHALL OCCUR WITHIN THE ALLOWABLE FISH WINDOW.
5. ALL CONSTRUCTION ACTIVITIES SHALL MINIMIZE DISTURBANCE TO AND MAXIMIZE RE-USE OF EXISTING RIPARIAN VEGETATION.
6. THE CONTRACTOR SHALL PROTECT ALL CONTROL POINTS DURING CONSTRUCTION ACTIVITIES.
7. CONTRACTOR SHALL PROVIDE AN EROSION AND SEDIMENT CONTROL AND DEWATERING PLAN TO OWNER AT LEAST TEN (10) DAYS PRIOR TO THE BEGINNING OF CONSTRUCTION ACTIVITIES.

SYMBOLS

SECTIONS ARE REFERENCED IN THE FOLLOWING MANNER:



CONSTRUCTION DETAILS ARE REFERENCED IN THE FOLLOWING MANNER:



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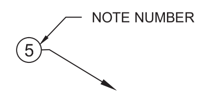

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NOT FOR CONSTRUCTION

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REV.	DATE	REVISION DESCRIPTION	DRW	ENG	APP
A	4/12/17	15 PERCENT CONCEPT DESIGN	JSA	JSA	CB

YAKAMA NATION FISHERIES - BEAVER CREEK REACH 5 DESIGN

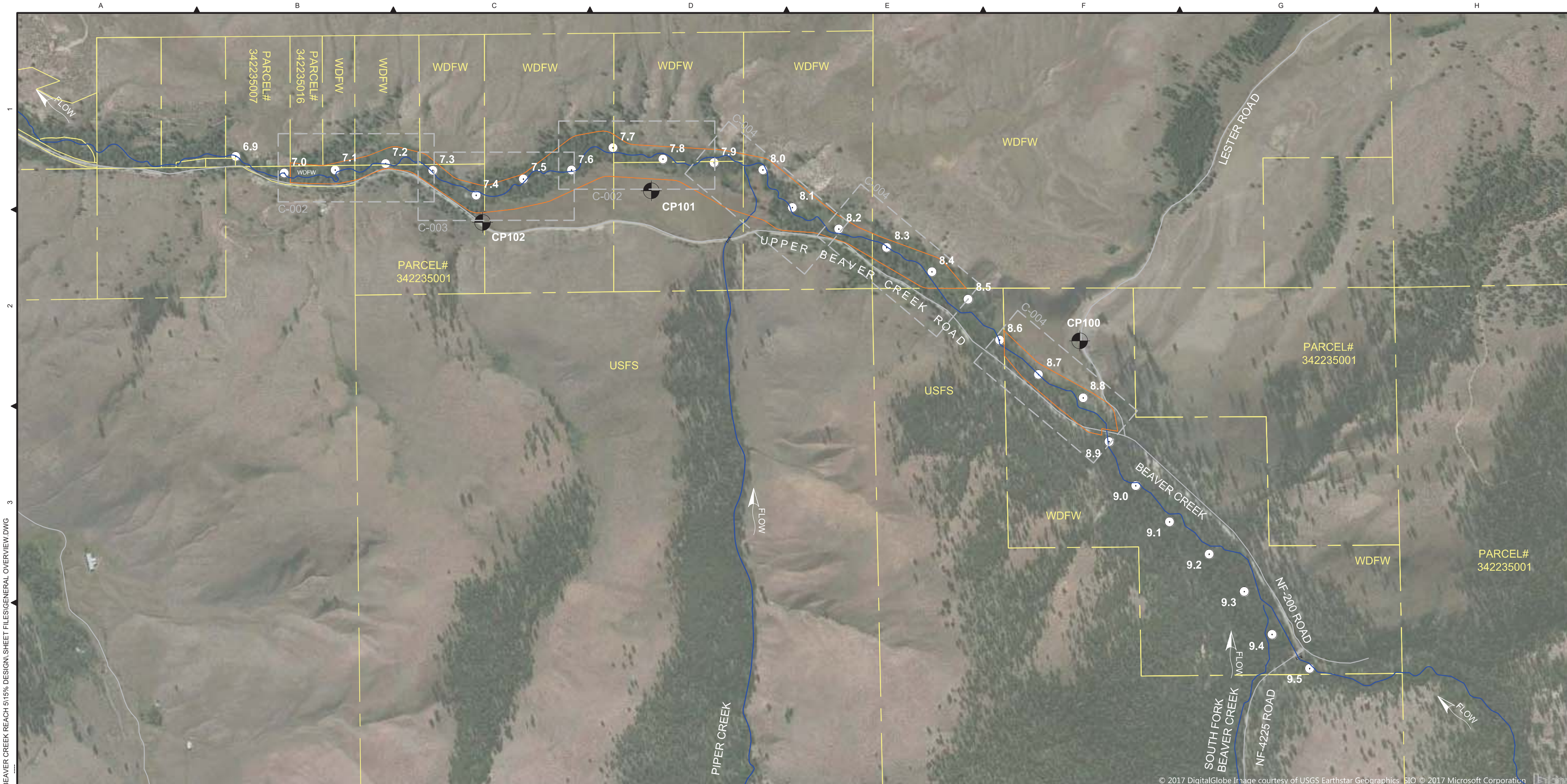
GENERAL NOTES

DWG. NO.: G-002

CREATED: 4/11/2017

SHEET: 2 of 12

Z:\PROJECTS\194-6017 YNF ON CALL SMALL PROJECTS\WORK ORDER 1 - BEAVER CREEK REACH 5\15% DESIGN\SHEET FILES\COVER PAGE AND NOTES.DWG
PLOT DETAILS: ANDREWS, JEREMY May 26, 2017 9:27 AM



0' 500' 1,000' 2,000'

Beaver Creek Control Points				
Point #	Northing	Easting	Elevation	Description
100	522693.1	1834728	2727.186	CP 100
101	518336.2	1833201	2526.271	CP 101
102	516619.6	1833524	2455.264	CP 102

LEGEND:
- BEAVER CREEK ALIGNMENT
- SHEET BOUNDARY
- PROJECT AREA BOUNDARY
- PROPERTY BOUNDARY
- EXISTING ROAD
- RIVER MILE
- SURVEY CONTROL POINT

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A	4/12/17	15 PERCENT CONCEPT DESIGN	JSA	JSA	CB

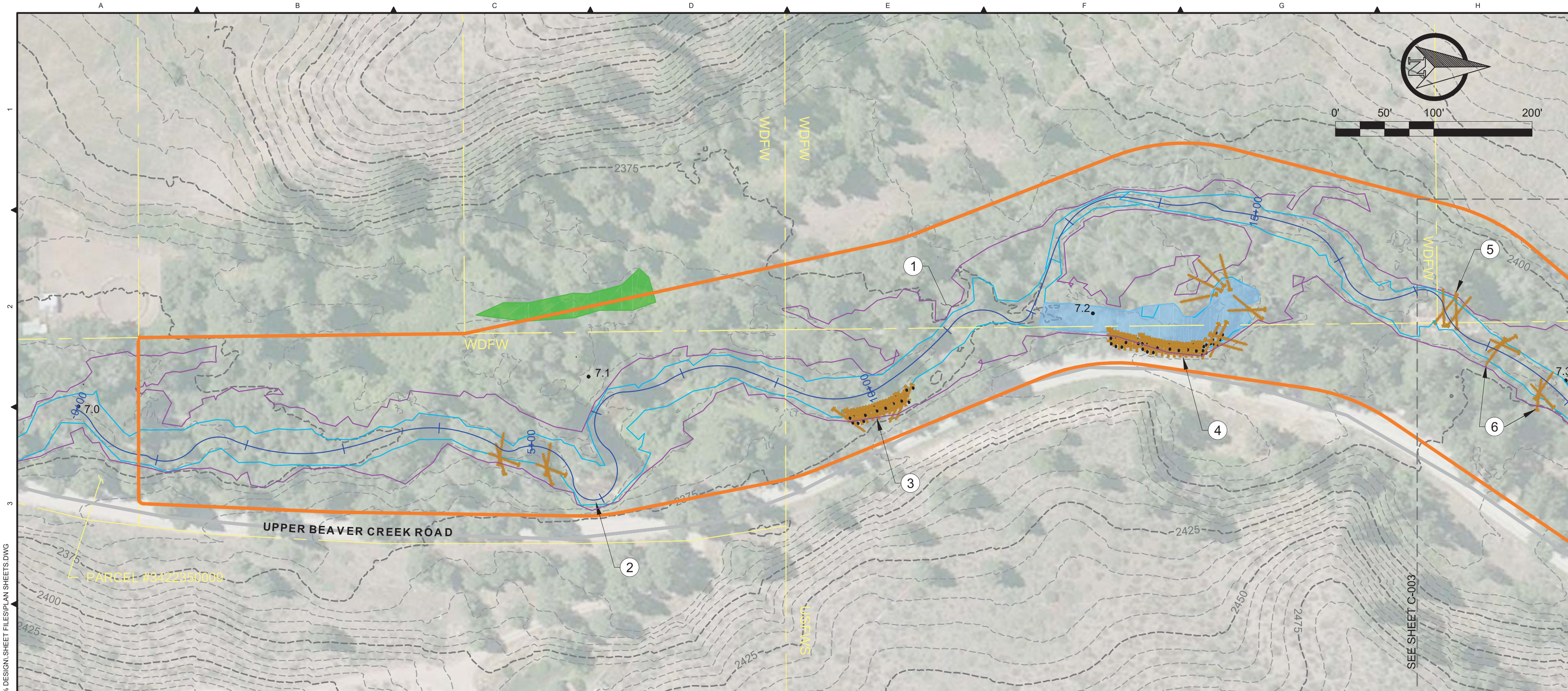
YAKAMA NATION FISHERIES - BEAVER CREEK REACH 5 DESIGN

GENERAL OVERVIEW

DWG. NO.: C-001

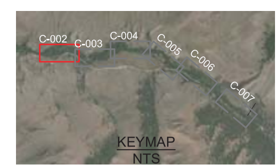
CREATED: 4/11/2017

Z:\PROJECTS\194-6017 YNF ON CALL SMALL PROJECTS\WORK ORDER 1 - BEAVER CREEK REACH 5\15% DESIGN\SHEET FILES\GENERAL OVERVIEW.DWG
PLOT DETAILS: ANDREWS, JEREMY May 25, 2017 2:47 PM



NOTES:
1. EXISTING PARMLEY IRRIGATION DIVERSION WITHIN AN EXISTING LOG JAM.
2. COUNTY ROAD DEPARTMENT PLACING RIPRAP TO PROTECT ROAD.
3. SUPPLEMENT EXISTING LWD TO PROTECT ROAD. SET LWD REVETMENT WITH BALLAST SO THAT ROAD PRISM IS NOT EXCAVATED.
4. INSTALL SEASONAL HIGH FLOW BACKWATER ALCOVE AND PRE-STAGE LWD FOR FUTURE RIVER RECAPTURE OF CHANNEL AND BANK REVETMENT WITH BALLAST TO PROTECT ROAD.
5. SUPPLEMENT EXISTING MID BAR LWD.
6. PLACE CHANNEL SPANNING LWD STRUCTURE TO INCREASE CHANNEL ROUGHNESS.

LEGEND:
- SHEET BOUNDARY
- PROJECT AREA BOUNDARY
- EXISTING 2-YEAR FLOW
- EXISTING 100-YEAR FLOW
- PROPOSED LWD
- PROPOSED BACKWATER/ ALCOVE
- RIVER MILE
- PROPERTY BOUNDARY
- EXISTING ROAD
- BEAVER CREEK ALIGNMENT
- WETLAND POND COMPLEX



KEYMAP
NTS

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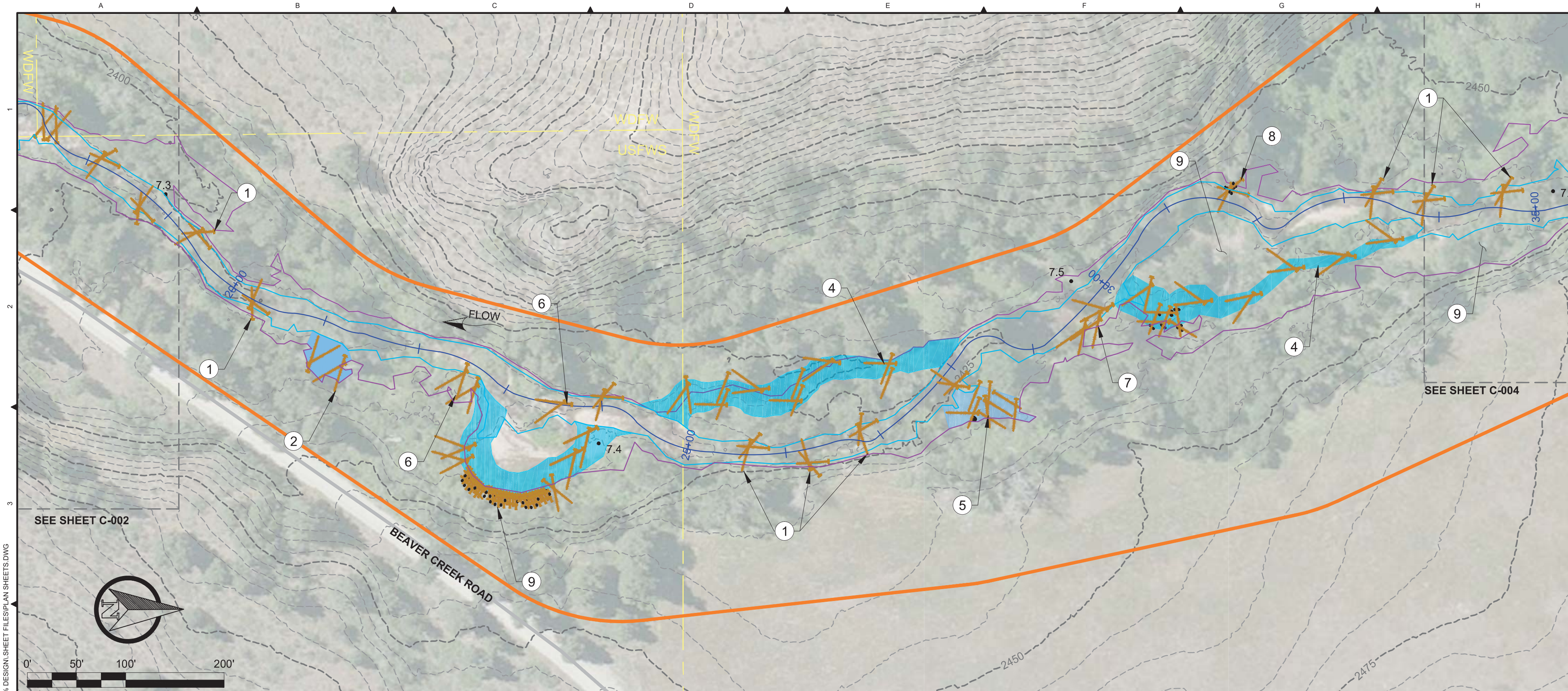
A	4/12/17	15 PERCENT CONCEPT DESIGN	JSA	JSA	CB

YAKAMA NATION FISHERIES - BEAVER CREEK REACH 5 DESIGN

CONCEPT DESIGN
FULL RESTORATION

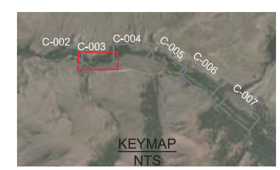
DWG. NO.: C-002
CREATED: 4/11/2017
SHEET: 4 of 12

Z:\PROJECTS\194-6017 YNF ON CALL SMALL PROJECTS\WORK ORDER 1 - BEAVER CREEK REACH 5\15% DESIGN\SHEET FILES\PLAN SHEETS.DWG
PLOT DETAILS: ANDREWS, JEREMY May 26, 2017 2:04 PM



NOTES:
1. PLACE CHANNEL SPANNING LWD STRUCTURE TO INCREASE CHANNEL ROUGHNESS.
2. ENHANCE EXISTING GROUNDWATER ALCOVE BY EXCAVATING DEEP POOL. AND ADDITIONAL LWD FOR COVER.
3. ENHANCE RELIC SIDE CHANNEL BY PLACING LWD BANK STRUCTURE AND ADDITIONAL LWD FOR COVER.
4. INSTALL LWD TO ACTIVATE EXISTING SIDE CHANNEL.AND INCORPORATE LARGE FELLED TREES INTO LWD.
5. ENHANCE EXISTING ALCOVE INITIATED BY EXISTING LARGE BOULDER AND PLACE LWD FOR COVER.
6. SUPPLEMENT EXISTING MID BAR LWD.
7. SUPPLEMENT EXISTING LOG JAM AND REMOVE OLD CABLE FORM STREAM.
8. PLACE CHANNEL SPANNING LWD STRICTURE WITH BALLAST.
9. FLOODPLAIN RECONNECTION.

LEGEND:
- PROJECT AREA BOUNDARY
- EXISTING 2-YEAR FLOW
- EXISTING 100-YEAR FLOW
- PROPOSED LWD
- PROPOSED NEW MAIN CHANNEL
- PROPOSED BACKWATER/ ALCOVE
- RIVER MILE
- PROPERTY BOUNDARY
- EXISTING ROAD
- BEAVER CREEK ALIGNMENT



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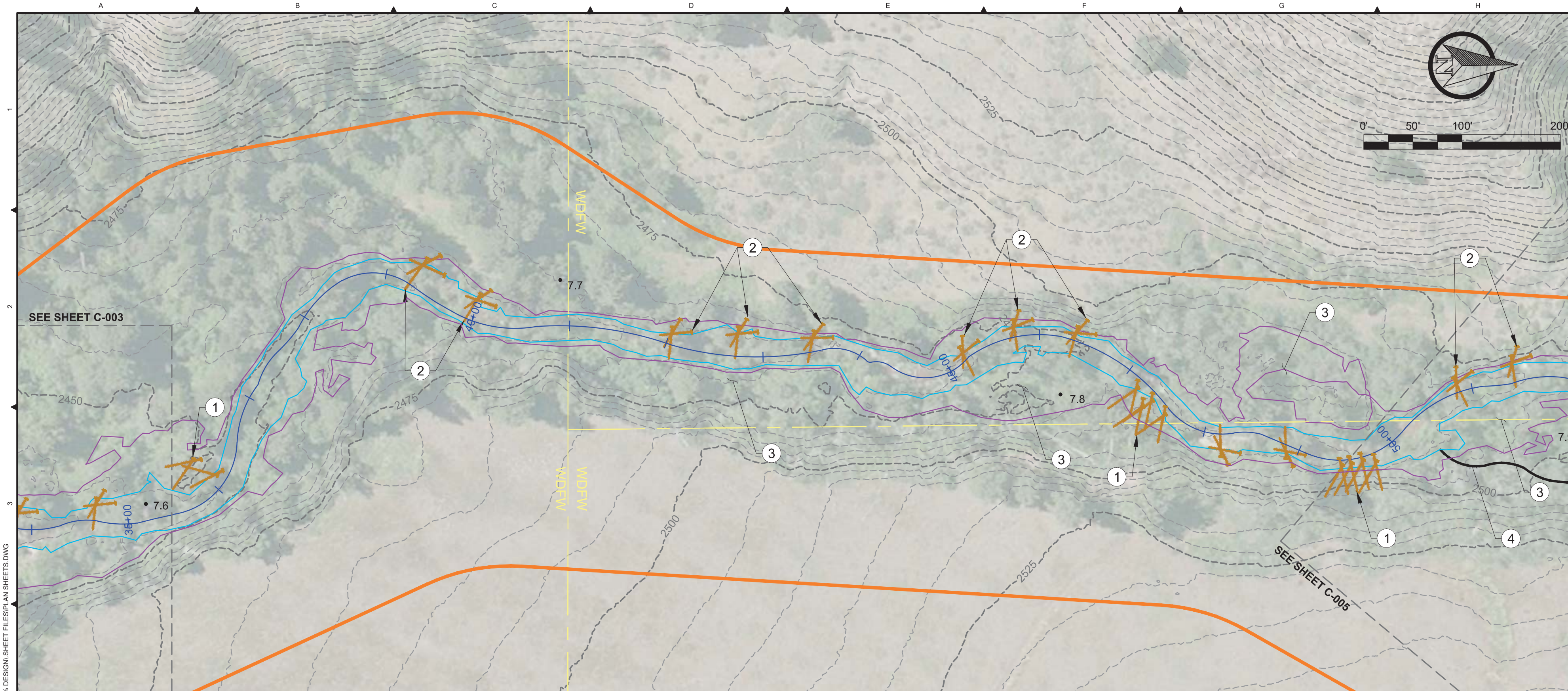
A	4/12/17	15 PERCENT CONCEPT DESIGN	JSA	JSA	CB

YAKAMA NATION FISHERIES - BEAVER CREEK REACH 5 DESIGN

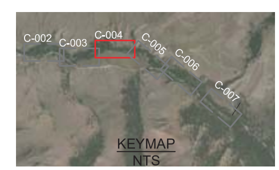
CONCEPT DESIGN FULL RESTORATION

DWG. NO.: C-003
CREATED: 4/11/2017
SHEET: 5 of 12



NOTES:
1. SUPPLEMENT EXISTING LWD STRUCTURE WITH ADDITIONAL WOODY DEBRIS.
2. PLACE CHANNEL SPANNING LWD STRUCTURE TO INCREASE CHANNEL ROUGHNESS.
2. PLACE CHANNEL SPANNING LWD STRUCTURE WITH BALLAST.
3. FLOODPLAIN RECONNECTION.
4. REMEANDER PIPER CREEK CONFLUENCE DOWNSTREAM.

LEGEND:
- SHEET BOUNDARY
- PROJECT AREA BOUNDARY
- EXISTING 2-YEAR FLOW
- EXISTING 100-YEAR FLOW
- PROPOSED LWD
- RIVER MILE
- PROPERTY BOUNDARY
- EXISTING ROAD
- BEAVER CREEK ALIGNMENT
- PIPER CREEK REALIGNMENT



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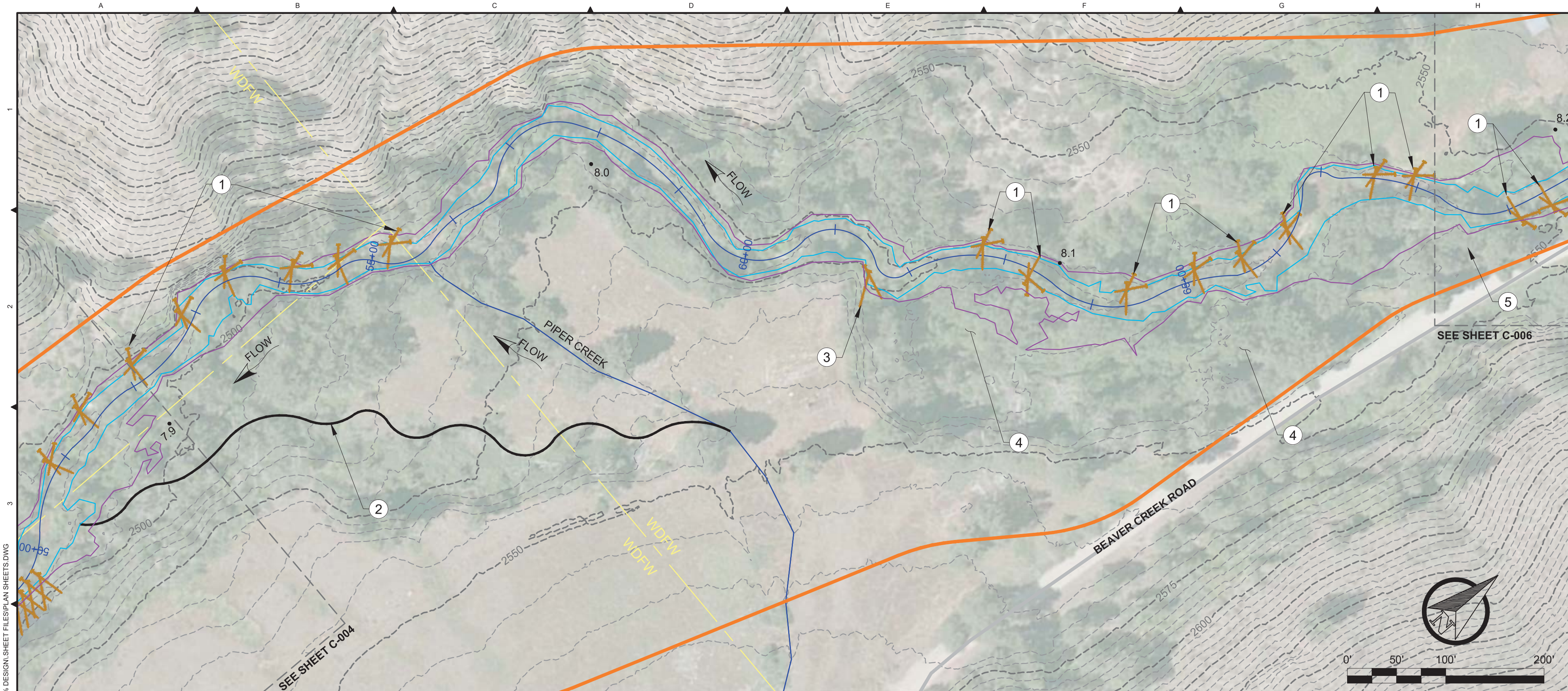
A	4/12/17	15 PERCENT CONCEPT DESIGN	JSA	JSA	CB

YAKAMA NATION FISHERIES - BEAVER CREEK REACH 5 DESIGN

CONCEPT DESIGN FULL RESTORATION

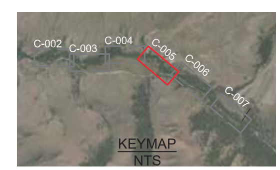
DWG. NO.: C-004
CREATED: 4/11/2017
SHEET: 6 of 12

Z:\PROJECTS\194-6017 YNF ON CALL SMALL PROJECTS\WORK ORDER 1 - BEAVER CREEK REACH 5\15% DESIGN\SHEET FILES\PLAN SHEETS.DWG
PLOT DETAILS: ANDREWS, JEREMY May 26, 2017 1:39 PM



NOTES:
1. PLACE CHANNEL SPANNING LWD STRUCTURE TO INCREASE CHANNEL ROUGHNESS.
2. REMEANDER PIPER CREEK CONFLUENCE DOWNSTREAM.
3. SUPPLEMENT EXISTING LWD STRUCTURE WITH ADDITIONAL WOODY DEBRIS.
4. FLOODPLAIN RECONNECTION.
5. WASHINGTON DEPARTMENT OF ECOLOGY GAGING STATION.

LEGEND:
- SHEET BOUNDARY
- PROJECT AREA BOUNDARY
- EXISTING 2-YEAR FLOW
- EXISTING 100-YEAR FLOW
- PROPOSED LWD
- RIVER MILE
- PROPERTY BOUNDARY
- EXISTING ROAD
- BEAVER CREEK ALIGNMENT
- PIPER CREEK REALIGNMENT



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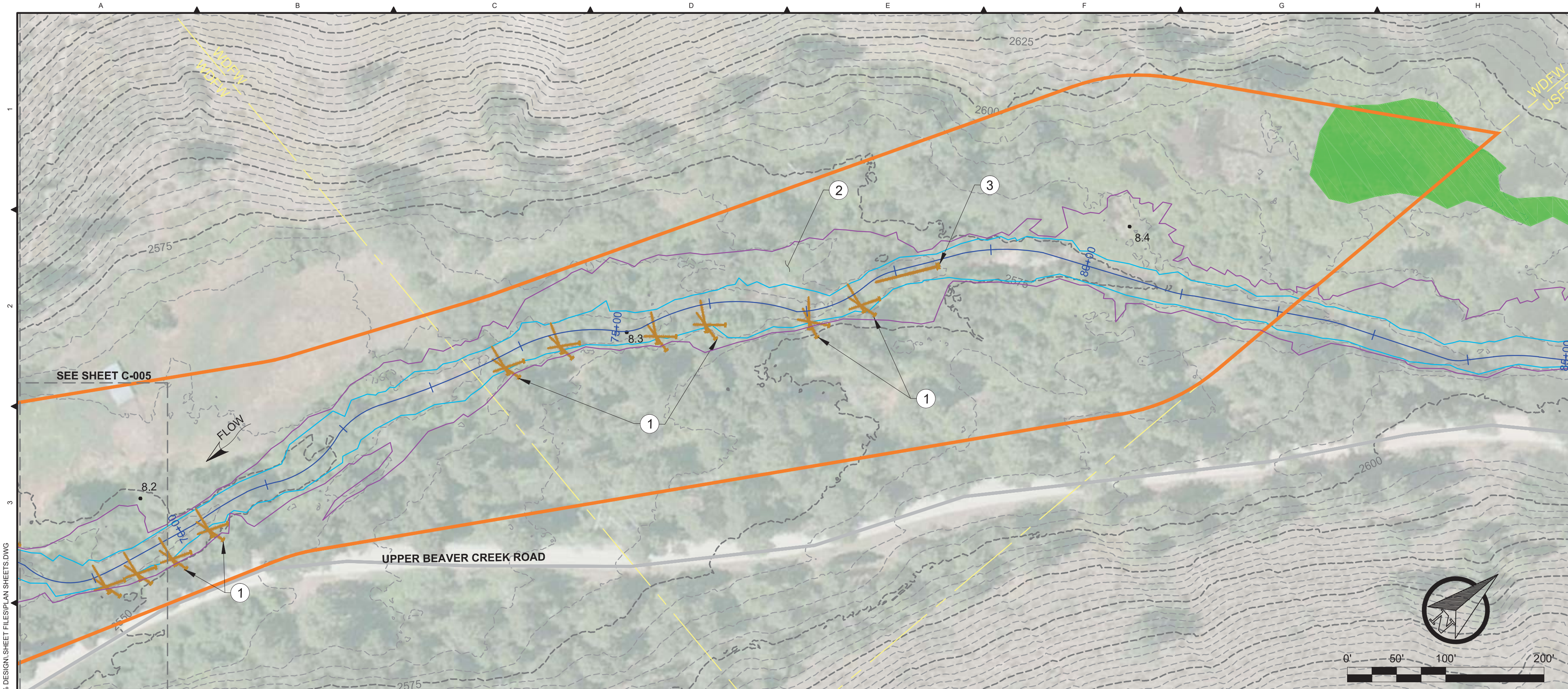
REV.	DATE	REVISION DESCRIPTION	DRW	ENG	APP
A	4/12/17	15 PERCENT CONCEPT DESIGN	JSA	JSA	CB

YAKAMA NATION FISHERIES - BEAVER CREEK REACH 5 DESIGN

CONCEPT DESIGN
FULL RESTORATION

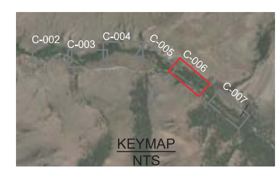
DWG. NO.: C-005
CREATED: 4/11/2017
SHEET: 7 of 12

Z:\PROJECTS\194-6017 YNF ON CALL SMALL PROJECTS\WORK ORDER 1 - BEAVER CREEK REACH 5\15% DESIGN\.SHEET FILES\PLAN SHEETS.DWG
PLOT DETAILS: ANDREWS, JEREMY May 26, 2017 1:43 PM



NOTES:
1. PLACE CHANNEL SPANNING LWD STRUCTURE TO INCREASE CHANNEL ROUGHNESS.
2. FLOODPLAIN RECONNECTION.
3. MOVE LARGE CONIFER TO EXISTING ISLAND TO PROMOTE SPLIT FLOW AND SCOUR.

LEGEND:
- SHEET BOUNDARY
- PROJECT AREA BOUNDARY
- EXISTING 2-YEAR FLOW
- EXISTING 100-YEAR FLOW
- PROPOSED LWD
- RIVER MILE
- PROPERTY BOUNDARY
- EXISTING ROAD
- BEAVER CREEK ALIGNMENT
- WETLAND POND COMPLEX



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A	4/12/17	15 PERCENT CONCEPT DESIGN	JSA	JSA	CB

YAKAMA NATION FISHERIES - BEAVER CREEK REACH 5 DESIGN

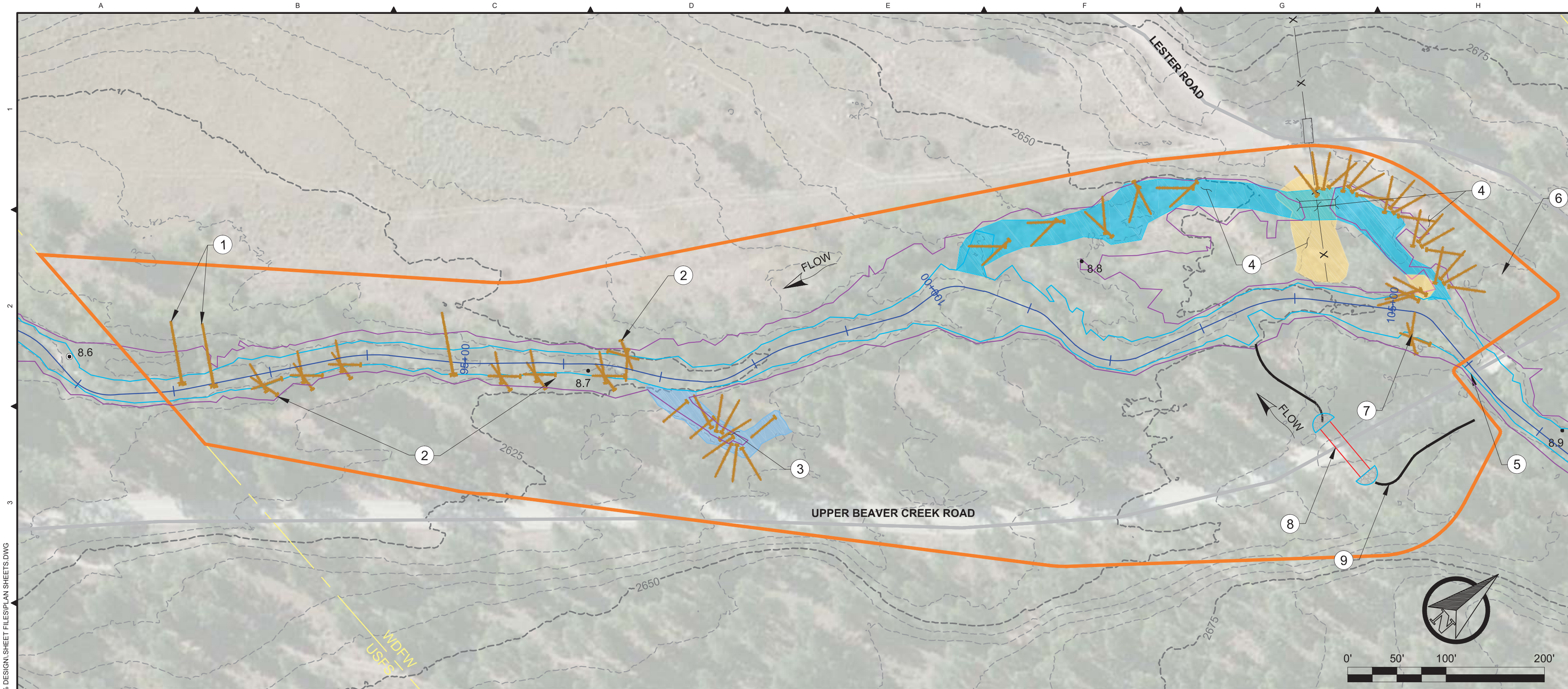
CONCEPT DESIGN
FULL RESTORATION

DWG. NO.: C-006

CREATED: 4/11/2017

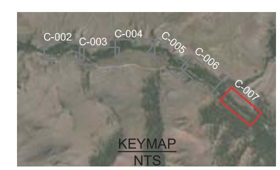
SHEET: 8 of 12

Z:\PROJECTS\194-6017 YNF ON CALL SMALL PROJECTS\WORK ORDER 1 - BEAVER CREEK REACH 5\15% DESIGN\SHEET FILES\PLAN SHEETS.DWG
PLOT DETAILS: ANDREWS, JEREMY May 26, 2017 1:46 PM



NOTES:
1. PLACE EXISTING LARGE FELLED CONIFER INTO STREAM FLOW TO PROMOTE SCOUR.
2. PLACE CHANNEL SPANNING LWD STRUCTURE TO INCREASE CHANNEL ROUGHNESS.
3. MOVE EXISTING WOOD TO PROPOSED ALCOVE AS COVER.
4. ENHANCE NEW MAIN CHANNEL AREA BY REMOVING EXISTING ROAD EMBANKMENT AND 2.5 FT DIAMETER CMP. EXISTING FENCELINE TO BE TEMPORARILY REMOVED AND REINSTALLED. INSTALL REVETMENT LWD TO PROTECT LESTER ROAD.
5. PRESERVE AND PROTECT EXISTING ROADWAY AND BRIDGE.
6. PRESERVE AND PROTECT EXISTING CAMPING AREA.
7. PLACE LWD TO ACTIVATE EXISTING CHANNEL.
8. FISH PASSABLE HIGH FLOW RELIEF CULVERT WITH INLET AND OUTLET RIPRAP SCOUR PROTECTION.
9. BEAVER CREEK HIGH FLOW PATH.

LEGEND:
- PROJECT AREA BOUNDARY
- EXISTING 2-YEAR FLOW
- EXISTING 100-YEAR FLOW
- PROPOSED LWD
- PROPOSED NEW MAIN CHANNEL
- PROPOSED BACKWATER/ ALCOVE
- RIPRAP
- RIVER MILE
- PROPERTY BOUNDARY
- EXISTING FENCE
- EXISTING ROAD
- BEAVER CREEK ALIGNMENT
- EXISTING CULVERT
- PROPOSED HIGH FLOW RELIEF CULVERT
- PROPOSED ROAD/LEVEE EXCAVATION



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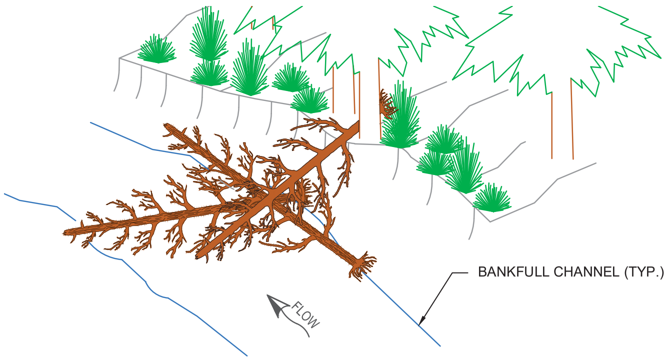
YAKAMA NATION FISHERIES - BEAVER CREEK REACH 5 DESIGN

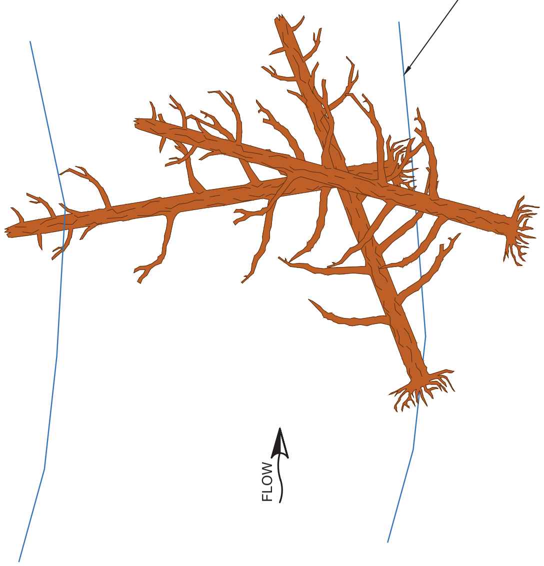
CONCEPT DESIGN
FULL RESTORATION

DWG. NO.: C-007
CREATED: 4/11/2017
SHEET: 9 of 12

Z:\PROJECTS\194-6017 YNF ON CALL SMALL PROJECTS\WORK ORDER 1 - BEAVER CREEK REACH 5\15% DESIGN\SHEET FILES\PLAN SHEETS.DWG
PLOT DETAILS: ANDREWS, JEREMY May 26, 2017 1:50 PM

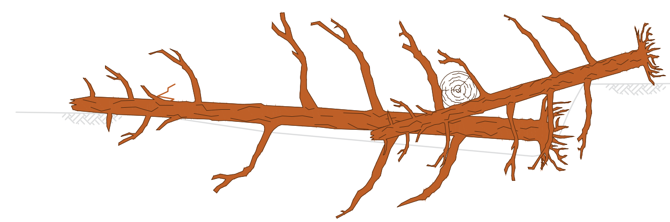


CHANNEL SPANNING STRUCTURE - ISOMETRIC VIEW
NTS

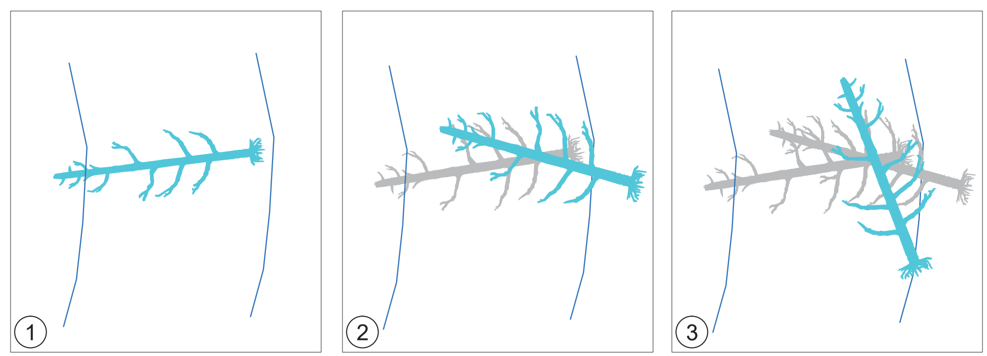


CHANNEL SPANNING STRUCTURE - PLAN VIEW
NTS

LWD NOTES:
1. INSTALL TEMPORARY COFFERDAM UPSTREAM OF STRUCTURE WHEN NEEDED.
2. FISH SALVAGE TO BE SUPERVISED BY QUALIFIED FISH BIOLOGIST.
3. WHOLE TREES WITH ROOTWADS USED IN STRUCTURE SHALL BE 18" DBH, 35 FOOT MIN IN LENGTH, QUANTITY = 3.
4. EXCAVATE STREAM BANK SIDE OF STRUCTURE TO PLACE TIPS OF TREES AND ROCK BELOW EXISTING GRADE.
5. PLACE SMALLER DIAMETER TREES ON BOTTOM LAYER OF STRUCTURE.



CHANNEL SPANNING STRUCTURE - SECTION VIEW
NTS



CHANNEL SPANNING STRUCTURE - LOG PLACEMENT SEQUENCING

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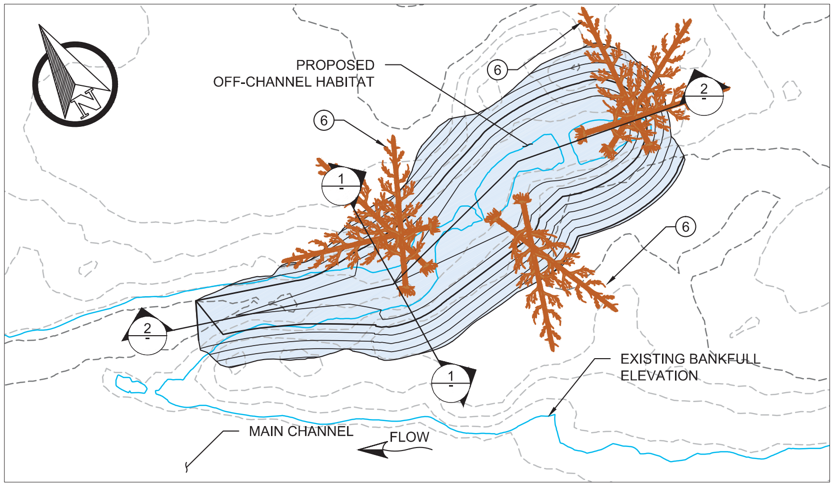
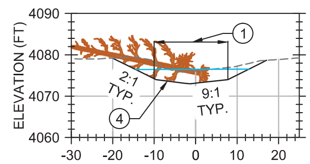
YAKAMA NATION FISHERIES - BEAVER CREEK REACH 5 DESIGN

LWD CONSTRUCTION EXAMPLE

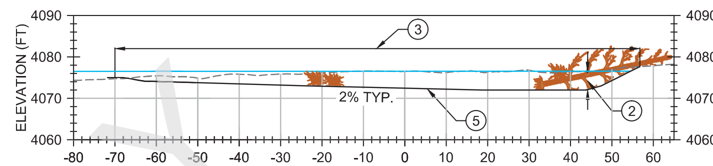
DWG. NO.: C-008
CREATED: 4/11/2017
SHEET: 10 of 12



- / - ALCOVE HABITAT CREATION
PLAN VIEW TYPICAL



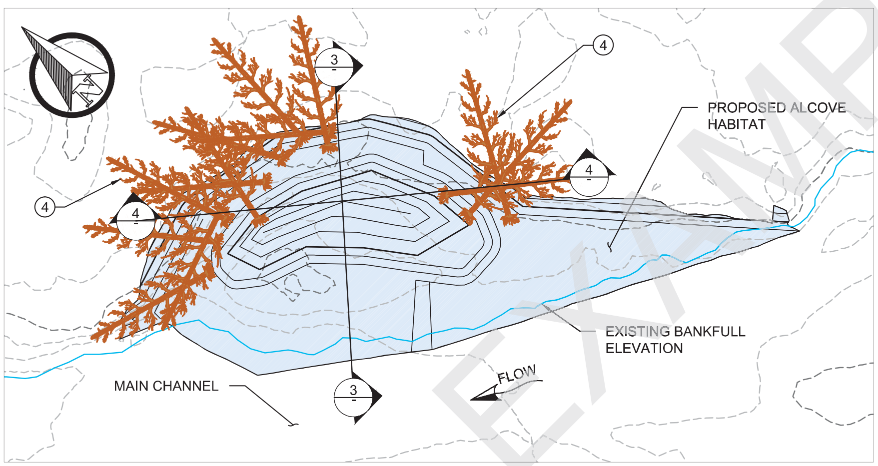
(SCALE 1" = 30', 1H:1V)
1 / - ALCOVE HABITAT CREATION
CROSS SECTION TYPICAL



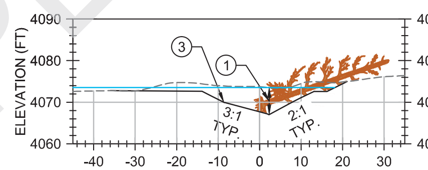
(SCALE 1" = 30', 1H:1V)
2 / - ALCOVE HABITAT CREATION
CROSS SECTION TYPICAL

ALCOVE HABITAT CREATION NOTES:
1. BOTTOM WIDTH OF OFF-CHANNEL VARIES AT EACH OFF-CHANNEL LOCATION.
2. DEPTH OF OFF-CHANNEL EXCAVATION VARIES TO CREATE OFF-CHANNEL WITH MINIMUM 2 FT DEPTH AT BANKFULL FLOWS.
3. LENGTH OF OFF-CHANNEL CREATION VARIES AT EACH OFF-CHANNEL LOCATION .
4. CHANNEL SLOPES SHOWN IN SECTION ARE TYPICAL AND WILL VARY AT EACH OFF-CHANNEL LOCATION.
5. CHANNEL GRADE SHOWN IN SECTION IS TYPICAL AND WILL VARY AT EACH OFF-CHANNEL LOCATION.
6. PLACE LARGE WOOD IN OFF-CHANNEL TO PROVIDE COVER FOR RESIDENT FISH SPECIES. TYPES OF LARGE WOOD STRUCTURES USED WILL VARY AT EACH OFF-CHANNEL LOCATION.

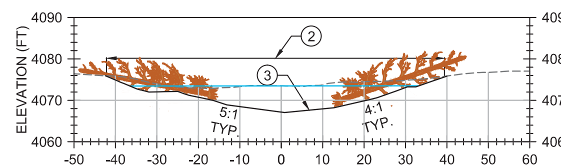
LEGEND:
- EXISTING CONTOUR MAJOR - 5FT
- EXISTING CONTOUR MINOR - 1FT
- EXISTING BANKFULL ELEVATION
- PROPOSED CHANNEL EXCAVATION
- PROPOSED CONTOUR MAJOR - 5FT
- PROPOSED CONTOUR MINOR - 1FT
- PROPOSED LWD



- / - ALCOVE HABITAT CREATION
PLAN VIEW TYPICAL



(SCALE 1" = 30', 1H:1V)
3 / - ALCOVE HABITAT CREATION
CROSS SECTION TYPICAL



(SCALE 1" = 30', 1H:1V)
4 / - ALCOVE HABITAT CREATION
CROSS SECTION TYPICAL

ALCOVE HABITAT CREATION NOTES:
1. DEPTH OF ALCOVE EXCAVATION VARIES AT EACH ALCOVE LOCATION TO CREATE MINIMUM 4 FT DEPTH AT BANKFULL FLOWS.
2. WIDTH OF ALCOVE VARIES AT EACH ALCOVE LOCATION.
3. CHANNEL SLOPES SHOWN IN SECTIONS ARE TYPICAL AND WILL VARY AT EACH ALCOVE LOCATION.
4. PLACE LARGE WOOD IN ALCOVE TO PROVIDE COVER FOR RESIDENT FISH SPECIES. TYPES OF LARGE WOOD STRUCTURES USED WILL VARY AT EACH ALCOVE LOCATION.

LEGEND:
- EXISTING CONTOUR MAJOR - 5FT
- EXISTING CONTOUR MINOR - 1FT
- EXISTING BANKFULL ELEVATION
- PROPOSED CHANNEL EXCAVATION
- PROPOSED CONTOUR MAJOR - 5FT
- PROPOSED CONTOUR MINOR - 1FT
- PROPOSED LWD

EXAMPLE ONLY

TETRA TECH
www.tetratech.com
19803 North Creek Parkway
Bothell, Washington 98011
Phone: 425-482-7600 Fax: 425-482-7652

NOT FOR CONSTRUCTION

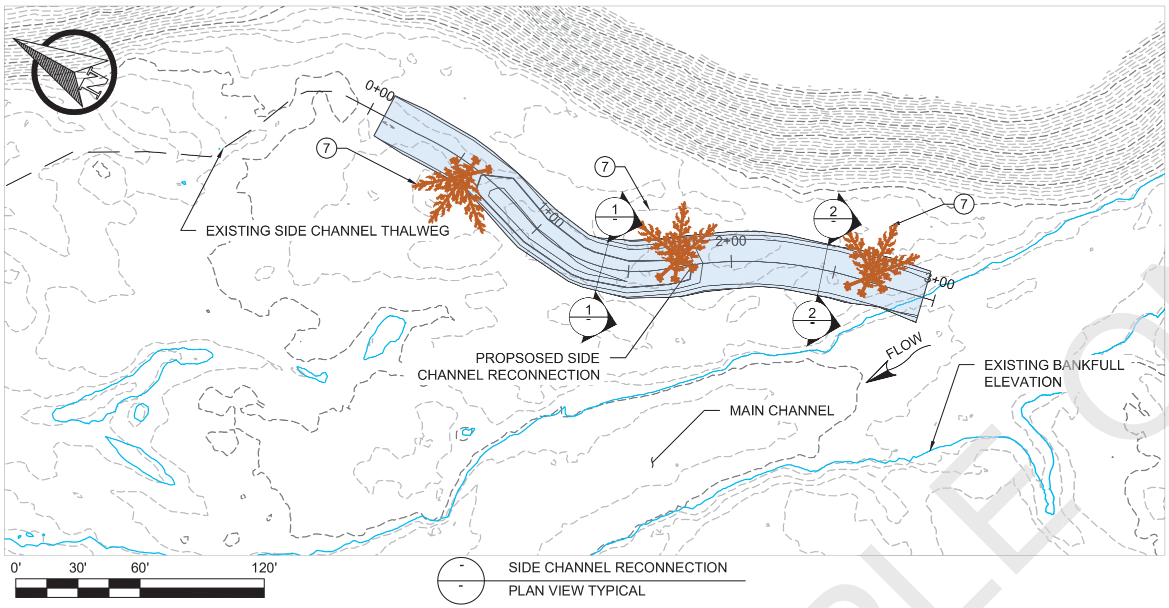
PLOTTED AS ANSI B (11" X 17"), PLAN SHEET FULL SIZE ANSI D (22" X 34")

REV.	DATE	REVISION DESCRIPTION	DRW	ENG	APP
A	4/12/17	15 PERCENT CONCEPT DESIGN	JSA	JSA	CB

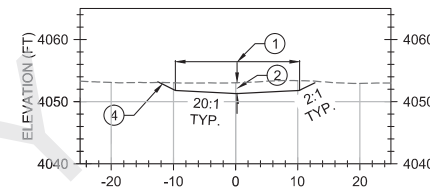
YAKAMA NATION FISHERIES - BEAVER CREEK REACH 5 DESIGN

ALCOVE HABITAT CREATION EXAMPLE

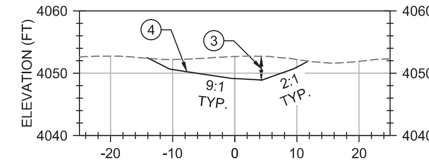
DWG. NO.: C-009
CREATED: 4/11/2017
SHEET: 11 of 12



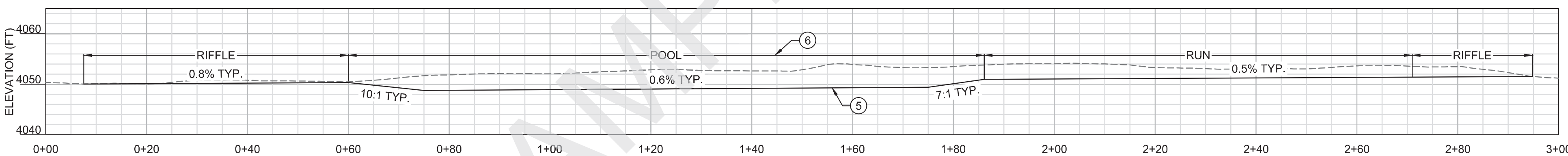
SIDE CHANNEL RECONNECTION
PLAN VIEW TYPICAL



OFFSET (FT)
(SCALE 1" = 20', 1H:1V)
SIDE CHANNEL RECONNECTION
RIFFLE CROSS SECTION TYPICAL



OFFSET (FT)
(SCALE 1" = 20', 1H:1V)
SIDE CHANNEL RECONNECTION
POOL CROSS SECTION TYPICAL



PROFILE (FT)
(SCALE 1" = 20', 1H:1V)
SIDE CHANNEL RECONNECTION
PROFILE VIEW TYPICAL

SIDE CHANNEL RECONNECTION NOTES:

1. BOTTOM WIDTH OF SIDE CHANNEL VARIES AT EACH SIDE CHANNEL LOCATION.
2. DEPTH OF RIFFLE EXCAVATED TO ALLOW INUNDATION AT VARIABLE FLOW EVENTS. DEPTH WILL VARY AT EACH SIDE CHANNEL LOCATION DEPENDING ON INTENDED SIDE CHANNEL FUNCTION.
3. DEPTH OF POOL EXCAVATION WILL VARY AT EACH SIDE CHANNEL AND WILL DEPEND ON INTENDED SIDE CHANNEL FUNCTION.
4. CHANNEL SLOPES SHOWN IN SECTIONS ARE TYPICAL AND WILL VARY AT EACH SIDE CHANNEL LOCATION.
5. LENGTH AND SLOPE OF SIDE CHANNEL RECONNECTION VARIES AT EACH SIDE CHANNEL LOCATION .
6. RIFFLE AND POOL HABITAT LENGTHS WILL VARY AT EACH SIDE CHANNEL RECONNECTION.
7. PLACE LARGE WOOD IN SIDE CHANNEL TO PROVIDE COVER FOR RESIDENT FISH SPECIES. TYPES OF LARGE WOOD STRUCTURES USED WILL VARY AT EACH SIDE CHANNEL LOCATION.

LEGEND:
- EXISTING CONTOUR MAJOR - 5FT
- EXISTING CONTOUR MINOR - 1FT
- EXISTING BANKFULL ELEVATION
- PROPOSED CHANNEL EXCAVATION
- PROPOSED CONTOUR MAJOR - 5FT
- PROPOSED CONTOUR MINOR - 1FT
- PROPOSED LWD

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YAKAMA NATION FISHERIES - BEAVER CREEK REACH 5 DESIGN

SIDE CHANNEL CONNECTION EXAMPLE

DWG. NO.: C-010
CREATED: 4/11/2017
SHEET: 12 of 12

Z:\PROJECTS\194-6017 YNF ON CALL SMALL PROJECTS\WORK ORDER 1 - BEAVER CREEK REACH 5\15% DESIGN\SHEET FILES\ALCOVE AND SIDE CHAN DETAILS.DWG
PLOT DETAILS: ANDREWS, JEREMY May 26, 2017 9:29 AM

TETRA TECH