Skinney Creek
Concept Design Report

SUBMITTED TO
Yakama Nation Fisheries

JUNE 2016

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Concept Design Report

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Yakama Nation Fisheries
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Introduction

OVERVIEW

This report presents concept designs for aquatic habitat restoration within the Skinney Creek project area in Chelan County, WA. The project area includes 1,800 feet of Skinney Creek and nearby uplands located between the confluence with Chiwaukum Creek and the first culvert under U.S. Highway 2. The purpose of this project is to enhance habitat for Endangered Species Act (ESA) listed Chinook salmon (*Oncorhynchus tshawytscha*) and steelhead (*Oncorhynchus mykiss*). Restoration of Skinney Creek is important to the system because it is the only known tributary of Chiwaukum Creek that supports salmonid spawning and rearing (Andonaegui 2001). Washington State Department of Transportation (WSDOT) recently replaced two undersized culverts in Skinney Creek along U.S. Highway 2 to restore fish passage. Stream function continues to be impaired within the project area due to ditching, confinement by the road corridor, and historical land use practices such as timber harvest and agriculture.

PROJECT AREA DESCRIPTION

The project area includes 1,800 linear feet of Skinney Creek situated between the confluence with Chiwaukum Creek and the first U.S. Highway 2 culvert. Skinney Creek within the project area is situated in a ditch between U.S. Highway 2 and the decommissioned historical road alignment of Highway 2 to the east. A large berm runs along the left bank of Skinney Creek between the channel and the old road alignment. The upstream 430 feet and downstream 550 feet of Skinney Creek in this area have been restored following culvert replacement and Hwy 2 realignment work by WSDOT. All property within the project area is owned by the U.S. Forest Service.

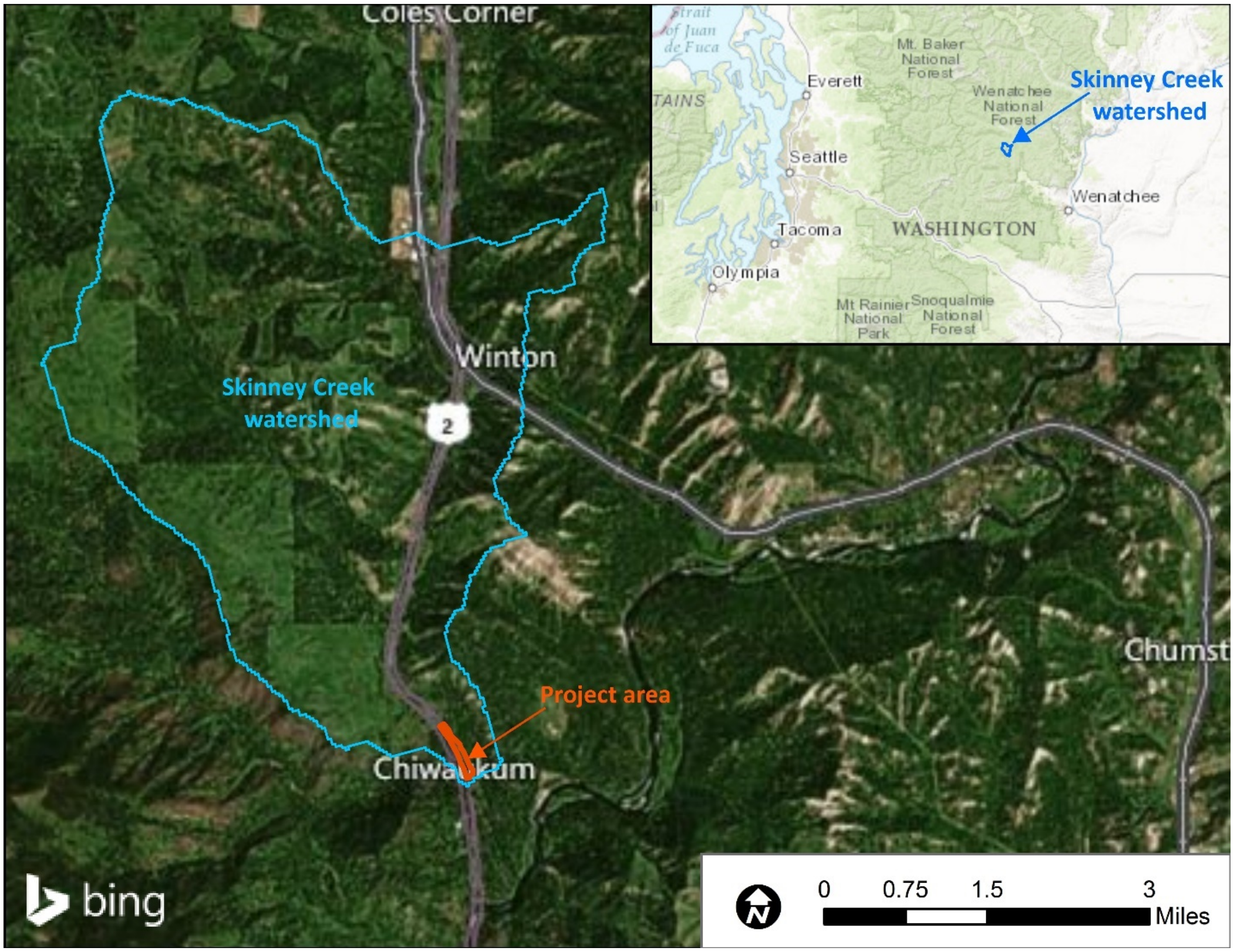

Figure 1. Location of the Skinney Creek watershed and the project area.

GOALS AND OBJECTIVES

Regional habitat objectives and priorities

Regional objectives for salmonid habitat protection and restoration in the Upper Columbia Region have been evaluated and summarized in the document *A Biological Strategy to Protect and Restore Salmonid Habitat in the Upper Columbia Region* (2014) by the Upper Columbia Salmon Recovery Board (UCSRB) Regional Technical Team (RTT). This Biological Strategy is part of the Upper Columbia Spring Chinook Salmon and Steelhead Recovery Plan (UCSRB 2007) and recommends region-wide biological considerations and approaches for salmonid habitat restoration and protection actions. The RTT guides the development and evaluation of salmonid recovery projects within the Upper Columbia Region.

The Biological Strategy has identified several assessment units within the major watersheds of the Upper Wenatchee River. The Skinney Creek project area falls within the Upper Wenatchee Assessment Unit, which was designated a Tier 1 watershed of highest protection priority and highest restoration potential (UCRTT 2014). Skinney Creek provides spawning and rearing habitat for steelhead and rearing habitat for spring Chinook.

Wenatchee River Subbasin Plan key management strategies

The Northwest Power and Conservation Council (NWPCC) completed the *Wenatchee Subbasin Plan* in 2004 to identify and prioritize actions needed to recover listed salmonids in tributary habitats within the Columbia River Basin (NWPCC 2004). This document identified riparian condition, floodplain connectivity, habitat diversity, sediment, temperature, obstructions, and competition as limiting factors for the assessment unit that included Skinney and Chiwaukum Creeks. The primary strategy for improving passage in Skinney Creek at the time of publication was the removal of two culverts located at RM 0.25 and 1.5 that were blocking anadromous fish migration. These culverts have since been replaced to improve fish passage. Restoration opportunities that are relevant to the Skinney Creek project today include the following (NWPCC 2004):

- Improve floodplain connectivity and reduce channel confinement where feasible
- Reduce fine sediment inputs that are likely a result of railroad and U.S. Highway 2 construction, agriculture, and timber harvest practices in the basin
- Improve riparian conditions where feasible

Site Conditions and Analysis

HYDROLOGY

The Skinney Creek watershed encompasses approximately 8.1 square miles and flows into Chiwaukum Creek at RM 0.6. Mean annual precipitation in the basin is 50 inches in the headwaters, decreasing to 35 inches near the confluence with Chiwaukum Creek (Andonaegui 2001). Skinney Creek has a snowmelt-driven hydrograph with low flows in late summer and peak stream flows occurring during snow melt in spring and early summer. Runoff timing and extent are affected by ambient air temperatures, snowpack mass, and the distribution of the season's snowpack.

A peak flow USGS gaging station operated on Skinney Creek near Winton from 1954 to 1973. Annual flow ranged from 6-75 cfs during this period, with typical peak flows in the 30s. Average annual baseflow in Skinney Creek is likely between 1 and 5 cfs (Andonaegui 2001). Recurrence flows (Table 1) were calculated for Skinney Creek using Stream Stats (USGS 2016).

Table 1. Flood recurrence flows for Skinney Creek (USGS 2016).

Recurrence Interval (years)	Discharge (cfs)
2	104
10	201
25	248
50	289
100	331

Existing data from WSDOT boreholes were used in a preliminary assessment of groundwater-surface water interaction in Skinney Creek. Groundwater elevations in the project vicinity were recorded by WSDOT during 2008 borehole testing (WSDOT 2010). Nine boreholes were drilled along the current U.S. Highway 2 alignment to test substrate composition and groundwater elevations (Figure 2). Boreholes were 4 inches in diameter and drilled 25 to 51 feet into the ground. Sediment was sampled and characterized at different depths. Groundwater was also noted at the time of detection, and after bailing and re-equilibration over time.

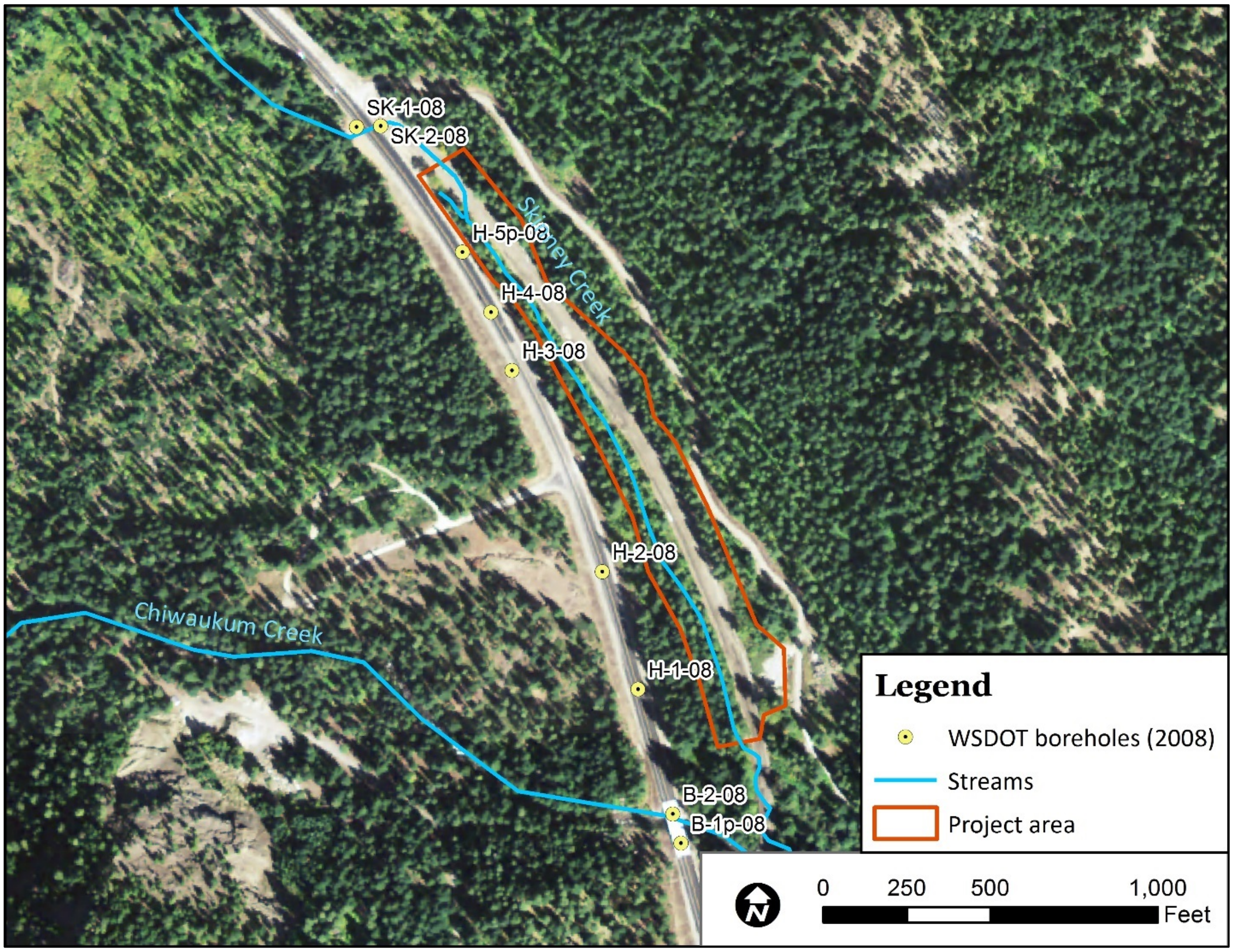

Figure 2. Locations of 2008 WSDOT boreholes.

Table 2. Dates and elevations of groundwater from borehole tests. Groundwater elevation was recorded by WSDOT at the time of detection and/or after bailing and re-equilibration (WSDOT 2010). The higher elevation was selected if multiple groundwater elevations were given for each borehole to best represent equilibrium water table elevations.

Borehole ID	Date	Groundwater elevation (feet)
SK-2-08	November 20 2008	1816
SK-1-08	November 18 2008	1785
H-5p-08	September 17 2008	1814.2
H-4-08	December 17 2008	1813
H-3-08	December 4 2008	1791
H-2-08	December 2 2008	1793.2
H-1-08	December 3 2008	1778
B-2-08	November 19 2008	No groundwater recorded
B-1p-08	November 18 2008	No groundwater recorded

Groundwater elevations were plotted with surveyed surface water elevations to characterize groundwater-surface water interaction in the project area (Figure 3). Groundwater was not recorded at the most downstream boreholes (B-2-08 and B-1p-08), and was found to be at a higher elevation than surface water at five boreholes. Groundwater elevations that are higher than surface water elevations suggest that Skinney Creek is gaining groundwater as it flows downstream.

Groundwater-surface water interaction is likely important for maintaining summer baseflows in Skinney Creek. The aquifer fills during rain and snowmelt events, and releases that stored water slowly into Skinney Creek during dry months. Conductivity of the aquifer is likely very low based on the large amounts of dense sand and silt found in the boreholes. This results in high aquifer storage time and low aquifer discharge.

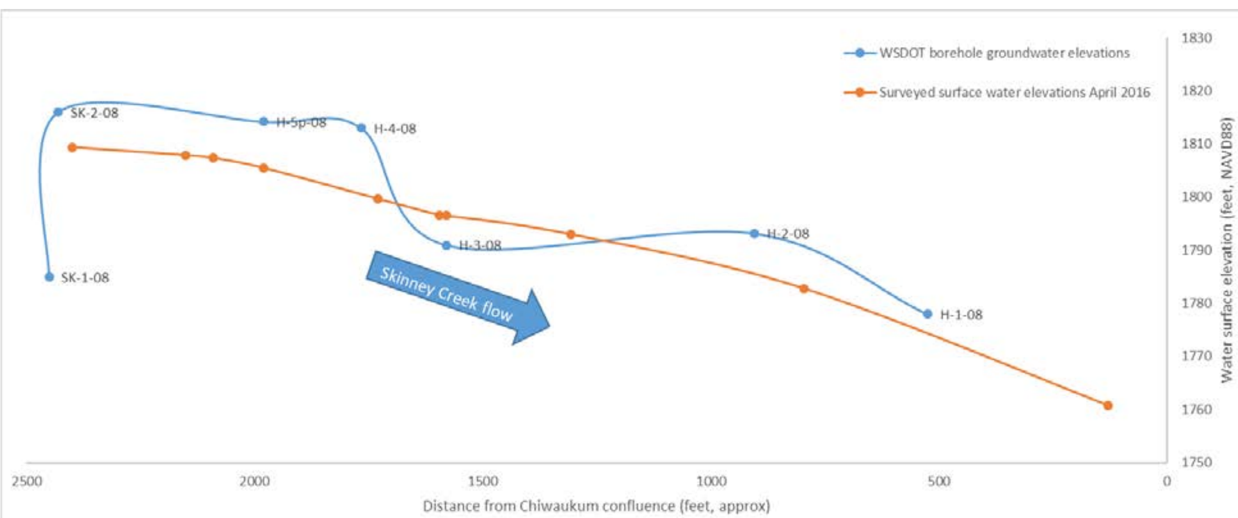

Figure 3. Groundwater elevations from 2008 boreholes plotted with surface water elevations surveyed in April 2016. The x-axis values are based on distance from Chiwaukum Creek on an arbitrary line drawn up the Skinney Creek Valley between the boreholes and surveyed water surface elevations.

Groundwater was not recorded in the test logs for B-2-08 and B-1p-08 (Table 2). It is not certain whether groundwater was simply not recorded or was actually absent from the area, but it is likely that groundwater was simply not recorded. Locations of these boreholes indicate that they were likely drilled to test substrate for bridge footings. Their close proximity to Chiwaukum Creek makes it likely that groundwater was present in the area at the time of testing.

Note that surveyed water surface elevations were taken in April while borehole tests were conducted in the fall and winter. These data therefore may not be directly comparable. Surface water pressure sensors have been placed at the upstream end of the project area on June 2nd, 2016. Pressure sensors should also be placed in floodplain piezometers to evaluate groundwater surface water dynamics more precisely over time.

PREVIOUS PROJECTS

Two habitat enhancement projects were completed upstream and downstream of the project area following the U.S. Highway 2 re-alignment (Figure 4). The upstream project included enhancement of a 430 feet segment of Skinney Creek between the upstream boundary of the project area and the U.S. Highway 2 culvert using bank lay-backs, large wood installations, and revegetation. The downstream project re-meandered a 550 feet segment of Skinney Creek from the confluence upstream. Log and rock weirs were used to create a step-pool morphology to improve fish passage through lower Skinney Creek, which had been impaired by a small waterfall at the confluence with Chiwaukum Creek. Large wood, rip rap, and riparian plantings were also installed.

Figure 4. Existing restoration projects at the upstream (left) and downstream (right) ends of Skinney Creek.

Two previously unpassable culverts under Highway 2 were removed during the highway realignment in 2013 and replaced with a three-sided box culvert through the new road alignment that allows for fish passage above the project area. Several other culverts have been replaced, updated or maintained since 2001 (WSDOT 2014) in lower Skinney Creek to improve fish passage, while Chelan County Natural Resources Department replaced an unpassable culvert with a bridge in 2007 in upper Skinney Creek as a part of the Upper Wenatchee Passage Program.

GEOMORPHOLOGY

Skinney Creek is situated within a terminal moraine which explains its low gradient (1.4% bed slopes within the project area) and relatively fine substrate (Andonaegui 2001). Pebble counts conducted at riffle crests in April 2016 showed that bedload is primarily composed of medium gravels, as D16, D50, and D84 were 6mm, 18mm, and 42mm, respectively. The substrate on the channel bed is loose and unarmored, suggesting regular active sediment mobilization and deposition. Some bedrock was observed in the channel near the downstream end of the project site. Pebble count data will be used for channel design in future design phases.

Boreholes tests were completed in 2008 by WSDOT that indicate high amounts of silts and sands in the valley bottom (WSDOT 2010). These boreholes were dug along the new U.S. Highway 2 alignment as part of the road re-alignment project. These holes typically showed loose silts with sand at 5 feet below the surface, transitioning to silty sand with gravel by 10 to 15 feet below the surface with substrate density increasing with depth. These findings are consistent with soil types mapped by the USDA NRCS which also suggest fine material in the valley (Figure 5).

The most dominant soil type in the Skinney Creek valley is Nard sandy loam, which is a deep moderately well drained soil that forms in residuum and colluvium from sandstone and old alluvium with some influence from volcanic ash and loess in the surface. Natapoc stony sandy loam is found closer to the confluence with Chiwaukum Creek, which is a very deep well drained soil formed in volcanic ash over glacial till. The Mippon series is a very deep moderately well drained soil formed in recent alluvium, and is found within the Chiwaukum Creek drainage (USDA NRCS 2016).

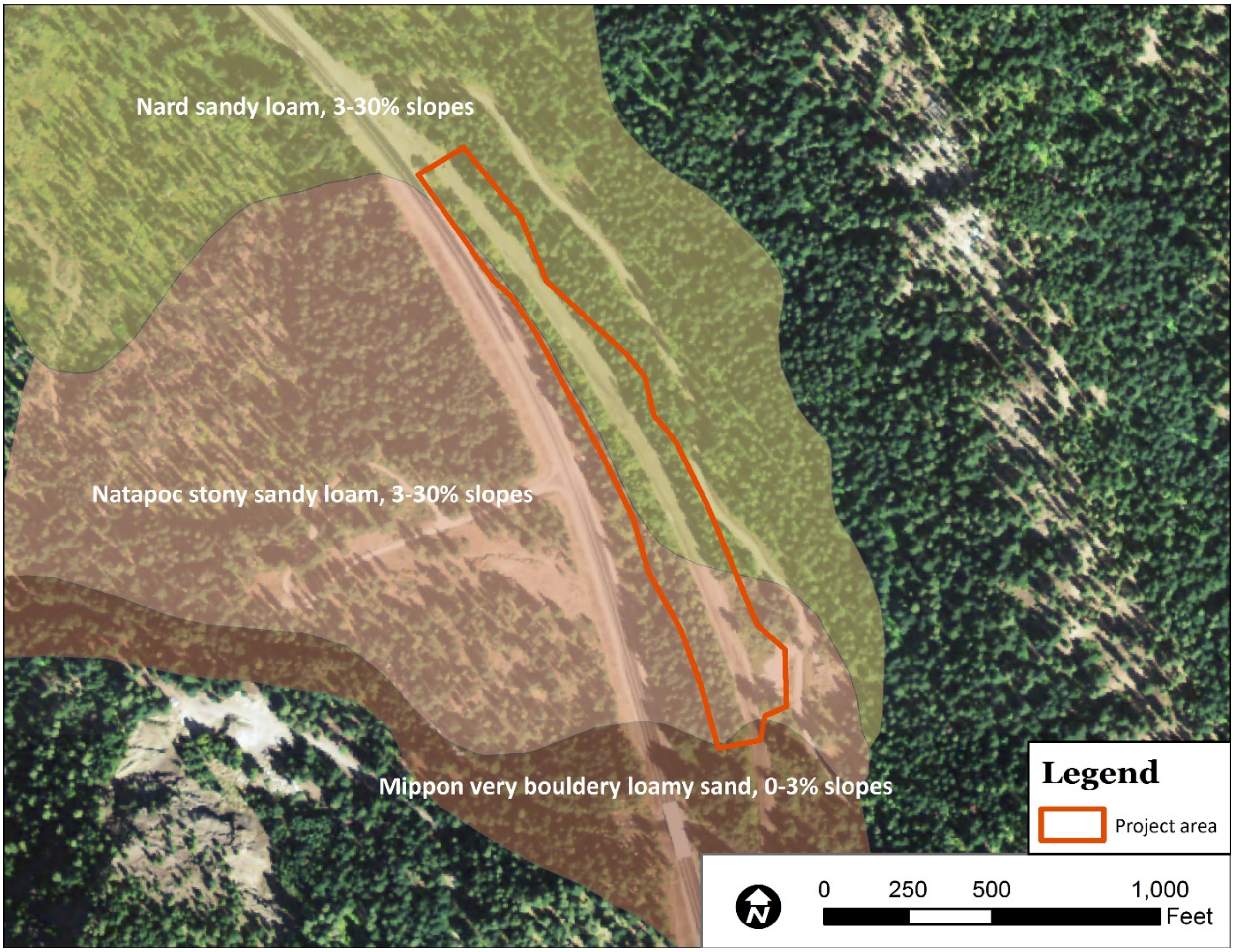

Figure 5. NRCS soils types within the Skinney Creek valley (USDA NRCS 2016).

Historical land use practices including agriculture and timber harvest have likely increased the amount of fines in the watershed while also reducing large wood recruitment (NWPCC 2004). Railroad and highway construction has led to channel confinement and associated downcutting within the project area (Andonaegui 2001). The recent U.S. Highway 2 re-alignment may have also impacted local sediment characteristics.

Figure 6. Skinney Creek looking upstream near station 21+00 showing in-set floodplain formation (pink outline) within the steep side slopes. The berm (seen in the center of the image) is relatively short and narrow at the upstream end of the project area.

Skinney Creek is confined on river right by the U.S. Highway 2 road and on river left by a berm and the historical road grade that extends to the toe of the valley wall. There are some small floodplain benches adjacent to the channel at the upstream end of the project area (Figure 6). Vegetation within the riparian area and on the berm consists of a thick understory of vine maple and alder and an overstory of cottonwoods and conifers that stabilize the side slopes and limit potential channel migration. Vegetation density and berm size both increase in the downstream direction (Figure 7). Field observations suggest that Skinney Creek does not inundate the old road grade during flood flows. Floodplain connectivity within the project area is limited to small floodplain benches at the upstream end of the project area.

Figure 7. Skinney Creek downstream near station 15+00 with much thicker riparian vegetation, more conifers, and a taller and wider berm. Note the straight channel that lacks floodplain connectivity.

FISH USE AND HABITAT CONDITIONS

Endangered Upper Columbia spring Chinook salmon and Upper Columbia steelhead have been documented using Skinney Creek for rearing. Steelhead also use Skinney Creek for spawning (Andonaegui 2001). Spring Chinook redds have been observed in Chiwaukum Creek near the Skinney Creek confluence, and it is likely that juvenile Chinook migrate into Skinney Creek for rearing (Figure 8). Bull trout are not known to be present in Skinney Creek, but have been documented in Chiwaukum Creek (Table 3) (Andonaegui 2001).

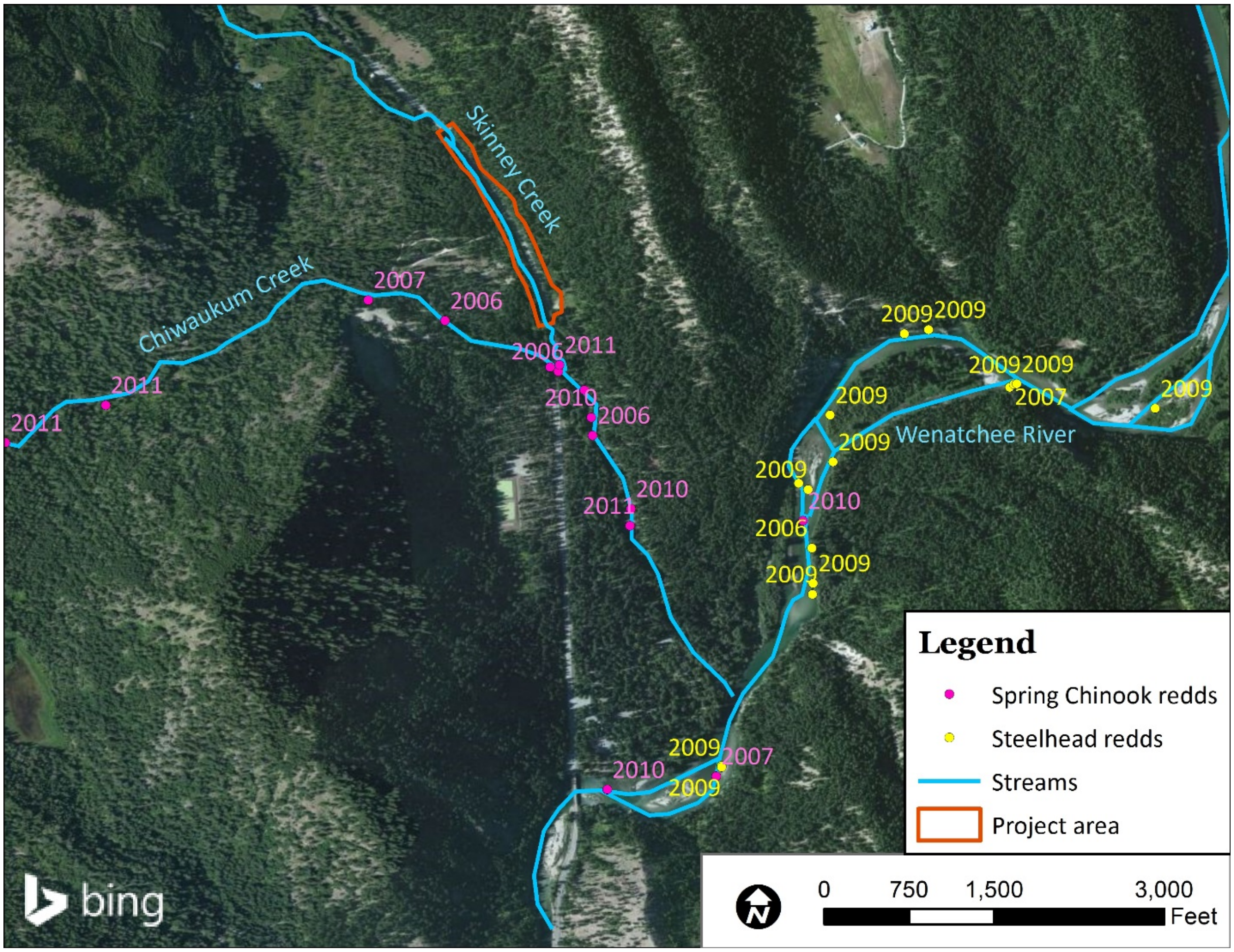

Figure 8. Spring Chinook and Steelhead redd survey results with date of redd observation labeling each point. It is unclear if redd surveys have been conducted in Skinney Creek (data from UCSRB).

Table 3. Fish use in the Upper Wenatchee River and its tributaries (adapted from Andonaegui 2001).

Mainstem Wenatchee River Watershed	Spring Chinook			Summer Chinook			Steelhead			Sockeye			Bull Trout		
	Spawning	Rearing	Migration	Spawning	Rearing	Migration	Spawning	Rearing	Migration	Spawning	Rearing	Migration	Spawning	Rearing	Migration
Upper Wenatchee River (RM 35.6 - 54.2)	X	X	X	X	X	X	X	X	X			X		X	X
Derby Canyon Creek							X	X							
Chumstick Creek		X					X	X	X						
Eagle Creek							X	X							
Chiwaukum Creek	X	X	X				X	X	X				X	X	X
Skinney Creek		X					X	X							
Beaver Creek							X	X							

Chiwaukum Creek is on the Washington Department of Ecology 303(d) list for temperature, though there is minimal data to determine if these temperatures are significantly different than historical temperatures. It is also uncertain whether or not these temperatures negatively impact salmonid migration, spawning, incubation or rearing in Chiwaukum Creek.

SITE SURVEY AND DATA COLLECTION

Topographic and bathymetric data were collected April 18-20, 2016 using rtkGPS and total station survey equipment. The data collection focused on capturing channel cross sections for hydraulic modeling, as well as topographic points in floodplain areas to inform concept design. Control points were placed near the U.S. Highway 2 bridge as well as throughout the project site.

To locate the survey data in space, static data at the rtkGPS base station were collected and adjusted using the National Geodetic Survey's Online Positioning User Service. The surveyed data were based on the Washington State Plane North coordinate system with the North American Datum of 1983.

HYDRAULIC MODELING

Existing channel and floodplain hydraulics were simulated using the U.S. Army Corps of Engineers Hydraulic Engineering Center River Analysis System (HEC-RAS 4.1.0; USACE 2010). HEC-RAS is a computer program that models the hydraulics of water flow through natural rivers and other channels. The program is one-dimensional, meaning that there is no direct modeling of the hydraulic effect of lateral cross section shape changes, bends, and other two- and three-dimensional aspects of flow. The hydraulic model calculates channel and floodplain water surface elevations, velocities, depths, and shear stresses (among other metrics) for various input flows.

The model geometry was developed using topography and bathymetry obtained through the surveys completed in April 2016 by Inter-Fluve. Model geometry for existing conditions were sampled from the

Inter-Fluve ground based survey. Cross sections extended through the floodplains to the valley walls. The 2-, 5-, 10-, 25-, 50-, and 100-year recurrence interval floods were modeled, based on hydrologic data from StreamStats (USGS 2016) as well as several flows below the 2-year event. Values for Manning's n (coefficient of hydraulic roughness) were set at 0.08 for the floodplain and 0.038-0.045 for the channel based on professional judgement. The models were run in mixed mode with an upstream critical depth boundary condition and a downstream normal depth boundary condition based on an energy slope slightly higher than the model reach results to avoid an artificial backwater condition.

Cross sectional geometries from survey data where floodplain benches were present and HEC-RAS inundations were used to inform an estimated bank full flow of 80 –cfs and a conceptual channel width:depth geometry. Proposed conditions were not modeled at this conceptual level and will be included as part of later phases of design.

Preliminary Design Criteria

A suite of preliminary design criteria have been developed to guide development of concepts. Design criteria serve three primary purposes: 1) to clearly document and communicate specific project objectives and constraints, 2) to help inform and guide the design process so that objectives are met, and 3) provide a basis for future performance monitoring. The design criteria will be refined in future design phases. The design criteria are divided into 4 categories: Habitat, geomorphology/hydrology, engineering and risk, and construction impacts.

HABITAT

- Increase in-stream and floodplain habitat quality and quantity for steelhead and Chinook salmon rearing at a range of flows
- Design habitat elements that have low risk of creating fish passage barriers
- Promote natural habitat forming processes to the maximum extent practicable
- Increase floodplain inundation

GEOMORPHOLOGY/HYDROLOGY

- Design channels and floodplains that are consistent with current and projected hydrologic and geomorphic regimes
- Promote dynamic habitat-forming processes
- Maintain sediment transport continuity to maximize design life and reduce in-filling
- Promote sediment sorting
- Minimize the chance of Skinney Creek re-occupying the ditch alignment in areas where the new alignment diverges from the ditch

ENGINEERING AND RISK

- Do not increase flooding or erosion risk to public or private infrastructure

- Provide adequate ballasting of placed logs to withstand high flows that overtop the structures (i.e. compensate for buoyancy)
- There is no recreational use of Skinney Creek to account for

CONSTRUCTION IMPACTS

- Minimize impacts to existing wetland habitat and mature vegetation that is providing shade to Skinney Creek
- Choose channel alignments that take advantage of existing mature riparian vegetation and low spots in the berm and old road grade
- Maximize shading of Skinney Creek

Concept Designs

Concepts were developed to represent a range of restoration intensities and construction impacts. All concepts involve large wood placements in the channel and floodplain. All newly excavated channels will include an inset floodplain to disperse energy at high flow, provide hydraulic complexity, and provide floodplain habitat. All graded slopes and floodplain benches will be revegetated with appropriate native species (Figure 9). In-channel wood will be designed to provide rearing habitat at a range of flows, while floodplain wood will be placed to promote channel complexity if the channel migrates over time.

Figure 9. Example of proposed planform showing a meandering channel within a vegetated inset floodplain. Upland species will be planted along slopes to provide shade and future large wood recruitment.

Test pits should be excavated in the project area to evaluate substrate composition prior to selecting a channel alignment. Multiple lines of evidence (field observations, WSDOT boreholes, and NRCS soils) suggest that there are large amounts of fine soils in the Skinney Creek valley which affect the design and construction of the channel. Bed material may need to be imported if substrate in the project area is not suited to channel energy for the channel bottom and side slope grading. Spoils may be placed in the old channel alignment to prevent re-occupation of the ditch, and/or along the east hillslope where the ground was excavated for the road bed. In addition, test pits may provide information on groundwater conditions at the site and thus inform further iterations of the concept designs. See Appendix B for concept designs and stationing information referenced in the following sections

CONCEPT 1: RE-MEANDER WITHIN EXISTING CHANNEL

This concept is the least intensive alternative, and involves re-meandering Skinney Creek along the left bank from station 15+00 to 23+00 and 7+00 to 10+00. Vegetation and side slopes on river right would not be altered by construction to maximize riparian shading. Log jams would be constructed where the new alignment diverges from the old channel to prevent Skinney Creek from re-occupying the old channel. If permit conditions allow, fill can be placed in the old channel behind the log structures to completely exclude flow from the old channel. Skinney Creek would be left in the existing alignment from station 10+00 to 15+00 where the berm is very wide and tall to minimize excavation and protect the existing mature canopy. It may be possible to install wood structures in the channel in this location without fill. Skinney Creek would be left in the existing alignment downstream of station 7+00 to minimize impacts to the downstream WSDOT project.

CONCEPT 2: RE-MEANDER WITHIN EXISTING CHANNEL WITH ADDITIONAL SINUOSITY

This alternative adds to the designs in Concept 1 and brings the channel and floodplain out into the old road alignment between stations 16+00 to 19+00 and 6+00 to 9+00. This new alignment from 16+00 to 19+00 would diverge from the existing channel at a low spot in the levee and would re-enter the old channel at a location where no levee is present adjacent to Skinney Creek as a result of the old road connection between U.S. Highway 2 and Chiwaukum Creek Rd. By utilizing low spots or locations with no levee present, this Concept minimizes excavation and riparian clearing while providing the benefits of a re-meandered channel. In addition, this alternative takes advantage of an existing low spot and mature riparian vegetation along the east valley toe. The old channel could be filled with excavated material where the new alignment diverges. Skinney Creek would remain in its current alignment from station 10+00 to 15+00 to minimize excavation and to protect riparian vegetation, though large wood would be added to the channel in this section to provide additional habitat. Skinney Creek would be left in its existing alignment downstream of station 6+00 to minimize impacts to the downstream WSDOT project.

CONCEPT 3: RE-MEANDER SKINNEY CREEK WITHIN THE OLD ROAD CORRIDOR

Concept 3 utilizes the majority of the historical road alignment, maximizing long-term channel and floodplain restoration for Skinney Creek within the project area. Skinney Creek would be brought into the old road corridor from station 19+00 to 6+00, and much of the cut soil could be placed within the old channel alignment. Large wood would be placed throughout the new channel and within the upper floodplain areas where functional. Similar to Concept 2, this alternative takes advantage of an existing low spot and mature riparian vegetation along the east valley toe.

The berm would be completely removed from station 7+50 to 18+50, and that material would be used to slope the existing cut bank along the east hillslope down to the new channel top of bank. This would return the valley toe to a more natural condition. Vegetation throughout the new alignment would be protected to the highest extent practicable to maximize shading of the new channel. Skinney Creek would be left in its existing alignment downstream of station 6+00 to minimize impacts to the downstream WSDOT project.

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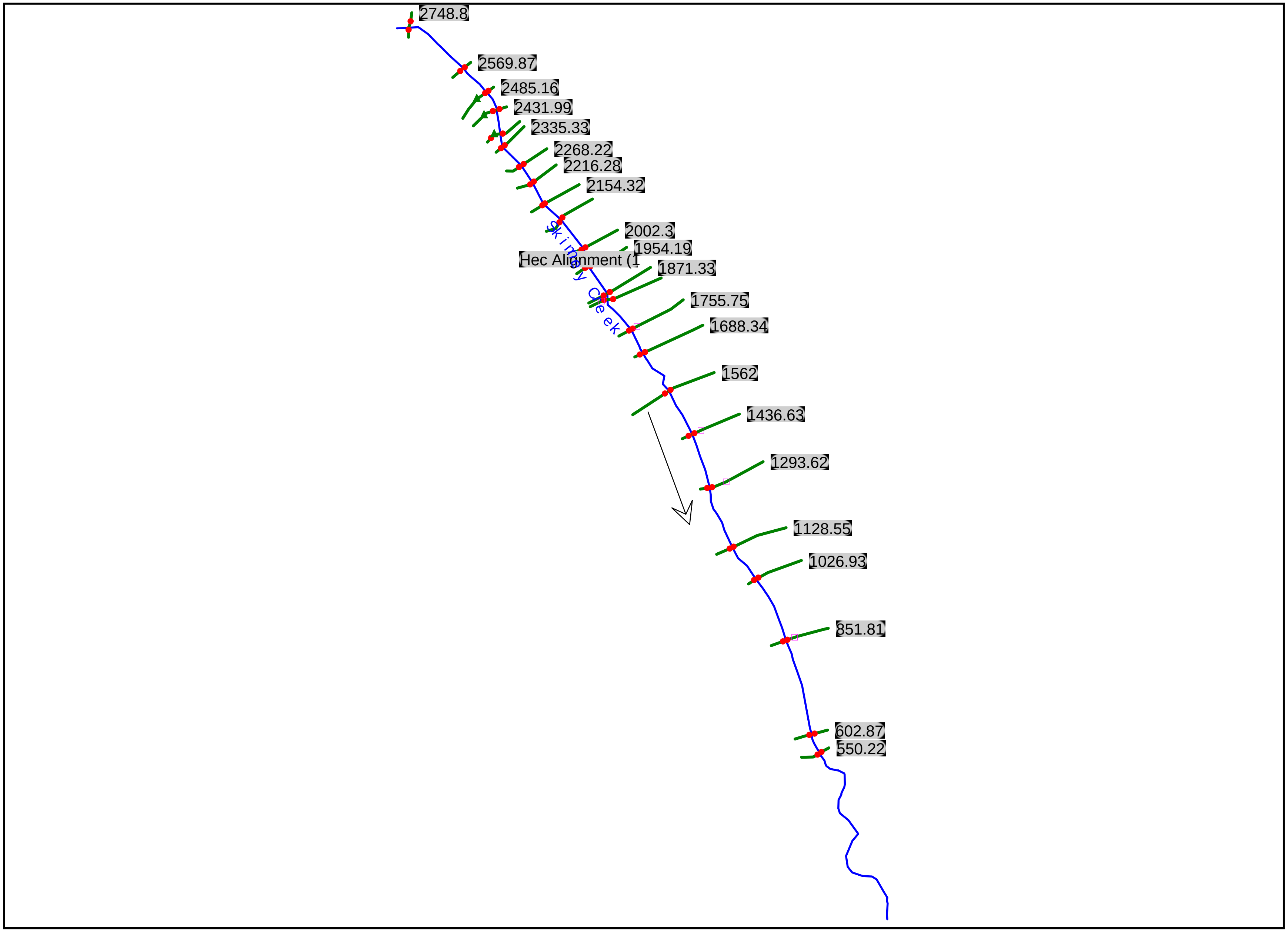
Appendix A: HEC-RAS Modeling Results

Existing hydraulic model results based on Inter-Fluve's April 2016 topographic survey using TotalStation and RTK GPS equipment.


2748.8
2569.87
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Hec Alignment (1
1871.33
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1293.62
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1026.93
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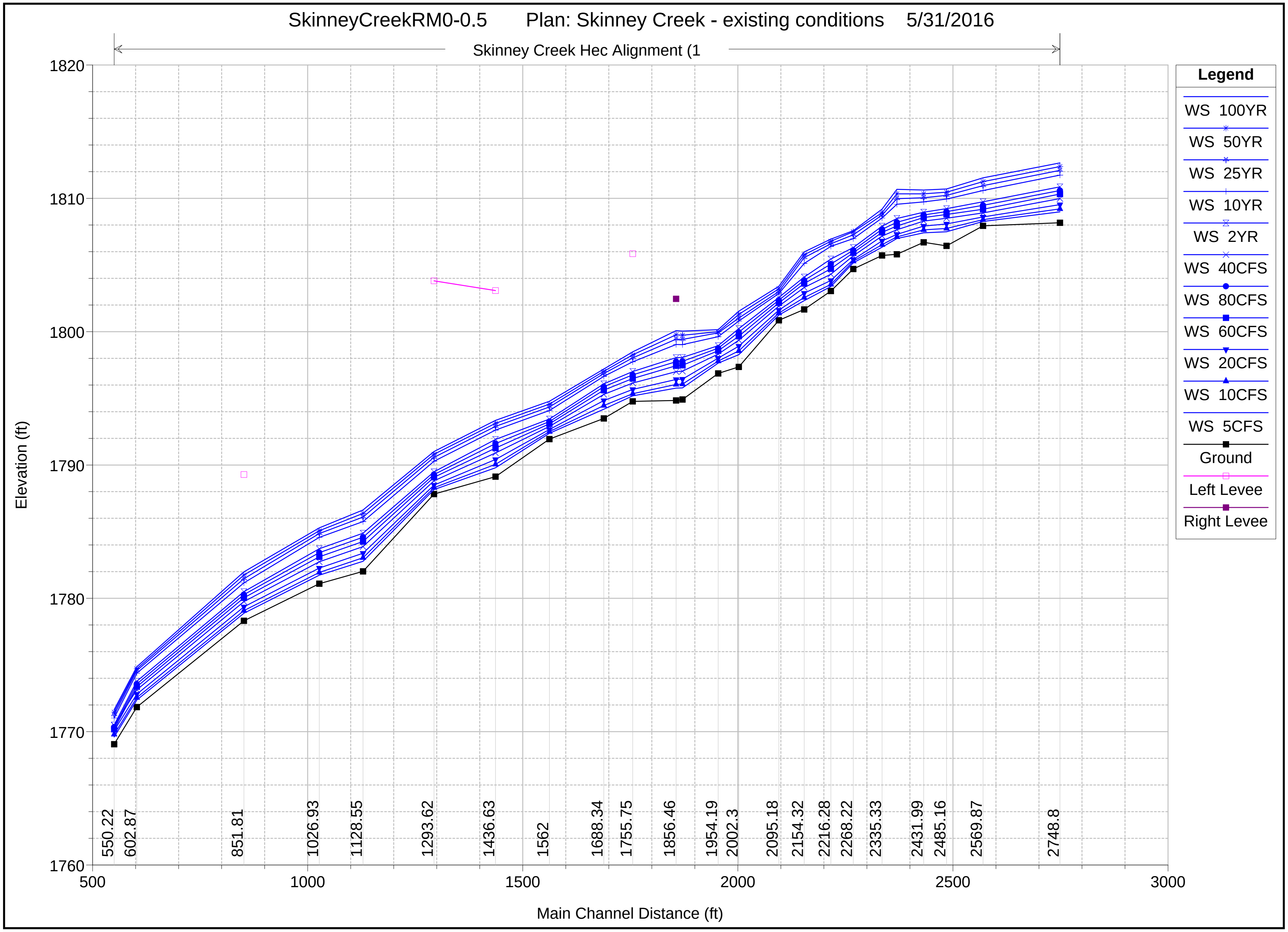

SkinneyCreekRM0-0.5 Plan: Skinney Creek - existing conditions 5/31/2016
Skinney Creek Hec Alignment (1
Elevation (ft)
Main Channel Distance (ft)
1820
1810
1800
1790
1780
1770
1760
500
1000
1500
2000
2500
3000
550.22
602.87
851.81
1026.93
1128.55
1293.62
1436.63
1562
1688.34
1755.75
1856.46
1954.19
2002.3
2095.18
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2268.22
2335.33
2431.99
2485.16
2569.87
2748.8
Legend
WS 100YR
WS 50YR
WS 25YR
WS 10YR
WS 2YR
WS 40CFS
WS 80CFS
WS 60CFS
WS 20CFS
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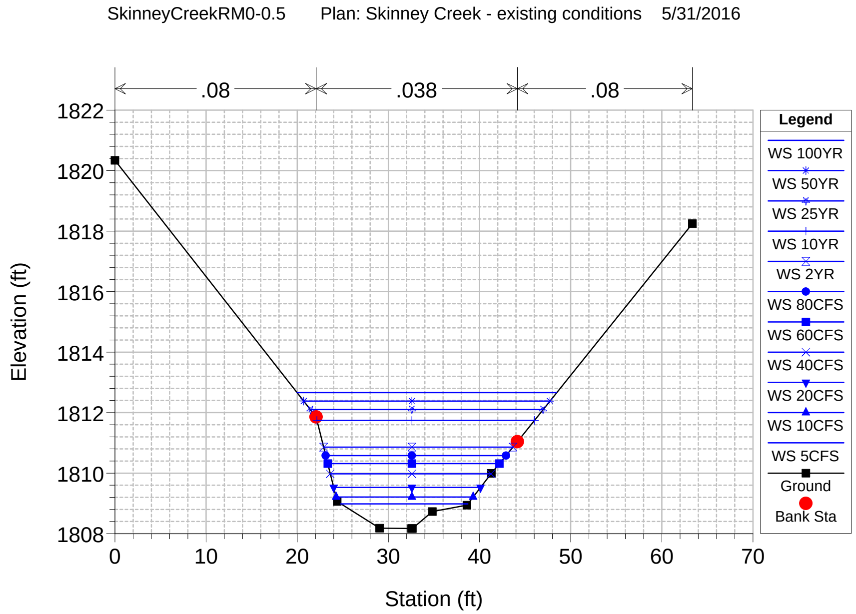
Ground
Left Levee
Right Levee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Elevation (ft)
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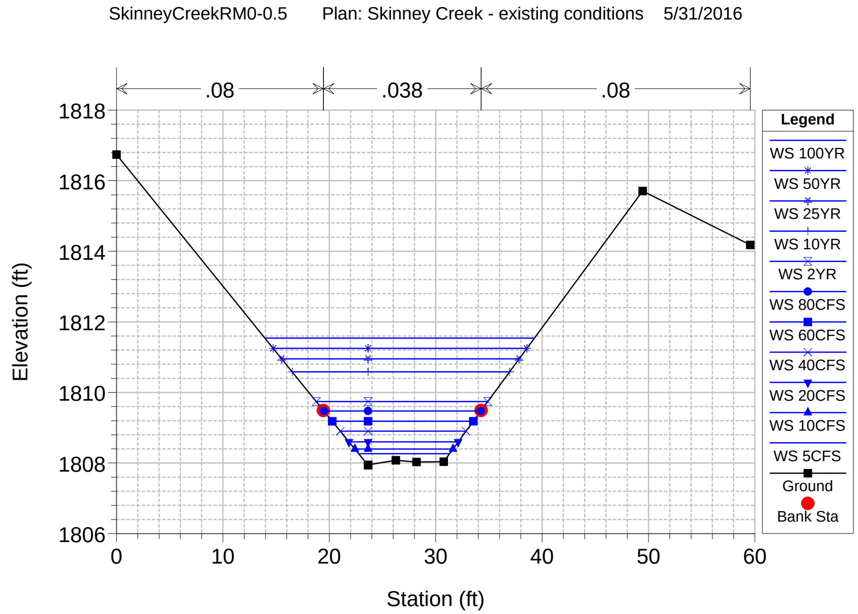
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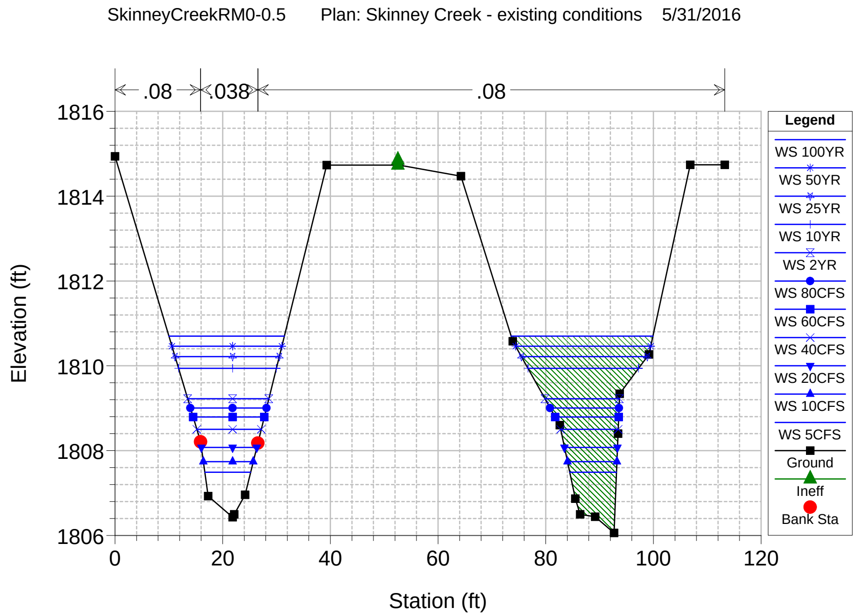
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Elevation (ft)
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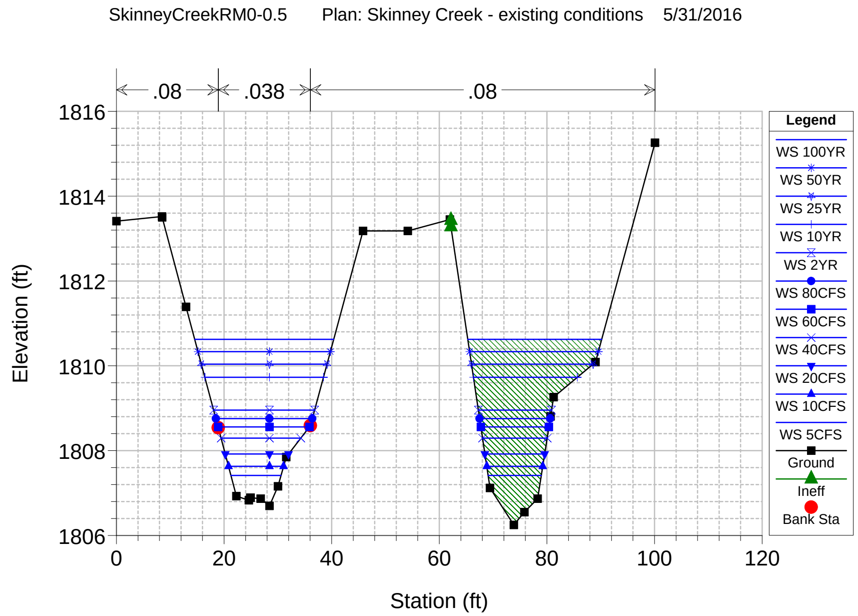
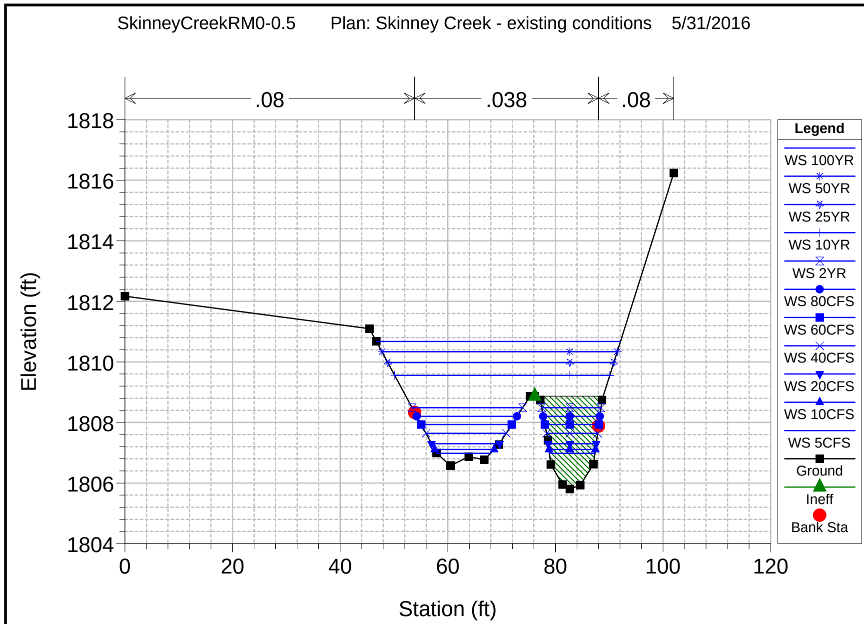
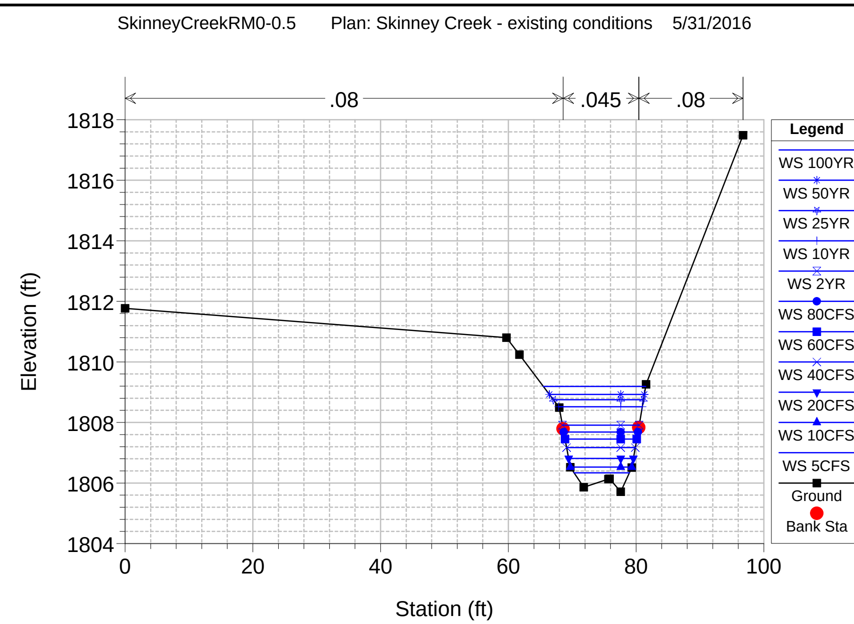
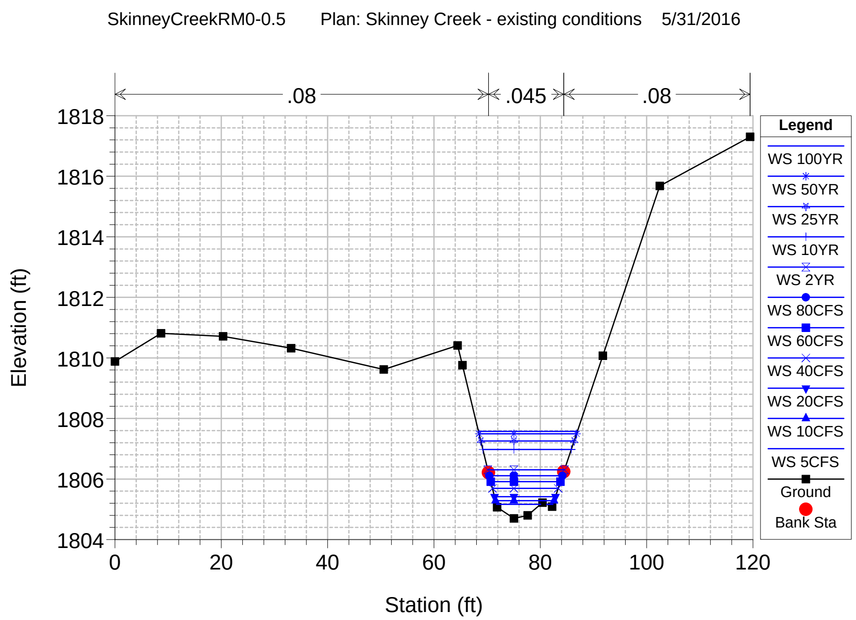
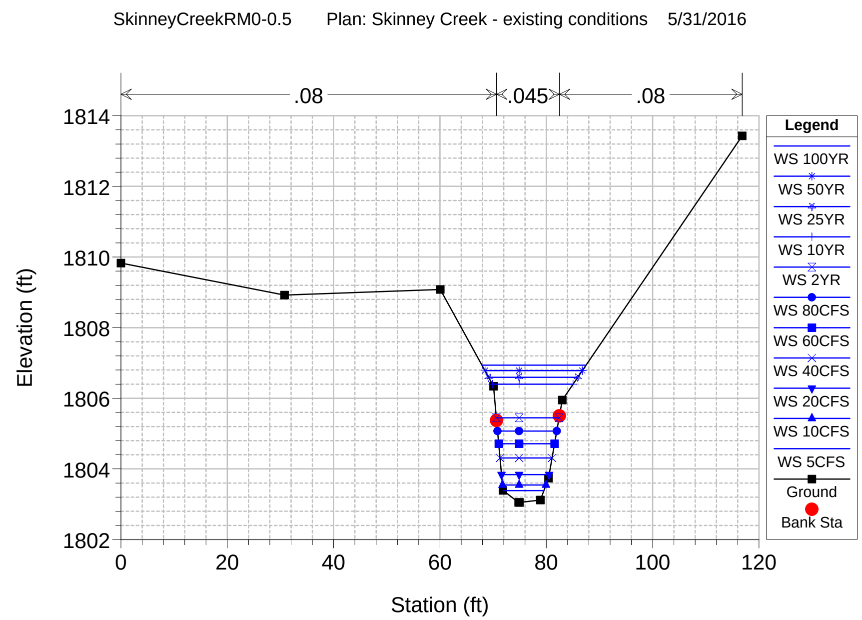
Bank Sta


SkinneyCreekRM0-0.5 Plan: Skinney Creek - existing conditions 5/31/2016
.08
.038
.08
Elevation (ft)
Station (ft)
Legend
WS 100YR
WS 50YR
WS 25YR
WS 10YR
WS 2YR
WS 80CFS
WS 60CFS
WS 40CFS
WS 20CFS
WS 10CFS
WS 5CFS
Ground
Ineff
Bank Sta

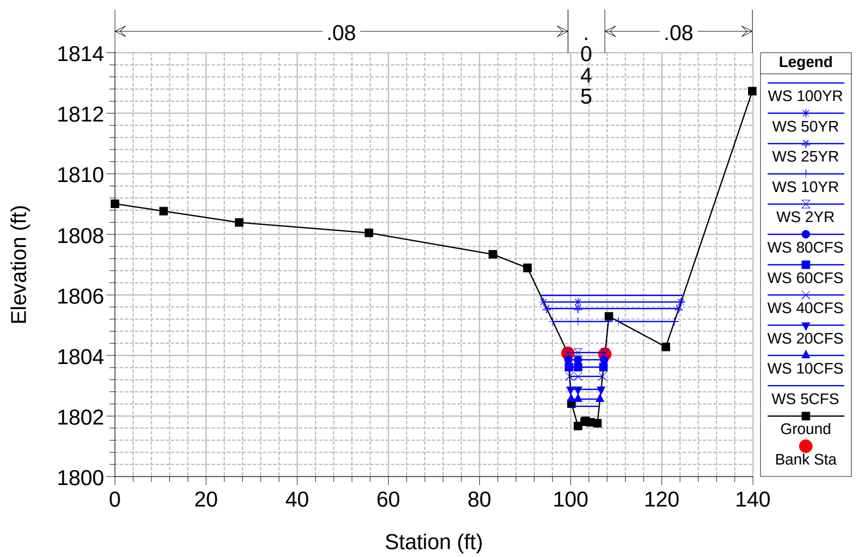

SkinneyCreekRM0-0.5 Plan: Skinney Creek - existing conditions 5/31/2016
.08
.038
.08
Elevation (ft)
1804
1806
1808
1810
1812
1814
1816
1818
Station (ft)
0
20
40
60
80
100
120
Legend
WS 100YR
WS 50YR
WS 25YR
WS 10YR
WS 2YR
WS 80CFS
WS 60CFS
WS 40CFS
WS 20CFS
WS 10CFS
WS 5CFS
Ground
Ineff
Bank Sta


SkinneyCreekRM0-0.5 Plan: Skinney Creek - existing conditions 5/31/2016
.08
.045
.08
Elevation (ft)
1804
1806
1808
1810
1812
1814
1816
1818
Station (ft)
0
20
40
60
80
100
Legend
WS 100YR
WS 50YR
WS 25YR
WS 10YR
WS 2YR
WS 80CFS
WS 60CFS
WS 40CFS
WS 20CFS
WS 10CFS
WS 5CFS
Ground
Bank Sta

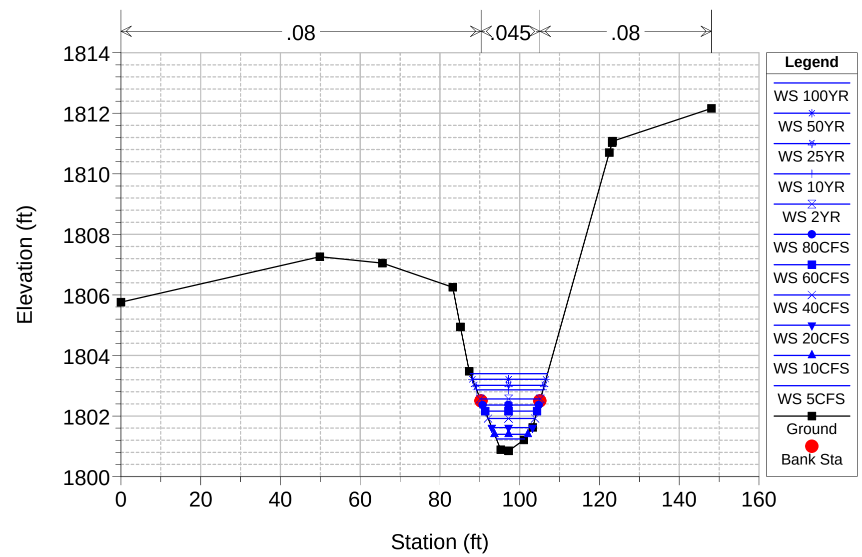

SkinneyCreekRM0-0.5 Plan: Skinney Creek - existing conditions 5/31/2016
.08
.045
.08
Elevation (ft)
1804
1806
1808
1810
1812
1814
1816
1818
Station (ft)
0
20
40
60
80
100
120
Legend
WS 100YR
WS 50YR
WS 25YR
WS 10YR
WS 2YR
WS 80CFS
WS 60CFS
WS 40CFS
WS 20CFS
WS 10CFS
WS 5CFS
Ground
Bank Sta


SkinneyCreekRM0-0.5 Plan: Skinney Creek - existing conditions 5/31/2016
.08
.045
.08
Elevation (ft)
1802
1804
1806
1808
1810
1812
1814
Station (ft)
0
20
40
60
80
100
120
Legend
WS 100YR
WS 50YR
WS 25YR
WS 10YR
WS 2YR
WS 80CFS
WS 60CFS
WS 40CFS
WS 20CFS
WS 10CFS
WS 5CFS
Ground
Bank Sta

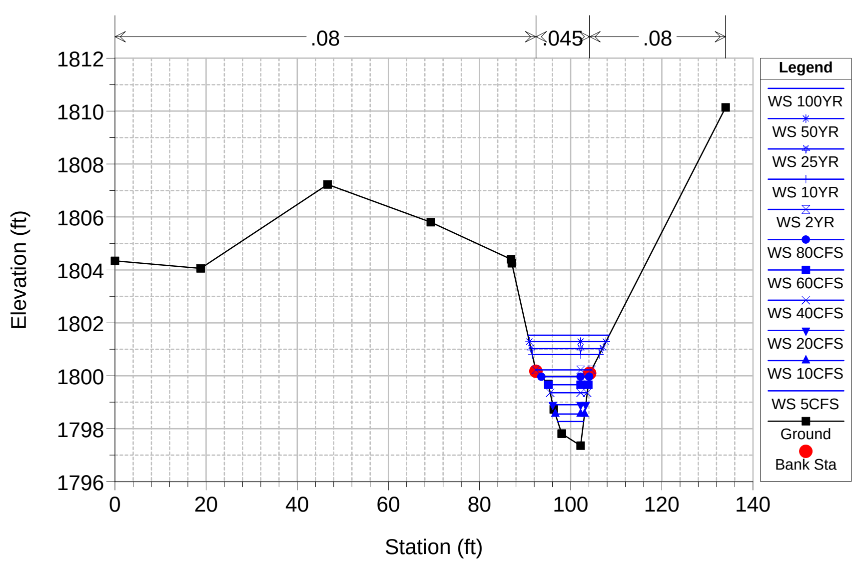
SkinneyCreekRM0-0.5 Plan: Skinney Creek - existing conditions 5/31/2016



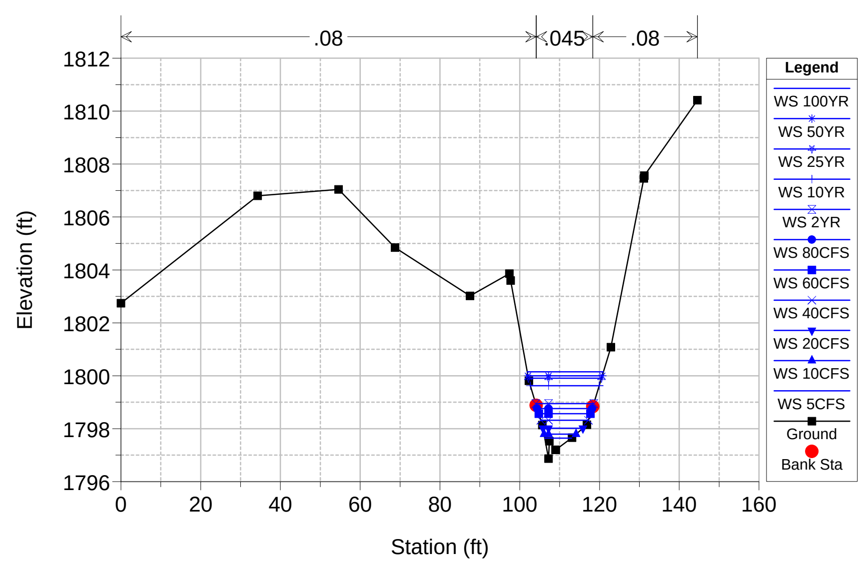
SkinneyCreekRM0-0.5 Plan: Skinney Creek - existing conditions 5/31/2016



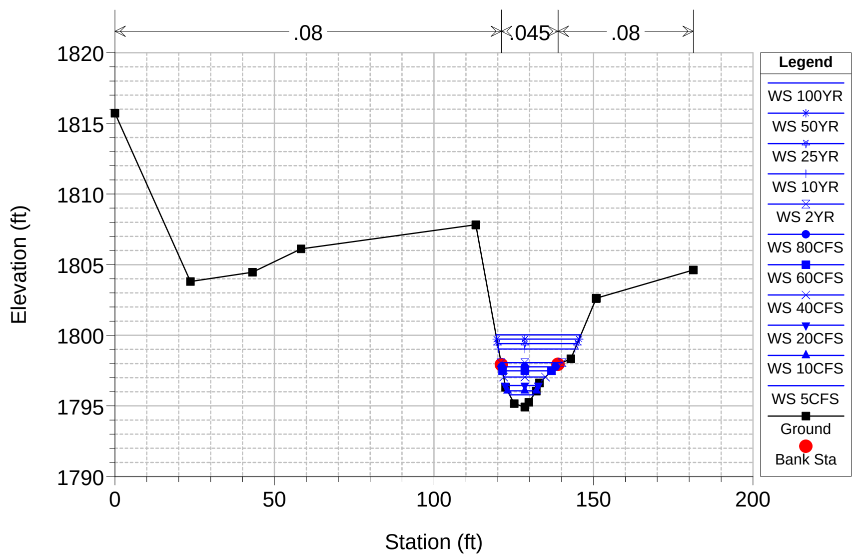
SkinneyCreekRM0-0.5 Plan: Skinney Creek - existing conditions 5/31/2016



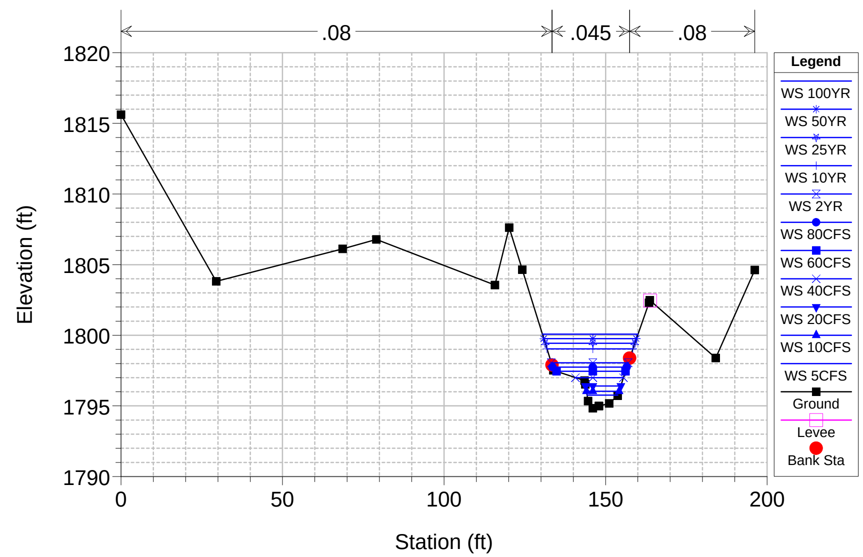
SkinneyCreekRM0-0.5 Plan: Skinney Creek - existing conditions 5/31/2016



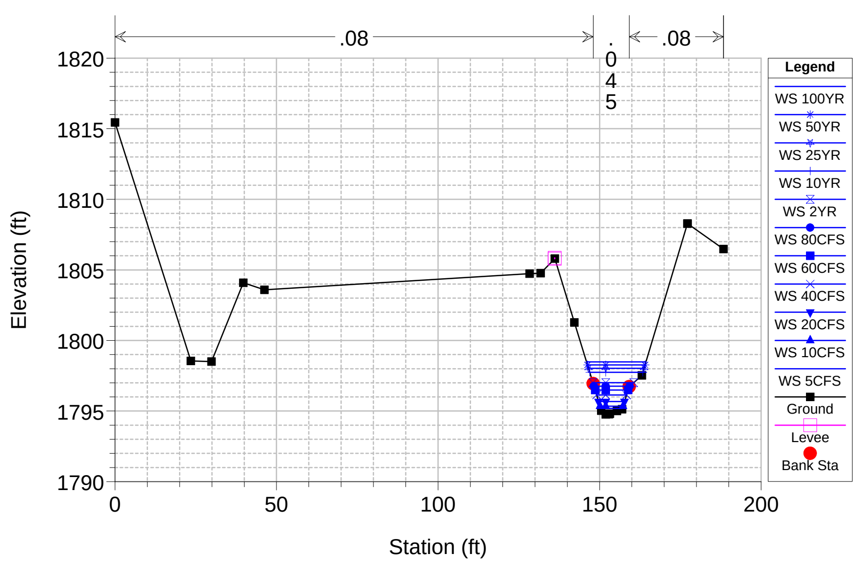
SkinneyCreekRM0-0.5 Plan: Skinney Creek - existing conditions 5/31/2016



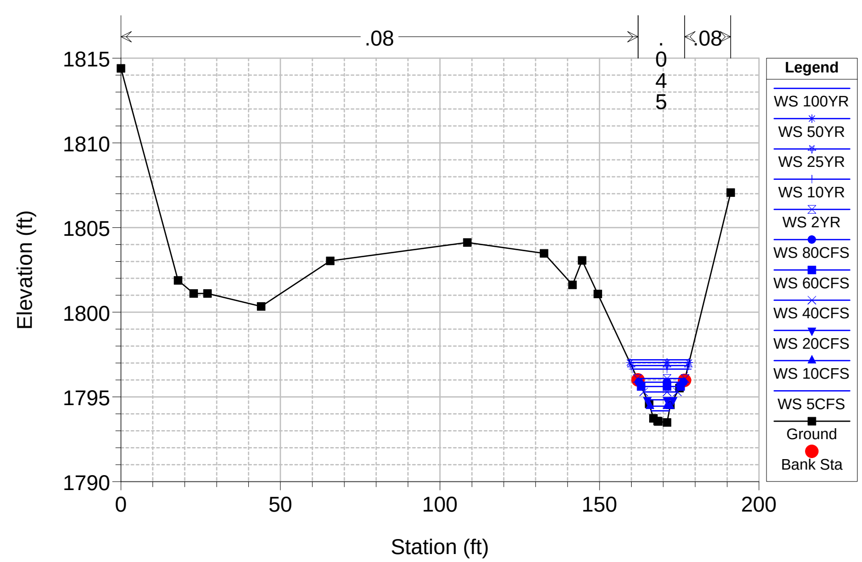
SkinneyCreekRM0-0.5 Plan: Skinney Creek - existing conditions 5/31/2016

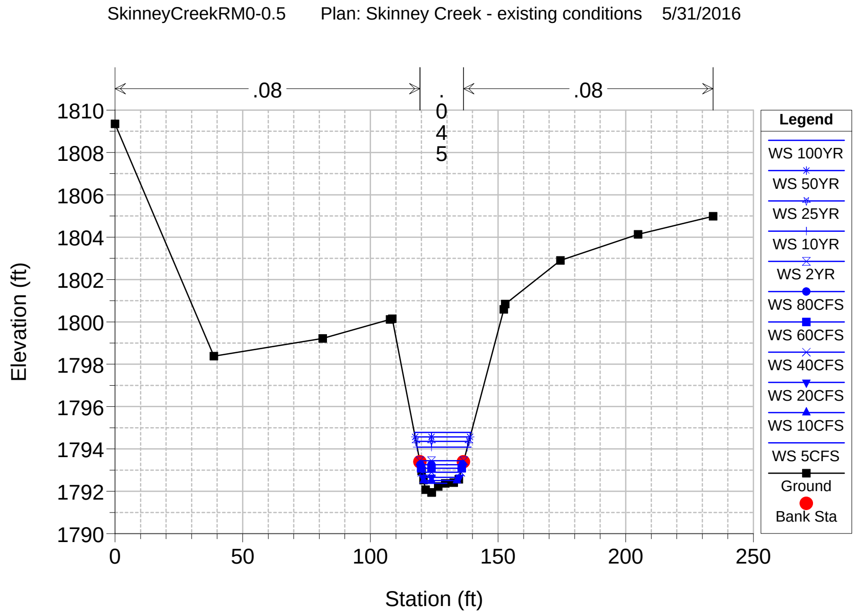


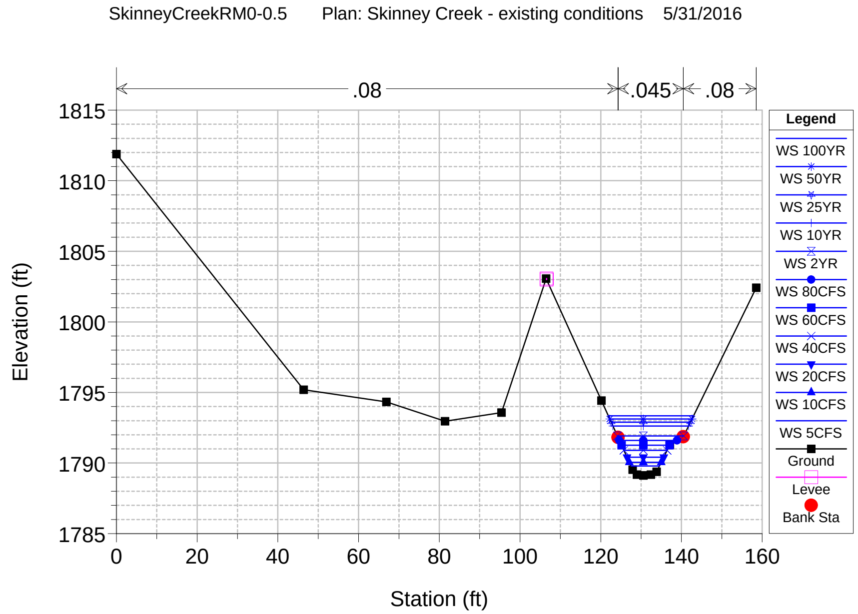
SkinneyCreekRM0-0.5 Plan: Skinney Creek - existing conditions 5/31/2016

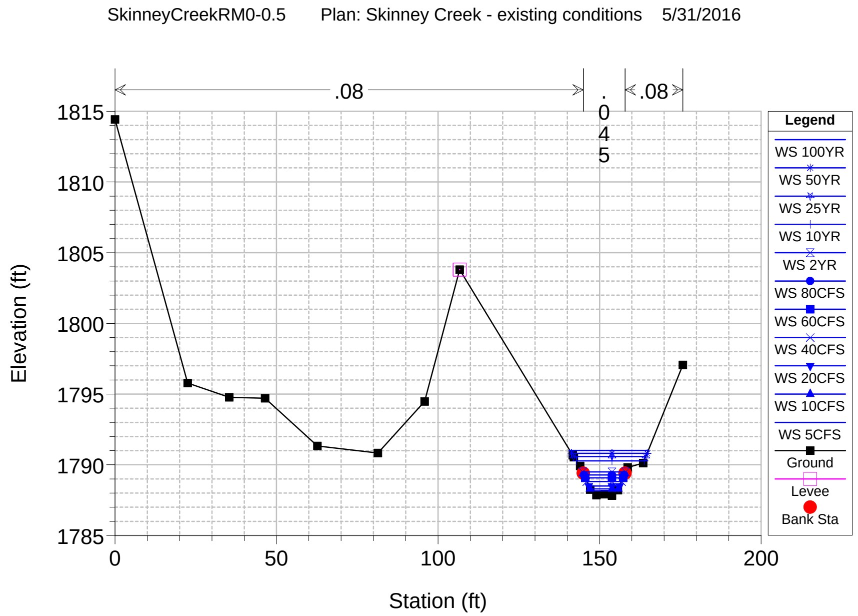


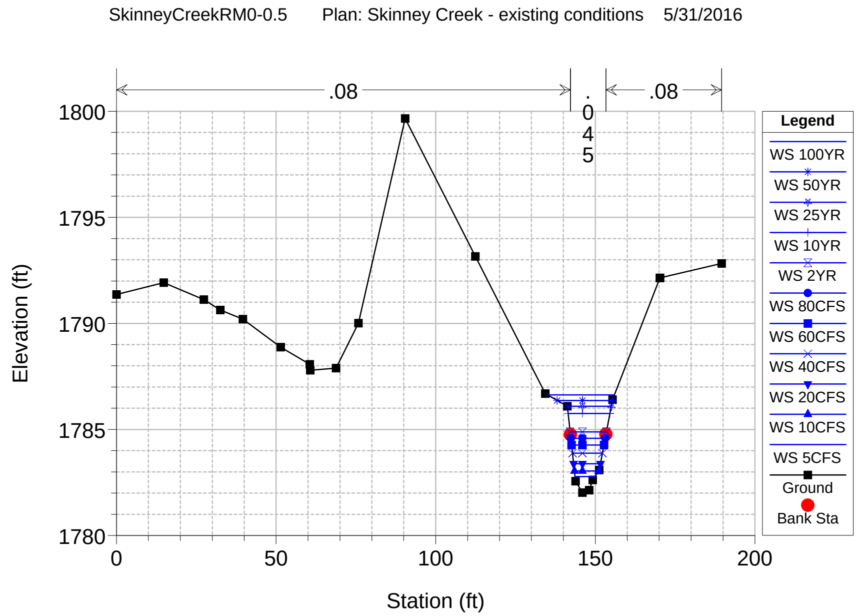
SkinneyCreekRM0-0.5 Plan: Skinney Creek - existing conditions 5/31/2016

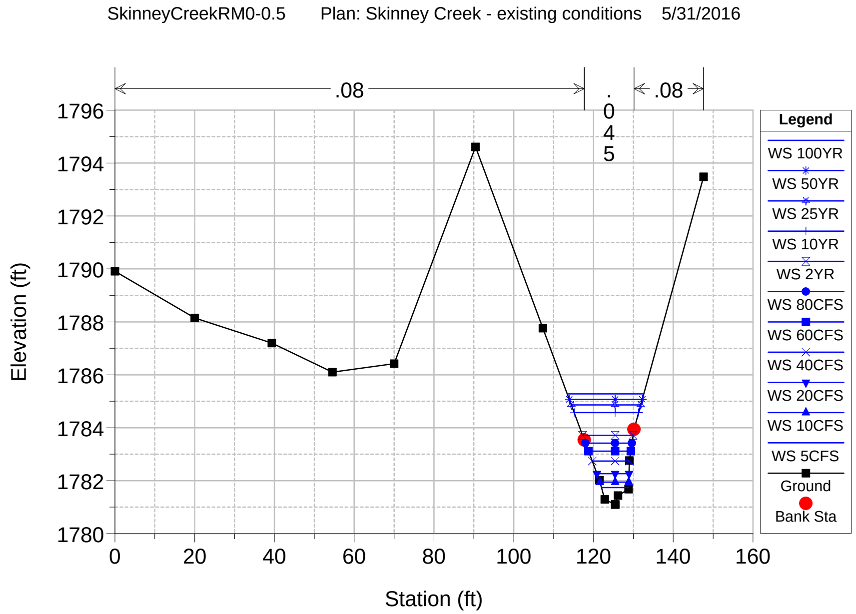
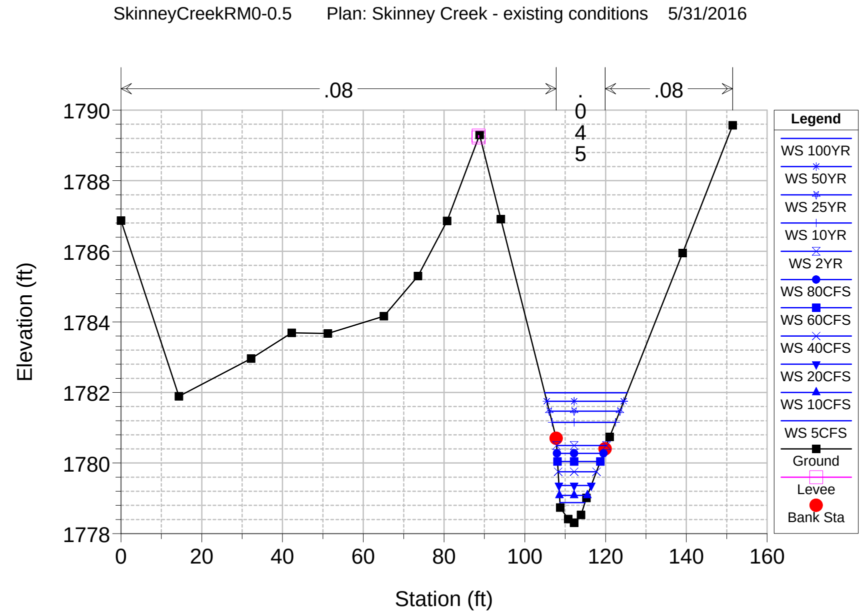
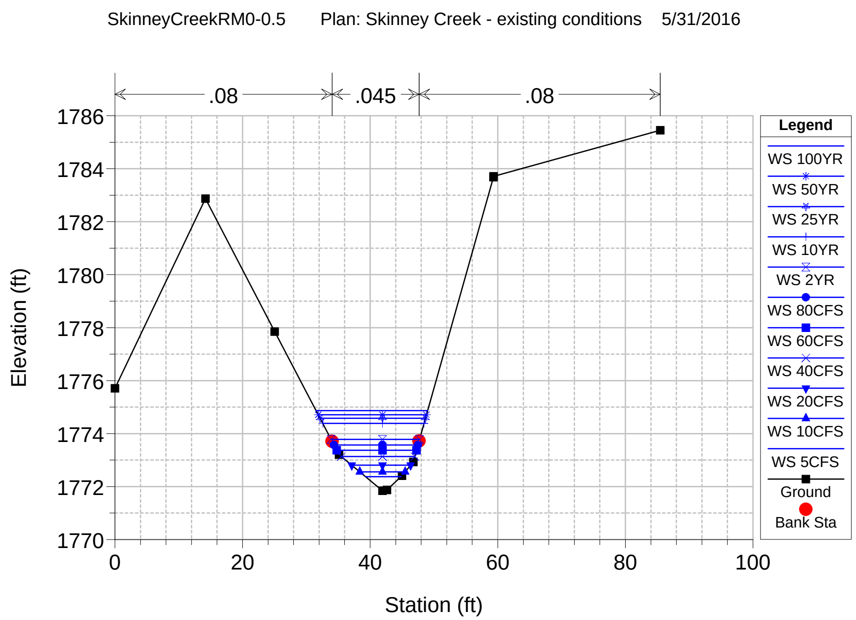
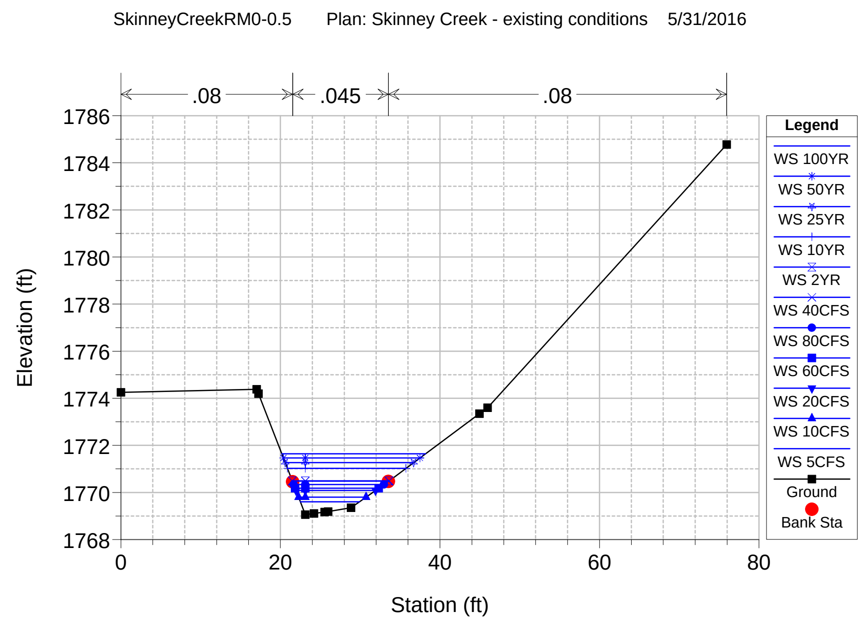



SkinneyCreekRM0-0.5 Plan: Skinney Creek - existing conditions 5/31/2016
.08
.045
.08
Elevation (ft)
Station (ft)
Legend
WS 100YR
WS 50YR
WS 25YR
WS 10YR
WS 2YR
WS 80CFS
WS 60CFS
WS 40CFS
WS 20CFS
WS 10CFS
WS 5CFS
Ground
Bank Sta


SkinneyCreekRM0-0.5 Plan: Skinney Creek - existing conditions 5/31/2016
.08
.045
.08
Elevation (ft)
Station (ft)
Legend
WS 100YR
WS 50YR
WS 25YR
WS 10YR
WS 2YR
WS 80CFS
WS 60CFS
WS 40CFS
WS 20CFS
WS 10CFS
WS 5CFS
Ground
Levee
Bank Sta


SkinneyCreekRM0-0.5 Plan: Skinney Creek - existing conditions 5/31/2016
.08
.045
.08
Elevation (ft)
Station (ft)
Legend
WS 100YR
WS 50YR
WS 25YR
WS 10YR
WS 2YR
WS 80CFS
WS 60CFS
WS 40CFS
WS 20CFS
WS 10CFS
WS 5CFS
Ground
Levee
Bank Sta


SkinneyCreekRM0-0.5 Plan: Skinney Creek - existing conditions 5/31/2016
.08
.045
.08
Elevation (ft)
Station (ft)
Legend
WS 100YR
WS 50YR
WS 25YR
WS 10YR
WS 2YR
WS 80CFS
WS 60CFS
WS 40CFS
WS 20CFS
WS 10CFS
WS 5CFS
Ground
Bank Sta


SkinneyCreekRM0-0.5 Plan: Skinney Creek - existing conditions 5/31/2016
.08
.045
.08
Elevation (ft)
Station (ft)
Legend
WS 100YR
WS 50YR
WS 25YR
WS 10YR
WS 2YR
WS 80CFS
WS 60CFS
WS 40CFS
WS 20CFS
WS 10CFS
WS 5CFS
Ground
Bank Sta

SkinneyCreekRM0-0.5 Plan: Skinney Creek - existing conditions 5/31/2016
.08
.045
.08
Elevation (ft)
Station (ft)
Legend
WS 100YR
WS 50YR
WS 25YR
WS 10YR
WS 2YR
WS 80CFS
WS 60CFS
WS 40CFS
WS 20CFS
WS 10CFS
WS 5CFS
Ground
Levee
Bank Sta

SkinneyCreekRM0-0.5 Plan: Skinney Creek - existing conditions 5/31/2016
.08
.045
.08
Elevation (ft)
Station (ft)
Legend
WS 100YR
WS 50YR
WS 25YR
WS 10YR
WS 2YR
WS 80CFS
WS 60CFS
WS 40CFS
WS 20CFS
WS 10CFS
WS 5CFS
Ground
Bank Sta

SkinneyCreekRM0-0.5 Plan: Skinney Creek - existing conditions 5/31/2016
.08
.045
.08
Elevation (ft)
Station (ft)
Legend
WS 100YR
WS 50YR
WS 25YR
WS 10YR
WS 2YR
WS 40CFS
WS 80CFS
WS 60CFS
WS 20CFS
WS 10CFS
WS 5CFS
Ground
Bank Sta

HEC-RAS Plan: Existing

River	River Station	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear Chan
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)
Skinney Creek	2748.8	5CFS	5	1808.17	1808.99	1808.51	1809	0.001165	0.79	6.37	13.95	0.2	0.03
Skinney Creek	2748.8	10CFS	10	1808.17	1809.21	1808.67	1809.23	0.001292	1.03	9.67	15.05	0.23	0.05
Skinney Creek	2748.8	20CFS	20	1808.17	1809.53	1808.92	1809.56	0.001462	1.37	14.58	16.12	0.25	0.08
Skinney Creek	2748.8	40CFS	40	1808.17	1809.98	1809.17	1810.03	0.001654	1.8	22.21	17.65	0.28	0.12
Skinney Creek	2748.8	60CFS	60	1808.17	1810.31	1809.36	1810.38	0.001822	2.12	28.34	18.84	0.3	0.16
Skinney Creek	2748.8	80CFS	80	1808.17	1810.58	1809.53	1810.67	0.001996	2.39	33.5	19.78	0.32	0.2
Skinney Creek	2748.8	2YR	104	1808.17	1810.86	1809.72	1810.97	0.002157	2.66	39.15	20.77	0.34	0.24
Skinney Creek	2748.8	10YR	201	1808.17	1811.74	1810.33	1811.93	0.002359	3.45	58.87	23.86	0.37	0.36
Skinney Creek	2748.8	25YR	248	1808.17	1812.1	1810.57	1812.32	0.002368	3.74	67.61	25.52	0.38	0.41
Skinney Creek	2748.8	50YR	289	1808.17	1812.38	1810.78	1812.63	0.002363	3.97	75.09	27.02	0.39	0.45
Skinney Creek	2748.8	100YR	331	1808.17	1812.66	1810.97	1812.93	0.002353	4.18	82.73	28.47	0.39	0.48
Skinney Creek	2569.87	5CFS	5	1807.94	1808.27	1808.27	1808.38	0.036188	2.68	1.87	8.54	1.01	0.49
Skinney Creek	2569.87	10CFS	10	1807.94	1808.4	1808.4	1808.57	0.032045	3.3	3.03	9.22	1.01	0.65
Skinney Creek	2569.87	20CFS	20	1807.94	1808.6	1808.6	1808.85	0.028018	4	5	10.26	1.01	0.83
Skinney Creek	2569.87	40CFS	40	1807.94	1808.9	1808.9	1809.26	0.024711	4.79	8.36	11.81	1	1.06
Skinney Creek	2569.87	60CFS	60	1807.94	1809.19	1809.14	1809.58	0.020213	5.05	11.88	13.25	0.94	1.09
Skinney Creek	2569.87	80CFS	80	1807.94	1809.47		1809.87	0.015668	5.03	15.92	14.74	0.85	1.02
Skinney Creek	2569.87	2YR	104	1807.94	1809.74		1810.17	0.012688	5.23	20.05	16.11	0.79	1.02
Skinney Creek	2569.87	10YR	201	1807.94	1810.59		1811.15	0.009002	6.1	35.49	20.44	0.73	1.18
Skinney Creek	2569.87	25YR	248	1807.94	1810.95		1811.57	0.007991	6.37	43.32	22.32	0.7	1.23
Skinney Creek	2569.87	50YR	289	1807.94	1811.25		1811.9	0.007349	6.57	50.22	23.85	0.69	1.26
Skinney Creek	2569.87	100YR	331	1807.94	1811.54		1812.22	0.006844	6.77	57.32	25.33	0.67	1.29
Skinney Creek	2485.16	5CFS	5	1806.43	1807.49	1806.95	1807.5	0.000792	0.84	5.95	17.16	0.18	0.03
Skinney Creek	2485.16	10CFS	10	1806.43	1807.74	1807.09	1807.76	0.001254	1.22	8.18	18.42	0.23	0.06
Skinney Creek	2485.16	20CFS	20	1806.43	1808.08	1807.33	1808.12	0.001903	1.74	11.47	20.12	0.29	0.12
Skinney Creek	2485.16	40CFS	40	1806.43	1808.5	1807.68	1808.6	0.002636	2.5	16.19	22.65	0.36	0.23
Skinney Creek	2485.16	60CFS	60	1806.43	1808.79		1808.94	0.003269	3.13	19.83	25	0.41	0.34
Skinney Creek	2485.16	80CFS	80	1806.43	1809.01		1809.22	0.003952	3.71	22.76	26.93	0.46	0.46
Skinney Creek	2485.16	2YR	104	1806.43	1809.22		1809.51	0.00468	4.32	25.93	28.9	0.51	0.6
Skinney Creek	2485.16	10YR	201	1806.43	1809.94		1810.51	0.006535	6.16	37.85	38.72	0.63	1.11
Skinney Creek	2485.16	25YR	248	1806.43	1810.22		1810.91	0.007211	6.86	43.03	42.75	0.67	1.34
Skinney Creek	2485.16	50YR	289	1806.43	1810.46		1811.25	0.007523	7.36	47.86	45.5	0.7	1.5
Skinney Creek	2485.16	100YR	331	1806.43	1810.7		1811.58	0.007714	7.8	52.91	47.79	0.71	1.65

HEC-RAS Plan: Existing (continued)

River	River Station	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear Chan
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)
Skinney Creek	2431.99	5CFS	5	1806.7	1807.42		1807.43	0.002149	1.1	4.53	19.19	0.28	0.06
Skinney Creek	2431.99	10CFS	10	1806.7	1807.63		1807.67	0.002749	1.5	6.65	20.64	0.33	0.11
Skinney Creek	2431.99	20CFS	20	1806.7	1807.92		1807.99	0.003662	2.04	9.79	22.86	0.39	0.18
Skinney Creek	2431.99	40CFS	40	1806.7	1808.3		1808.41	0.005071	2.71	14.77	26.82	0.48	0.3
Skinney Creek	2431.99	60CFS	60	1806.7	1808.56		1808.72	0.005922	3.16	18.96	29.62	0.53	0.4
Skinney Creek	2431.99	80CFS	80	1806.7	1808.75		1808.95	0.006222	3.59	22.37	31.04	0.55	0.49
Skinney Creek	2431.99	2YR	104	1806.7	1808.96		1809.21	0.006476	4.03	26.09	32.38	0.58	0.59
Skinney Creek	2431.99	10YR	201	1806.7	1809.73		1810.13	0.00595	5.09	41.83	41.33	0.59	0.81
Skinney Creek	2431.99	25YR	248	1806.7	1810.04		1810.5	0.005817	5.48	48.93	45.96	0.6	0.91
Skinney Creek	2431.99	50YR	289	1806.7	1810.33		1810.82	0.005456	5.7	55.93	48.52	0.59	0.94
Skinney Creek	2431.99	100YR	331	1806.7	1810.62		1811.14	0.005117	5.89	63.26	50.72	0.58	0.98
Skinney Creek	2369.75	5CFS	5	1805.8	1806.98	1806.98	1807.08	0.034762	2.49	2.01	18.44	0.98	0.43
Skinney Creek	2369.75	10CFS	10	1805.8	1807.11	1807.1	1807.25	0.030563	3.03	3.3	19.68	0.98	0.56
Skinney Creek	2369.75	20CFS	20	1805.8	1807.3	1807.28	1807.5	0.02521	3.58	5.59	21.56	0.95	0.69
Skinney Creek	2369.75	40CFS	40	1805.8	1807.64		1807.88	0.016583	3.89	10.28	24.39	0.83	0.7
Skinney Creek	2369.75	60CFS	60	1805.8	1807.93		1808.18	0.012833	4.03	14.89	26.84	0.75	0.7
Skinney Creek	2369.75	80CFS	80	1805.8	1808.2		1808.46	0.010286	4.06	19.71	29.14	0.7	0.66
Skinney Creek	2369.75	2YR	104	1805.8	1808.49		1808.75	0.008404	4.12	25.3	31.55	0.65	0.65
Skinney Creek	2369.75	10YR	201	1805.8	1809.55		1809.74	0.004486	3.51	59.84	39.97	0.48	0.43
Skinney Creek	2369.75	25YR	248	1805.8	1809.98		1810.15	0.003158	3.42	77.11	42	0.42	0.38
Skinney Creek	2369.75	50YR	289	1805.8	1810.33		1810.51	0.002485	3.38	92.51	43.73	0.38	0.35
Skinney Creek	2369.75	100YR	331	1805.8	1810.67		1810.85	0.002085	3.37	107.6	45.36	0.36	0.34
Skinney Creek	2335.33	5CFS	5	1805.71	1806.34		1806.38	0.012887	1.75	2.85	8.65	0.54	0.26
Skinney Creek	2335.33	10CFS	10	1805.71	1806.53		1806.6	0.012225	2.18	4.6	9.64	0.56	0.35
Skinney Creek	2335.33	20CFS	20	1805.71	1806.81	1806.56	1806.92	0.010951	2.7	7.41	10.13	0.56	0.47
Skinney Creek	2335.33	40CFS	40	1805.71	1807.17		1807.37	0.012549	3.59	11.15	10.74	0.62	0.75
Skinney Creek	2335.33	60CFS	60	1805.71	1807.45		1807.73	0.013629	4.22	14.22	11.22	0.66	0.97
Skinney Creek	2335.33	80CFS	80	1805.71	1807.68	1807.33	1808.03	0.014553	4.74	16.89	11.62	0.69	1.18
Skinney Creek	2335.33	2YR	104	1805.71	1807.91	1807.57	1808.35	0.015623	5.32	19.56	12	0.73	1.43
Skinney Creek	2335.33	10YR	201	1805.71	1808.52	1808.33	1809.39	0.020384	7.49	27.2	13.09	0.88	2.55
Skinney Creek	2335.33	25YR	248	1805.71	1808.75	1808.65	1809.83	0.022384	8.37	30.32	14.09	0.93	3.08
Skinney Creek	2335.33	50YR	289	1805.71	1808.93	1808.93	1810.2	0.024031	9.09	32.9	14.87	0.98	3.55
Skinney Creek	2335.33	100YR	331	1805.71	1809.19	1809.19	1810.56	0.022872	9.43	36.94	16.01	0.97	3.71

HEC-RAS Plan: Existing (continued)

River	River Station	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear Chan
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)
Skinney Creek	2268.22	5CFS	5	1804.7	1805.16	1805.09	1805.23	0.02376	2.05	2.44	9.46	0.71	0.38
Skinney Creek	2268.22	10CFS	10	1804.7	1805.29	1805.24	1805.4	0.028736	2.69	3.72	11.02	0.81	0.6
Skinney Creek	2268.22	20CFS	20	1804.7	1805.42	1805.42	1805.65	0.04036	3.86	5.19	11.46	1.01	1.12
Skinney Creek	2268.22	40CFS	40	1804.7	1805.69	1805.69	1806.04	0.035524	4.73	8.46	12.37	1.01	1.47
Skinney Creek	2268.22	60CFS	60	1804.7	1805.91	1805.91	1806.35	0.03313	5.3	11.31	13.11	1.01	1.71
Skinney Creek	2268.22	80CFS	80	1804.7	1806.11	1806.11	1806.62	0.031772	5.75	13.91	13.75	1.01	1.92
Skinney Creek	2268.22	2YR	104	1804.7	1806.31	1806.31	1806.91	0.030444	6.23	16.71	14.41	1.01	2.14
Skinney Creek	2268.22	10YR	201	1804.7	1806.98	1806.98	1807.87	0.024987	7.62	27.14	16.63	0.99	2.75
Skinney Creek	2268.22	25YR	248	1804.7	1807.26	1807.26	1808.27	0.023565	8.13	31.91	17.55	0.98	2.99
Skinney Creek	2268.22	50YR	289	1804.7	1807.49	1807.49	1808.59	0.022378	8.49	36.11	18.32	0.97	3.15
Skinney Creek	2268.22	100YR	331	1804.7	1807.57	1807.71	1808.92	0.026134	9.38	37.6	18.59	1.06	3.8
Skinney Creek	2216.28	5CFS	5	1803.05	1803.39	1803.39	1803.5	0.048964	2.77	1.8	7.65	1.01	0.71
Skinney Creek	2216.28	10CFS	10	1803.05	1803.55	1803.53	1803.71	0.036591	3.24	3.08	8.19	0.93	0.84
Skinney Creek	2216.28	20CFS	20	1803.05	1803.84	1803.74	1804.04	0.023363	3.57	5.6	8.96	0.8	0.87
Skinney Creek	2216.28	40CFS	40	1803.05	1804.31	1804.07	1804.56	0.015813	3.99	10.04	9.8	0.69	0.93
Skinney Creek	2216.28	60CFS	60	1803.05	1804.71	1804.33	1804.99	0.012948	4.25	14.13	10.51	0.65	0.97
Skinney Creek	2216.28	80CFS	80	1803.05	1805.07	1804.57	1805.38	0.011415	4.45	18	11.14	0.62	1.01
Skinney Creek	2216.28	2YR	104	1803.05	1805.45	1804.82	1805.79	0.010324	4.66	22.33	11.81	0.6	1.05
Skinney Creek	2216.28	10YR	201	1803.05	1806.4	1805.63	1806.95	0.009924	5.97	34.67	15.15	0.62	1.51
Skinney Creek	2216.28	25YR	248	1803.05	1806.6	1805.95	1807.32	0.011987	6.86	37.82	16.77	0.69	1.96
Skinney Creek	2216.28	50YR	289	1803.05	1806.78	1806.23	1807.64	0.013217	7.49	41.09	18.3	0.74	2.29
Skinney Creek	2216.28	100YR	331	1803.05	1806.94	1806.51	1807.95	0.014684	8.15	44.02	19.56	0.78	2.66
Skinney Creek	2154.32	5CFS	5	1801.67	1802.32	1802.1	1802.37	0.008361	1.76	2.84	5.91	0.45	0.23
Skinney Creek	2154.32	10CFS	10	1801.67	1802.56	1802.28	1802.64	0.009667	2.34	4.28	6.32	0.5	0.37
Skinney Creek	2154.32	20CFS	20	1801.67	1802.88	1802.55	1803.03	0.01158	3.12	6.4	6.71	0.56	0.6
Skinney Creek	2154.32	40CFS	40	1801.67	1803.31	1802.96	1803.59	0.015239	4.26	9.38	7.23	0.66	1.02
Skinney Creek	2154.32	60CFS	60	1801.67	1803.61	1803.29	1804.03	0.0186	5.16	11.63	7.59	0.73	1.42
Skinney Creek	2154.32	80CFS	80	1801.67	1803.86	1803.58	1804.4	0.021669	5.92	13.51	7.88	0.8	1.82
Skinney Creek	2154.32	2YR	104	1801.67	1804.1	1803.89	1804.8	0.024973	6.74	15.44	8.24	0.86	2.29
Skinney Creek	2154.32	10YR	201	1801.67	1805.12	1805.12	1806.06	0.019871	8.01	31.03	24.44	0.83	2.8
Skinney Creek	2154.32	25YR	248	1801.67	1805.55	1805.55	1806.44	0.016579	8.02	42.83	28.99	0.77	2.68
Skinney Creek	2154.32	50YR	289	1801.67	1805.77	1805.77	1806.71	0.016872	8.43	49.23	30.16	0.79	2.9
Skinney Creek	2154.32	100YR	331	1801.67	1805.98	1805.98	1806.97	0.016836	8.76	55.87	31.33	0.79	3.07

HEC-RAS Plan: Existing (continued)

River	River Station	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear Chan
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)
Skinney Creek	2095.18	5CFS	5	1800.85	1801.24	1801.24	1801.37	0.048259	2.84	1.76	7.09	1.01	0.74
Skinney Creek	2095.18	10CFS	10	1800.85	1801.4	1801.4	1801.58	0.043275	3.39	2.95	8.38	1.01	0.94
Skinney Creek	2095.18	20CFS	20	1800.85	1801.62	1801.62	1801.87	0.039132	4.01	4.99	10.22	1.01	1.17
Skinney Creek	2095.18	40CFS	40	1800.85	1801.92	1801.92	1802.28	0.03486	4.81	8.32	11.78	1.01	1.5
Skinney Creek	2095.18	60CFS	60	1800.85	1802.16	1802.16	1802.6	0.032428	5.31	11.3	13.01	1	1.71
Skinney Creek	2095.18	80CFS	80	1800.85	1802.36	1802.36	1802.87	0.030989	5.69	14.06	14.06	1	1.87
Skinney Creek	2095.18	2YR	104	1800.85	1802.56	1802.56	1803.15	0.030028	6.13	16.96	15.08	1.01	2.08
Skinney Creek	2095.18	10YR	201	1800.85	1802.86	1803.22	1804.23	0.051495	9.38	21.72	16.63	1.37	4.5
Skinney Creek	2095.18	25YR	248	1800.85	1803.01	1803.5	1804.7	0.056054	10.45	24.29	17.4	1.46	5.41
Skinney Creek	2095.18	50YR	289	1800.85	1803.21	1803.72	1805.01	0.051242	10.8	27.82	18.42	1.42	5.55
Skinney Creek	2095.18	100YR	331	1800.85	1803.4	1803.93	1805.3	0.047718	11.14	31.38	19.39	1.39	5.71
Skinney Creek	2002.3	5CFS	5	1797.36	1798.27	1797.93	1798.31	0.004745	1.49	3.34	5.68	0.34	0.16
Skinney Creek	2002.3	10CFS	10	1797.36	1798.55	1798.12	1798.62	0.005825	1.98	5.04	6.42	0.39	0.25
Skinney Creek	2002.3	20CFS	20	1797.36	1798.91	1798.42	1799.02	0.007597	2.68	7.47	7.23	0.46	0.43
Skinney Creek	2002.3	40CFS	40	1797.36	1799.36	1798.85	1799.57	0.01036	3.66	10.93	8.13	0.56	0.74
Skinney Creek	2002.3	60CFS	60	1797.36	1799.66	1799.18	1799.97	0.01293	4.44	13.5	8.74	0.63	1.04
Skinney Creek	2002.3	80CFS	80	1797.36	1799.96	1799.47	1800.33	0.015259	4.89	16.34	10.51	0.69	1.25
Skinney Creek	2002.3	2YR	104	1797.36	1800.22	1799.79	1800.67	0.016921	5.38	19.36	12.25	0.74	1.48
Skinney Creek	2002.3	10YR	201	1797.36	1800.8	1800.68	1801.7	0.022917	7.65	27.11	14.7	0.91	2.71
Skinney Creek	2002.3	25YR	248	1797.36	1801.02	1801.01	1802.14	0.025092	8.53	30.49	15.65	0.96	3.26
Skinney Creek	2002.3	50YR	289	1797.36	1801.29	1801.29	1802.5	0.023665	8.89	34.86	16.8	0.95	3.42
Skinney Creek	2002.3	100YR	331	1797.36	1801.53	1801.53	1802.83	0.02304	9.28	39	17.82	0.95	3.62
Skinney Creek	1954.19	5CFS	5	1796.87	1797.64	1797.64	1797.77	0.049399	2.81	1.78	6.72	0.96	0.73
Skinney Creek	1954.19	10CFS	10	1796.87	1797.79	1797.79	1797.98	0.049978	3.47	2.88	8.05	1.02	1.01
Skinney Creek	1954.19	20CFS	20	1796.87	1798.02	1798.02	1798.27	0.044201	4.06	4.93	10.05	1.02	1.23
Skinney Creek	1954.19	40CFS	40	1796.87	1798.32	1798.32	1798.68	0.039179	4.83	8.28	11.92	1.02	1.55
Skinney Creek	1954.19	60CFS	60	1796.87	1798.56	1798.56	1799	0.034536	5.29	11.34	12.96	1	1.73
Skinney Creek	1954.19	80CFS	80	1796.87	1798.76	1798.76	1799.27	0.03359	5.74	13.93	13.77	1.01	1.94
Skinney Creek	1954.19	2YR	104	1796.87	1798.95	1798.95	1799.56	0.032663	6.25	16.66	14.56	1.02	2.19
Skinney Creek	1954.19	10YR	201	1796.87	1799.63	1799.63	1800.52	0.02638	7.6	27.4	17.27	0.99	2.78
Skinney Creek	1954.19	25YR	248	1796.87	1799.91	1799.91	1800.91	0.024646	8.08	32.43	18.33	0.98	2.99
Skinney Creek	1954.19	50YR	289	1796.87	1800	1800.15	1801.24	0.028904	9	34.14	18.63	1.06	3.66
Skinney Creek	1954.19	100YR	331	1796.87	1800.15	1800.35	1801.56	0.030294	9.62	36.94	19.11	1.1	4.1

HEC-RAS Plan: Existing (continued)

River	River Station	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear Chan
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)
Skinney Creek	1871.33	5CFS	5	1794.91	1795.79	1795.39	1795.81	0.002937	1.18	4.23	7.6	0.28	0.1
Skinney Creek	1871.33	10CFS	10	1794.91	1796.07	1795.57	1796.1	0.00348	1.53	6.55	9.08	0.32	0.15
Skinney Creek	1871.33	20CFS	20	1794.91	1796.44	1795.83	1796.5	0.003842	1.95	10.24	10.41	0.35	0.22
Skinney Creek	1871.33	40CFS	40	1794.91	1797.04	1796.2	1797.13	0.003799	2.33	17.17	13.06	0.36	0.29
Skinney Creek	1871.33	60CFS	60	1794.91	1797.48	1796.46	1797.58	0.003794	2.56	23.43	15.37	0.37	0.33
Skinney Creek	1871.33	80CFS	80	1794.91	1797.77	1796.7	1797.9	0.004174	2.84	28.14	16.89	0.39	0.4
Skinney Creek	1871.33	2YR	104	1794.91	1798.07	1796.96	1798.22	0.004294	3.12	33.41	19.21	0.4	0.46
Skinney Creek	1871.33	10YR	201	1794.91	1799.03	1797.73	1799.26	0.003891	3.91	54.89	23.98	0.41	0.64
Skinney Creek	1871.33	25YR	248	1794.91	1799.42	1798	1799.68	0.003777	4.2	64.41	25.02	0.41	0.7
Skinney Creek	1871.33	50YR	289	1794.91	1799.73	1798.23	1800.02	0.00369	4.42	72.45	25.87	0.41	0.75
Skinney Creek	1871.33	100YR	331	1794.91	1800.04	1798.43	1800.35	0.003613	4.62	80.47	26.68	0.42	0.8
Skinney Creek	1856.46	5CFS	5	1794.84	1795.76	1795.3	1795.78	0.001533	0.89	5.63	9.53	0.2	0.05
Skinney Creek	1856.46	10CFS	10	1794.84	1796.04	1795.46	1796.06	0.001845	1.2	8.34	10.11	0.23	0.09
Skinney Creek	1856.46	20CFS	20	1794.84	1796.41	1795.68	1796.45	0.002334	1.63	12.24	10.91	0.27	0.15
Skinney Creek	1856.46	40CFS	40	1794.84	1797	1796	1797.07	0.003065	2.06	19.38	14.86	0.32	0.23
Skinney Creek	1856.46	60CFS	60	1794.84	1797.45	1796.26	1797.52	0.003436	2.19	27.41	21.34	0.34	0.26
Skinney Creek	1856.46	80CFS	80	1794.84	1797.75	1796.47	1797.83	0.003252	2.34	34.15	22.98	0.34	0.28
Skinney Creek	1856.46	2YR	104	1794.84	1798.05	1796.71	1798.15	0.003038	2.52	41.3	23.79	0.34	0.31
Skinney Creek	1856.46	10YR	201	1794.84	1799.04	1797.59	1799.19	0.002562	3.08	66.2	26.6	0.33	0.4
Skinney Creek	1856.46	25YR	248	1794.84	1799.44	1797.8	1799.61	0.002453	3.31	77.02	27.76	0.33	0.44
Skinney Creek	1856.46	50YR	289	1794.84	1799.76	1797.98	1799.95	0.002379	3.48	86.14	28.69	0.33	0.47
Skinney Creek	1856.46	100YR	331	1794.84	1800.07	1798.14	1800.28	0.002318	3.64	95.23	29.6	0.33	0.5
Skinney Creek	1755.75	5CFS	5	1794.77	1795.18	1795.18	1795.32	0.048348	2.91	1.72	6.68	1.01	0.76
Skinney Creek	1755.75	10CFS	10	1794.77	1795.35	1795.35	1795.54	0.040678	3.53	2.83	7.12	0.99	0.98
Skinney Creek	1755.75	20CFS	20	1794.77	1795.67	1795.57	1795.89	0.024325	3.78	5.29	8	0.82	0.95
Skinney Creek	1755.75	40CFS	40	1794.77	1796.14	1795.95	1796.43	0.018248	4.27	9.38	9.28	0.75	1.07
Skinney Creek	1755.75	60CFS	60	1794.77	1796.49	1796.24	1796.83	0.01713	4.71	12.73	10.22	0.74	1.22
Skinney Creek	1755.75	80CFS	80	1794.77	1796.77	1796.49	1797.17	0.016865	5.11	15.67	11.09	0.75	1.37
Skinney Creek	1755.75	2YR	104	1794.77	1797.01	1796.74	1797.51	0.017148	5.64	18.61	12.64	0.77	1.6
Skinney Creek	1755.75	10YR	201	1794.77	1797.74	1797.6	1798.57	0.018076	7.4	29.43	16.46	0.84	2.43
Skinney Creek	1755.75	25YR	248	1794.77	1798.03	1797.9	1799	0.018224	8.02	34.34	17.23	0.86	2.75
Skinney Creek	1755.75	50YR	289	1794.77	1798.26	1798.16	1799.34	0.018394	8.51	38.37	17.84	0.88	3.01
Skinney Creek	1755.75	100YR	331	1794.77	1798.48	1798.41	1799.67	0.018536	8.97	42.36	18.42	0.89	3.26

HEC-RAS Plan: Existing (continued)

River	River Station	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear Chan
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)
Skinney Creek	1688.34	5CFS	5	1793.49	1794.18	1793.9	1794.22	0.006337	1.65	3.03	5.65	0.4	0.2
Skinney Creek	1688.34	10CFS	10	1793.49	1794.45	1794.1	1794.53	0.007215	2.15	4.66	6.35	0.44	0.3
Skinney Creek	1688.34	20CFS	20	1793.49	1794.83	1794.39	1794.95	0.008691	2.71	7.37	8.11	0.5	0.45
Skinney Creek	1688.34	40CFS	40	1793.49	1795.3	1794.83	1795.48	0.010553	3.42	11.7	10.6	0.57	0.67
Skinney Creek	1688.34	60CFS	60	1793.49	1795.61	1795.16	1795.85	0.011768	3.91	15.34	12.36	0.62	0.84
Skinney Creek	1688.34	80CFS	80	1793.49	1795.87	1795.42	1796.15	0.012579	4.28	18.7	13.9	0.65	0.98
Skinney Creek	1688.34	2YR	104	1793.49	1796.09	1795.68	1796.44	0.013548	4.77	21.82	14.93	0.69	1.17
Skinney Creek	1688.34	10YR	201	1793.49	1796.65	1796.4	1797.34	0.017411	6.68	30.76	17.05	0.82	2.06
Skinney Creek	1688.34	25YR	248	1793.49	1796.86	1796.68	1797.71	0.019002	7.45	34.45	17.86	0.87	2.48
Skinney Creek	1688.34	50YR	289	1793.49	1797.03	1796.92	1798.02	0.020048	8.04	37.6	18.51	0.91	2.82
Skinney Creek	1688.34	100YR	331	1793.49	1797.19	1797.13	1798.33	0.021018	8.6	40.69	19.13	0.94	3.16
Skinney Creek	1562	5CFS	5	1791.94	1792.38	1792.38	1792.48	0.048705	2.61	1.92	8.86	0.99	0.65
Skinney Creek	1562	10CFS	10	1791.94	1792.51	1792.51	1792.64	0.046464	2.91	3.44	13	1	0.76
Skinney Creek	1562	20CFS	20	1791.94	1792.66	1792.66	1792.86	0.041946	3.58	5.58	14.29	1.01	1.01
Skinney Creek	1562	40CFS	40	1791.94	1792.9	1792.9	1793.2	0.036889	4.42	9.04	15.21	1.01	1.34
Skinney Creek	1562	60CFS	60	1791.94	1793.09	1793.09	1793.47	0.034211	4.98	12.04	15.93	1.01	1.57
Skinney Creek	1562	80CFS	80	1791.94	1793.26	1793.26	1793.71	0.032511	5.41	14.78	16.54	1.01	1.76
Skinney Creek	1562	2YR	104	1791.94	1793.44	1793.43	1793.97	0.030323	5.81	17.9	17.23	1	1.92
Skinney Creek	1562	10YR	201	1791.94	1794.09	1794.02	1794.83	0.02274	6.92	29.78	19.67	0.94	2.33
Skinney Creek	1562	25YR	248	1791.94	1794.35	1794.28	1795.18	0.021033	7.34	35.18	20.69	0.92	2.49
Skinney Creek	1562	50YR	289	1791.94	1794.57	1794.47	1795.47	0.019976	7.67	39.73	21.51	0.92	2.63
Skinney Creek	1562	100YR	331	1791.94	1794.78	1794.67	1795.75	0.019161	7.98	44.27	22.29	0.91	2.76
Skinney Creek	1436.63	5CFS	5	1789.12	1789.79	1789.5	1789.82	0.004581	1.39	3.59	7.04	0.34	0.14
Skinney Creek	1436.63	10CFS	10	1789.12	1790.05	1789.66	1790.1	0.005183	1.81	5.52	7.9	0.38	0.22
Skinney Creek	1436.63	20CFS	20	1789.12	1790.42	1789.91	1790.5	0.005729	2.31	8.65	9.11	0.42	0.32
Skinney Creek	1436.63	40CFS	40	1789.12	1790.91	1790.29	1791.04	0.006591	2.96	13.49	10.72	0.47	0.48
Skinney Creek	1436.63	60CFS	60	1789.12	1791.26	1790.57	1791.44	0.00719	3.42	17.53	11.9	0.5	0.61
Skinney Creek	1436.63	80CFS	80	1789.12	1791.6	1790.83	1791.81	0.007674	3.65	21.94	14.28	0.52	0.68
Skinney Creek	1436.63	2YR	104	1789.12	1791.92	1791.08	1792.15	0.007852	3.89	26.78	16.43	0.53	0.75
Skinney Creek	1436.63	10YR	201	1789.12	1792.62	1791.95	1793.05	0.008865	5.24	39.23	18.76	0.6	1.21
Skinney Creek	1436.63	25YR	248	1789.12	1792.9	1792.21	1793.41	0.009308	5.77	44.47	19.66	0.63	1.42
Skinney Creek	1436.63	50YR	289	1789.12	1793.12	1792.42	1793.71	0.009511	6.17	49.05	20.42	0.64	1.57
Skinney Creek	1436.63	100YR	331	1789.12	1793.35	1792.63	1794	0.009651	6.53	53.66	21.15	0.66	1.72

HEC-RAS Plan: Existing (continued)

River	River Station	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear Chan
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)
Skinney Creek	1293.62	5CFS	5	1787.82	1788.16	1788.16	1788.27	0.049607	2.76	1.81	7.83	1.01	0.71
Skinney Creek	1293.62	10CFS	10	1787.82	1788.3	1788.3	1788.47	0.041479	3.28	3.05	8.81	0.98	0.88
Skinney Creek	1293.62	20CFS	20	1787.82	1788.5	1788.5	1788.76	0.040021	4.14	4.83	9.54	1.02	1.24
Skinney Creek	1293.62	40CFS	40	1787.82	1788.82	1788.82	1789.2	0.034304	4.95	8.09	10.74	1	1.56
Skinney Creek	1293.62	60CFS	60	1787.82	1789.08	1789.08	1789.54	0.031494	5.46	10.99	11.7	0.99	1.77
Skinney Creek	1293.62	80CFS	80	1787.82	1789.29	1789.29	1789.83	0.030757	5.91	13.53	12.49	1	1.98
Skinney Creek	1293.62	2YR	104	1787.82	1789.49	1789.49	1790.13	0.030092	6.43	16.19	13.28	1.01	2.23
Skinney Creek	1293.62	10YR	201	1787.82	1790.28	1790.28	1791.13	0.021229	7.48	29.26	20.97	0.92	2.57
Skinney Creek	1293.62	25YR	248	1787.82	1790.58	1790.58	1791.51	0.019688	7.89	35.72	22.4	0.91	2.73
Skinney Creek	1293.62	50YR	289	1787.82	1790.8	1790.8	1791.81	0.019002	8.24	40.91	23.41	0.91	2.89
Skinney Creek	1293.62	100YR	331	1787.82	1791.01	1791.01	1792.09	0.018712	8.61	45.83	24.32	0.91	3.08
Skinney Creek	1128.55	5CFS	5	1782.02	1782.78	1782.51	1782.82	0.006679	1.63	3.07	6.26	0.41	0.2
Skinney Creek	1128.55	10CFS	10	1782.02	1783.04	1782.71	1783.11	0.007461	2.04	4.89	7.6	0.45	0.28
Skinney Creek	1128.55	20CFS	20	1782.02	1783.38	1782.99	1783.49	0.008047	2.62	7.63	8.42	0.49	0.42
Skinney Creek	1128.55	40CFS	40	1782.02	1783.88	1783.36	1784.05	0.008427	3.31	12.08	9.4	0.51	0.6
Skinney Creek	1128.55	60CFS	60	1782.02	1784.27	1783.65	1784.49	0.008779	3.79	15.82	10.15	0.54	0.74
Skinney Creek	1128.55	80CFS	80	1782.02	1784.58	1783.9	1784.86	0.009111	4.18	19.16	10.78	0.55	0.87
Skinney Creek	1128.55	2YR	104	1782.02	1784.89	1784.17	1785.22	0.009505	4.62	22.52	11.38	0.57	1.02
Skinney Creek	1128.55	10YR	201	1782.02	1785.75	1785.03	1786.35	0.010693	6.22	33.13	13.1	0.65	1.64
Skinney Creek	1128.55	25YR	248	1782.02	1786.1	1785.36	1786.82	0.01113	6.84	37.72	13.83	0.67	1.91
Skinney Creek	1128.55	50YR	289	1782.02	1786.37	1785.63	1787.19	0.011454	7.32	41.96	17.3	0.69	2.13
Skinney Creek	1128.55	100YR	331	1782.02	1786.63	1785.91	1787.54	0.011676	7.75	46.91	20.91	0.7	2.33
Skinney Creek	1026.93	5CFS	5	1781.1	1781.74		1781.8	0.016315	2.07	2.42	6.79	0.61	0.35
Skinney Creek	1026.93	10CFS	10	1781.1	1781.95	1781.79	1782.05	0.015319	2.58	3.87	7.21	0.62	0.48
Skinney Creek	1026.93	20CFS	20	1781.1	1782.27		1782.42	0.01441	3.17	6.32	8.03	0.63	0.64
Skinney Creek	1026.93	40CFS	40	1781.1	1782.74		1782.97	0.01369	3.82	10.46	9.33	0.64	0.84
Skinney Creek	1026.93	60CFS	60	1781.1	1783.12		1783.39	0.013426	4.24	14.15	10.61	0.65	0.98
Skinney Creek	1026.93	80CFS	80	1781.1	1783.42	1782.96	1783.74	0.013228	4.55	17.57	11.67	0.65	1.08
Skinney Creek	1026.93	2YR	104	1781.1	1783.72	1783.23	1784.09	0.01298	4.92	21.16	12.69	0.66	1.21
Skinney Creek	1026.93	10YR	201	1781.1	1784.57		1785.18	0.012583	6.27	33.42	16.16	0.69	1.73
Skinney Creek	1026.93	25YR	248	1781.1	1784.86		1785.59	0.01319	6.89	38.28	17.4	0.72	2.02
Skinney Creek	1026.93	50YR	289	1781.1	1785.08	1784.62	1785.91	0.01387	7.42	42.11	18.32	0.75	2.28
Skinney Creek	1026.93	100YR	331	1781.1	1785.28	1784.87	1786.23	0.014434	7.91	45.98	19.21	0.77	2.54

HEC-RAS Plan: Existing (continued)

River	River Station	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear Chan
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)
Skinney Creek	851.81	5CFS	5	1778.31	1778.88	1778.77	1778.95	0.016325	2.15	2.33	6.2	0.62	0.37
Skinney Creek	851.81	10CFS	10	1778.31	1779.08	1778.94	1779.2	0.017283	2.74	3.64	6.91	0.67	0.54
Skinney Creek	851.81	20CFS	20	1778.31	1779.37	1779.19	1779.55	0.018855	3.48	5.75	8	0.72	0.79
Skinney Creek	851.81	40CFS	40	1778.31	1779.75	1779.58	1780.05	0.020611	4.37	9.16	9.5	0.78	1.14
Skinney Creek	851.81	60CFS	60	1778.31	1780.04	1779.88	1780.43	0.02177	4.97	12.06	10.62	0.82	1.4
Skinney Creek	851.81	80CFS	80	1778.31	1780.28	1780.12	1780.74	0.022799	5.46	14.65	11.52	0.85	1.63
Skinney Creek	851.81	2YR	104	1778.31	1780.5	1780.39	1781.06	0.023777	6.02	17.3	12.37	0.89	1.91
Skinney Creek	851.81	10YR	201	1778.31	1781.16	1781.16	1782.12	0.025245	7.89	26.43	15.7	0.96	2.91
Skinney Creek	851.81	25YR	248	1778.31	1781.47	1781.47	1782.54	0.023486	8.37	31.69	17.5	0.95	3.12
Skinney Creek	851.81	50YR	289	1778.31	1781.75	1781.75	1782.88	0.021643	8.64	36.76	19.07	0.93	3.21
Skinney Creek	851.81	100YR	331	1778.31	1781.99	1781.99	1783.2	0.020868	8.99	41.49	20.43	0.93	3.37
Skinney Creek	602.87	5CFS	5	1771.84	1772.37	1772.37	1772.52	0.046899	3.1	1.61	5.55	1.01	0.84
Skinney Creek	602.87	10CFS	10	1771.84	1772.56	1772.56	1772.76	0.042797	3.6	2.78	7.12	1.01	1.02
Skinney Creek	602.87	20CFS	20	1771.84	1772.81	1772.81	1773.07	0.038114	4.13	4.84	9.23	1	1.22
Skinney Creek	602.87	40CFS	40	1771.84	1773.14	1773.14	1773.5	0.034607	4.83	8.28	11.52	1	1.51
Skinney Creek	602.87	60CFS	60	1771.84	1773.37	1773.37	1773.82	0.03297	5.41	11.1	12.49	1.01	1.76
Skinney Creek	602.87	80CFS	80	1771.84	1773.57	1773.57	1774.1	0.031551	5.85	13.68	13.15	1.01	1.96
Skinney Creek	602.87	2YR	104	1771.84	1773.78	1773.78	1774.4	0.030312	6.32	16.47	13.84	1.01	2.18
Skinney Creek	602.87	10YR	201	1771.84	1774.39	1774.47	1775.4	0.028917	8.09	25.48	15.86	1.06	3.12
Skinney Creek	602.87	25YR	248	1771.84	1774.58	1774.76	1775.82	0.031182	8.99	28.61	16.51	1.12	3.72
Skinney Creek	602.87	50YR	289	1771.84	1774.71	1774.99	1776.19	0.033971	9.79	30.85	16.96	1.18	4.33
Skinney Creek	602.87	100YR	331	1771.84	1774.87	1775.22	1776.53	0.035096	10.43	33.51	17.48	1.21	4.79
Skinney Creek	550.22	5CFS	5	1769.06	1769.6	1769.48	1769.66	0.014011	1.91	2.62	7.41	0.57	0.3
Skinney Creek	550.22	10CFS	10	1769.06	1769.8	1769.64	1769.89	0.014003	2.38	4.2	8.47	0.6	0.42
Skinney Creek	550.22	20CFS	20	1769.06	1770.08	1769.87	1770.22	0.013998	2.94	6.81	9.98	0.63	0.57
Skinney Creek	550.22	40CFS	40	1769.06	1770.48	1770.2	1770.68	0.014019	3.59	11.15	12.07	0.66	0.77
Skinney Creek	550.22	60CFS	60	1769.06	1770.18	1770.46	1771.1	0.086435	7.71	7.79	10.49	1.58	3.82
Skinney Creek	550.22	80CFS	80	1769.06	1770.34	1770.66	1771.44	0.088043	8.42	9.5	11.32	1.62	4.38
Skinney Creek	550.22	2YR	104	1769.06	1770.5	1770.88	1771.79	0.088333	9.14	11.39	12.17	1.65	4.95
Skinney Creek	550.22	10YR	201	1769.06	1771.02	1771.62	1772.98	0.074954	11.28	18.46	14.85	1.64	6.53
Skinney Creek	550.22	25YR	248	1769.06	1771.27	1771.92	1773.41	0.067203	11.84	22.24	16.1	1.59	6.82
Skinney Creek	550.22	50YR	289	1769.06	1771.47	1772.17	1773.74	0.062001	12.24	25.59	17.12	1.56	7.03
Skinney Creek	550.22	100YR	331	1769.06	1771.64	1772.4	1774.09	0.059598	12.73	28.7	18.03	1.55	7.39

Appendix B: Conceptual Cost Estimates

Cost estimates based on concept-level designs of Alternatives 1 – 3. Quantities and unit prices are approximate and to be used as ballpark planning estimates for comparison of Alternatives on a relative scale. Budgeting should not be based on these conceptual cost estimates, and rather should wait for preliminary design-level estimates. Soils pits data will be used to complete the channel stability designs, and could significantly impact cost estimates.

Skinney Creek - Alternative 1
Preliminary estimate of quantities and probable cost
June 14, 2016 - Preliminary

Project features:
Excavate re-meanders and a low floodplain for Skinney Creek within adjacent historic Highway 2 road alignment, to improve aquatic habitat conditions.
Place LWM within Skinney Creek and throughout floodplain for added habitat complexity.

Assumptions:
Earthwork volumes are "in place condition" and do not include expansion of excavated material and compaction of placed material.
Unit prices are approximate.
Imported gravel/cobble required for LWM trench backfill. Salvage and reuse on site materials to extent possible.
LWM is 18"dbh x 40' long. Procured and delivered to on site staging by YN. Contractor moves from onsite staging area and installs.
Revegetation is separate contract to be implemented by others.

Item	Qty	Unit	Unit Cost	Cost	Notes
Miscellaneous					
Mobilization/demobilization (10% per WSDOT recommendations)	1	LS	$ 37,000	$ 37,000	
Diversion, dewatering	1	LS	$ 10,000	$ 10,000	
Erosion & sediment control	1	LS	$ 5,000	$ 5,000	
Access/temporary bridge	0	LS	$ 10,000	$ -	
			Subtotal =	$ 52,000	
Remeander channel excavation and fill					
Excavation,dispose on site	4,600	CY	$ 20	$ 92,000	
Imported gravel/cobble for channel substrate, 8" depth, 10' width, entire length of channel	570	CY	$ 30	$ 17,100	Assumed - pending soils pits data
			Subtotal =	$ 109,100	
Habitat enhancement large wood structures					
Large wood (rootwads) hauled from on site staging and installed	95	EA	$ 400	$ 38,000	
Vertical log installation	27	EA	$ 500	$ 13,500	
Excavation for LWM - salvage reuse and on site disposal	1300	CY	$ 12	$ 15,600	Assumed - pending soils pits data
Imported gravel/cobble, salvaged topsoil for LWM trench backfill	650	CY	$ 30	$ 19,500	
			Subtotal =	$ 86,600	
Floodplain roughness wood					
Large wood (rootwads) hauled from on site staging and installed	12	EA	$ 400	$ 4,800	
Large wood (no rootwads) hauled from on site staging and installed	12	EA	$ 400	$ 4,800	
Vertical log installation	36	EA	$ 500	$ 18,000	
			Subtotal =	$ 27,600	
Site restoration					
Seed and mulch	100	MSF	$ 125	$ 12,500	
			Subtotal =	$ 12,500	
Contingency					
30%	1	LS	$ 86,000	$ 86,000	
			Subtotal =	$ 86,000	
			Total =	**$ 374,000**	
Optional					
Off-site excavated materials disposal at Sooper Pit	5,900	CY	$ 30	$ 177,000	
			Subtotal =	$ 177,000	
			Total =	**$ 551,000**	

CY = cubic yard
EA = each
LF = lineal feet
LS = lump sum
MSF = 1,000-square feet

Skinney Creek - Alternative 2
Preliminary estimate of quantities and probable cost
June 14, 2016 - Preliminary

Project features:
Excavate re-meanders and a low floodplain for Skinney Creek within adjacent historic Highway 2 road alignment, to improve aquatic habitat conditions.
Place LWM within Skinney Creek and throughout floodplain for added habitat complexity.

Assumptions:
Earthwork volumes are "in place condition" and do not include expansion of excavated material and compaction of placed material.
Unit prices are approximate.
Imported gravel/cobble required for LWM trench backfill. Salvage and reuse on site materials to extent possible.
LWM is 18"dbh x 40' long. Procured and delivered to on site staging by YN. Contractor moves from onsite staging area and installs.
Revegetation is separate contract to be implemented by others.

Item	Qty	Unit	Unit Cost	Cost	Notes
Miscellaneous					
Mobilization/demobilization (10% per WSDOT recommendations)	1	LS	$ 43,000	$ 43,000	
Diversion, dewatering	1	LS	$ 12,500	$ 12,500	
Erosion & sediment control	1	LS	$ 7,500	$ 7,500	
Access/temporary bridge	0	LS	$ 10,000	$ -	
			Subtotal =	$ 63,000	
Remeander channel excavation and fill					
Excavation,dispose on site	8,150	CY	$ 20	$ 163,000	
Imported gravel/cobble for channel substrate, 8" depth, 10' width, entire length of channel	570	CY	$ 30	$ 17,100	Assumed - pending soils pits data
			Subtotal =	$ 180,100	
Habitat enhancement large wood structures					
Large wood (rootwads) hauled from on site staging and installed	105	EA	$ 400	$ 42,000	
Vertical log installation	21	EA	$ 500	$ 10,500	
Excavation for LWM - salvage reuse and on site disposal	1400	CY	$ 12	$ 16,800	Assumed - pending soils pits data
Imported gravel/cobble, salvaged topsoil for LWM trench backfill	700	CY	$ 30	$ 21,000	
			Subtotal =	$ 90,300	
Floodplain roughness wood					
Large wood (rootwads) hauled from on site staging and installed	9	EA	$ 400	$ 3,600	
Large wood (no rootwads) hauled from on site staging and installed	9	EA	$ 400	$ 3,600	
Vertical log installation	27	EA	$ 500	$ 13,500	
			Subtotal =	$ 20,700	
Site restoration					
Seed and mulch	100	MSF	$ 125	$ 12,500	
			Subtotal =	$ 12,500	
Contingency					
30%	1	LS	$ 110,000	$ 110,000	
			Subtotal =	$ 110,000	
			Total =	**$ 477,000**	
Optional					
Off-site excavated materials disposal at Sooper Pit	9,550	CY	$ 30	$ 286,500	
			Subtotal =	$ 286,500	
			Total =	**$ 764,000**	

CY = cubic yard
EA = each
LF = lineal feet
LS = lump sum
MSF = 1,000-square feet

Skinney Creek - Alternative 3
Preliminary estimate of quantities and probable cost
June 14, 2016 - Preliminary

Project features:
Excavate re-meanders and a low floodplain for Skinney Creek within adjacent historic Highway 2 road alignment, to improve aquatic habitat conditions.
Place LWM within Skinney Creek and throughout floodplain for added habitat complexity.

Assumptions:
Earthwork volumes are "in place condition" and do not include expansion of excavated material and compaction of placed material.
Unit prices are approximate.
Imported gravel/cobble required for LWM trench backfill. Salvage and reuse on site materials to extent possible.
LWM is 18"dbh x 40' long. Procured and delivered to on site staging by YN. Contractor moves from onsite staging area and installs.
Revegetation is separate contract to be implemented by others.

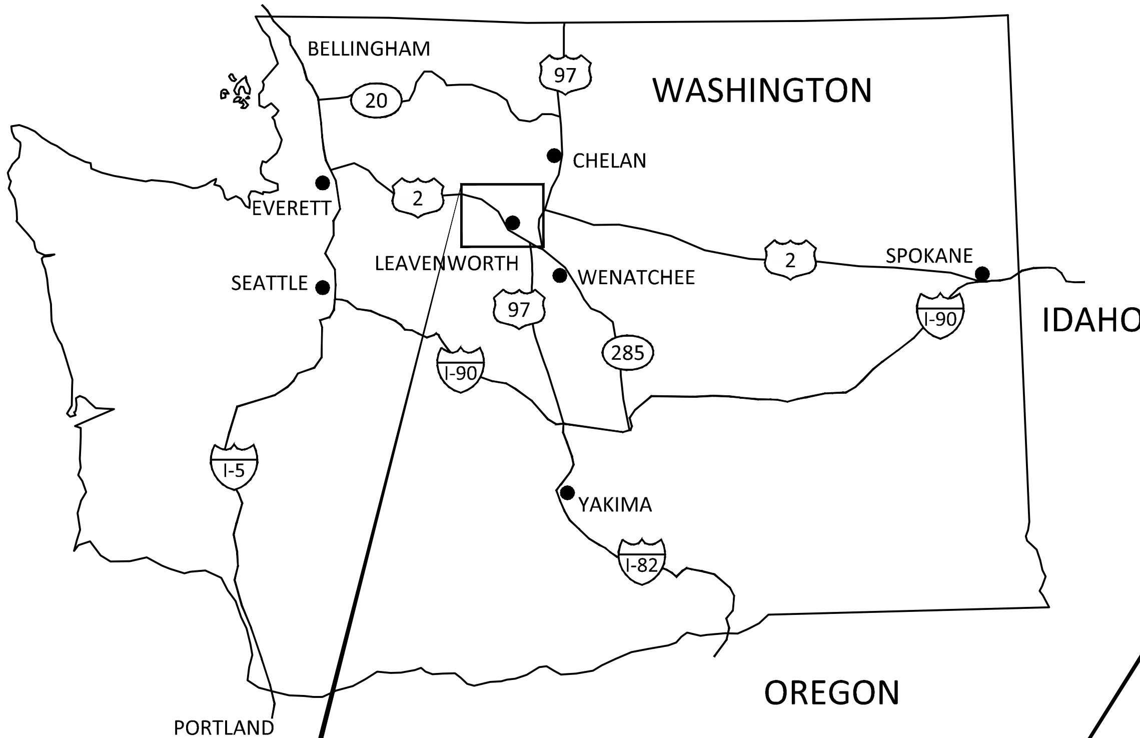
Item	Qty	Unit	Unit Cost	Cost	Notes
Miscellaneous					
Mobilization/demobilization (10% per WSDOT recommendations)	1	LS	$ 50,000	$ 50,000	
Diversion, dewatering	1	LS	$ 15,000	$ 15,000	
Erosion & sediment control	1	LS	$ 10,000	$ 10,000	
Access/temporary bridge	0	LS	$ 10,000	$ -	
			Subtotal =	$ 75,000	
Remeander channel excavation and fill					
Excavation,dispose on site	13,250	CY	$ 20	$ 265,000	
Imported gravel/cobble for channel substrate, 8" depth, 10' width, entire length of channel	570	CY	$ 30	$ 17,100	Assumed - pending soils pits data
			Subtotal =	$ 282,100	
Habitat enhancement large wood structures					
Large wood (rootwads) hauled from on site staging and installed	97	EA	$ 400	$ 38,800	
Vertical log installation	15	EA	$ 500	$ 7,500	
Excavation for LWM - salvage reuse and on site disposal	1300	CY	$ 12	$ 15,600	Assumed - pending soils pits data
Imported gravel/cobble, salvaged topsoil for LWM trench backfill	650	CY	$ 30	$ 19,500	
			Subtotal =	$ 81,400	
Floodplain roughness wood					
Large wood (rootwads) hauled from on site staging and installed	9	EA	$ 400	$ 3,600	
Large wood (no rootwads) hauled from on site staging and installed	9	EA	$ 400	$ 3,600	
Vertical log installation	27	EA	$ 500	$ 13,500	
			Subtotal =	$ 20,700	
Site restoration					
Seed and mulch	100	MSF	$ 125	$ 12,500	
			Subtotal =	$ 12,500	
Contingency					
30%	1	LS	$ 142,000	$ 142,000	
			Subtotal =	$ 142,000	
			Total =	**$ 614,000**	
Optional					
Off-site excavated materials disposal at Sooper Pit	14,550	CY	$ 30	$ 436,500	
			Subtotal =	$ 436,500	
			Total =	**$ 1,051,000**	

CY = cubic yard
EA = each
LF = lineal feet
LS = lump sum
MSF = 1,000-square feet

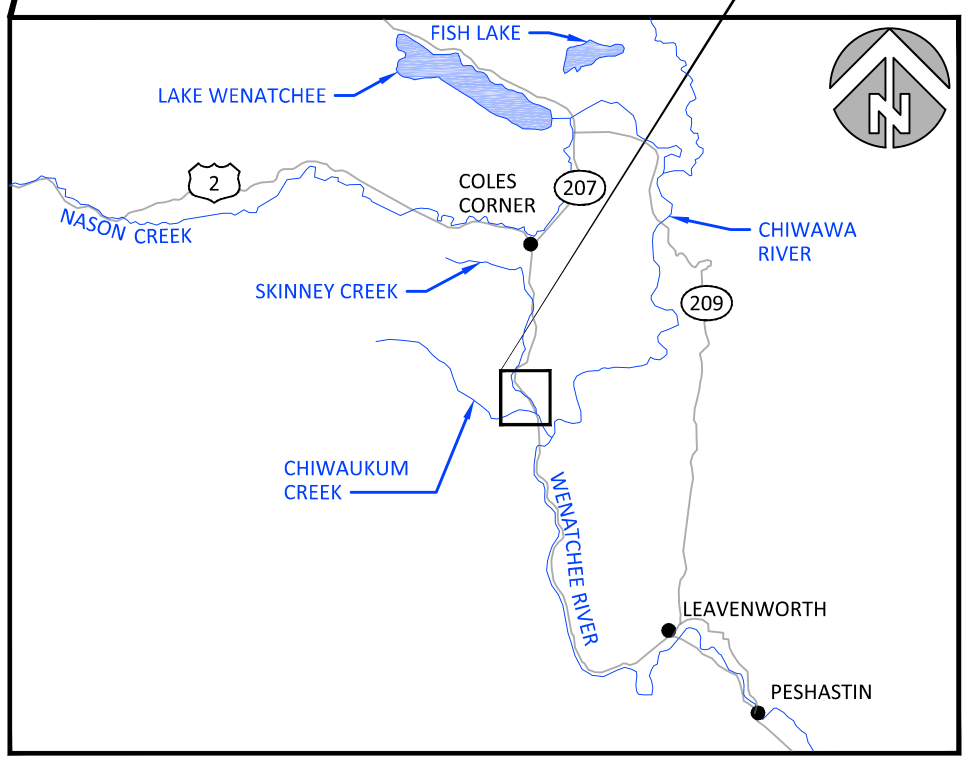
Appendix C: Concept Design Drawings

SKINNEY CREEK - FISH HABITAT ENHANCEMENT PROJECT
CONCEPT DESIGN

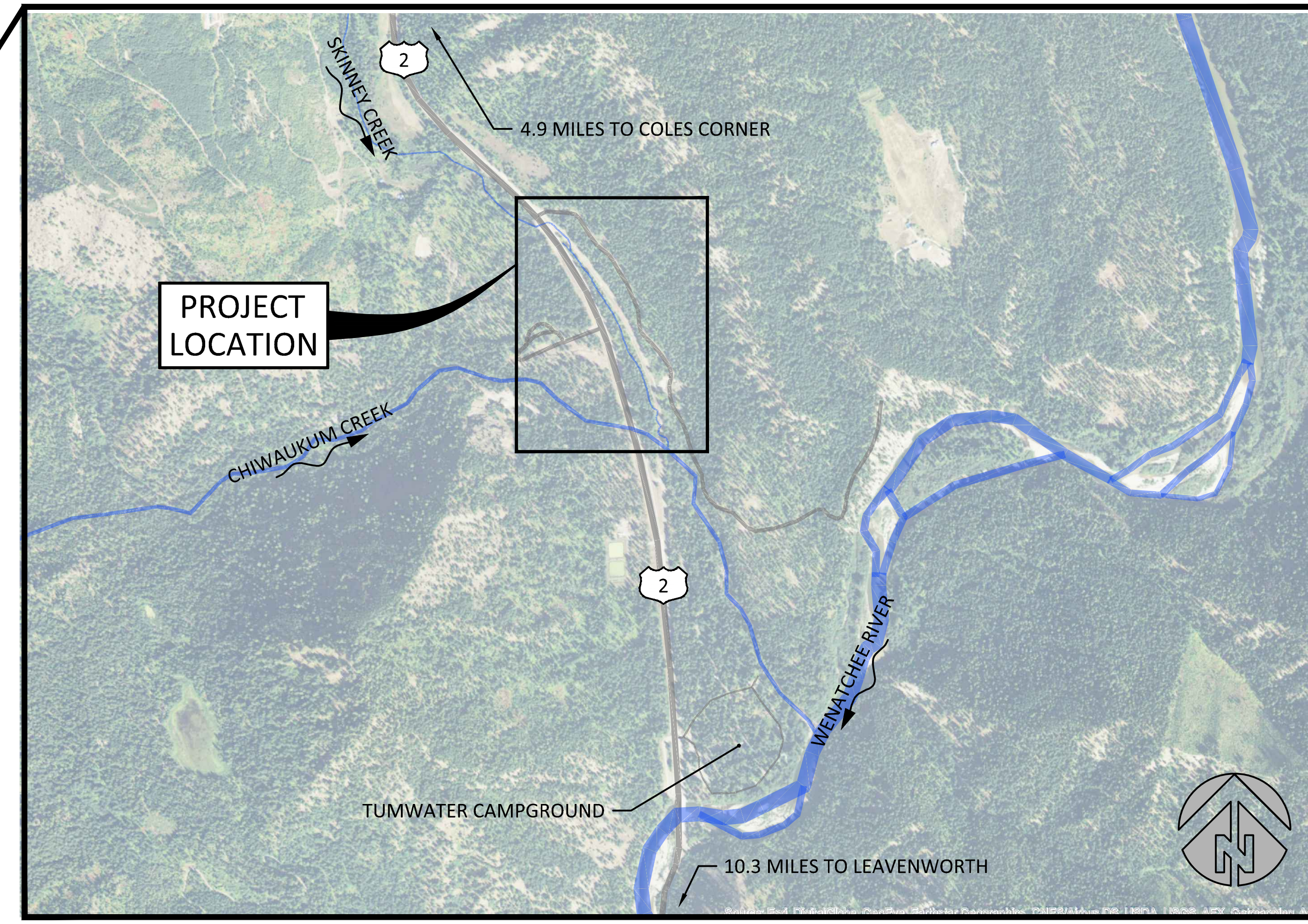
CHELAN COUNTY, WA
JUNE, 2016



LOCATION MAP
STATE OF WASHINGTON
NOT TO SCALE



VICINITY MAP
NOT TO SCALE



SITE MAP
NOT TO SCALE

SHEET INDEX:

COORDINATES:
LATITUDE: 47°41'31.21" N
LONGITUDE 120°44'18.10 W

TOWNSHIP 25N, RANGE 17E, SECTION 4 & 5

WATERBODY: SKINNEY CREEK
TRIBUTARY OF: CHIWAUKUM CHREEK

NO.	BY	DATE	REVISION DESCRIPTION

NS	MB, JP, DM, NS	DM
DRAWN	DESIGNED	CHECKED
DM	6/14/2016	160223
APPROVED	DATE	PROJECT

YAKAMA NATION FISHERIES
SKINNEY CREEK FISH HABITAT ENHANCEMENT PROJECT
CONCEPT DESIGN

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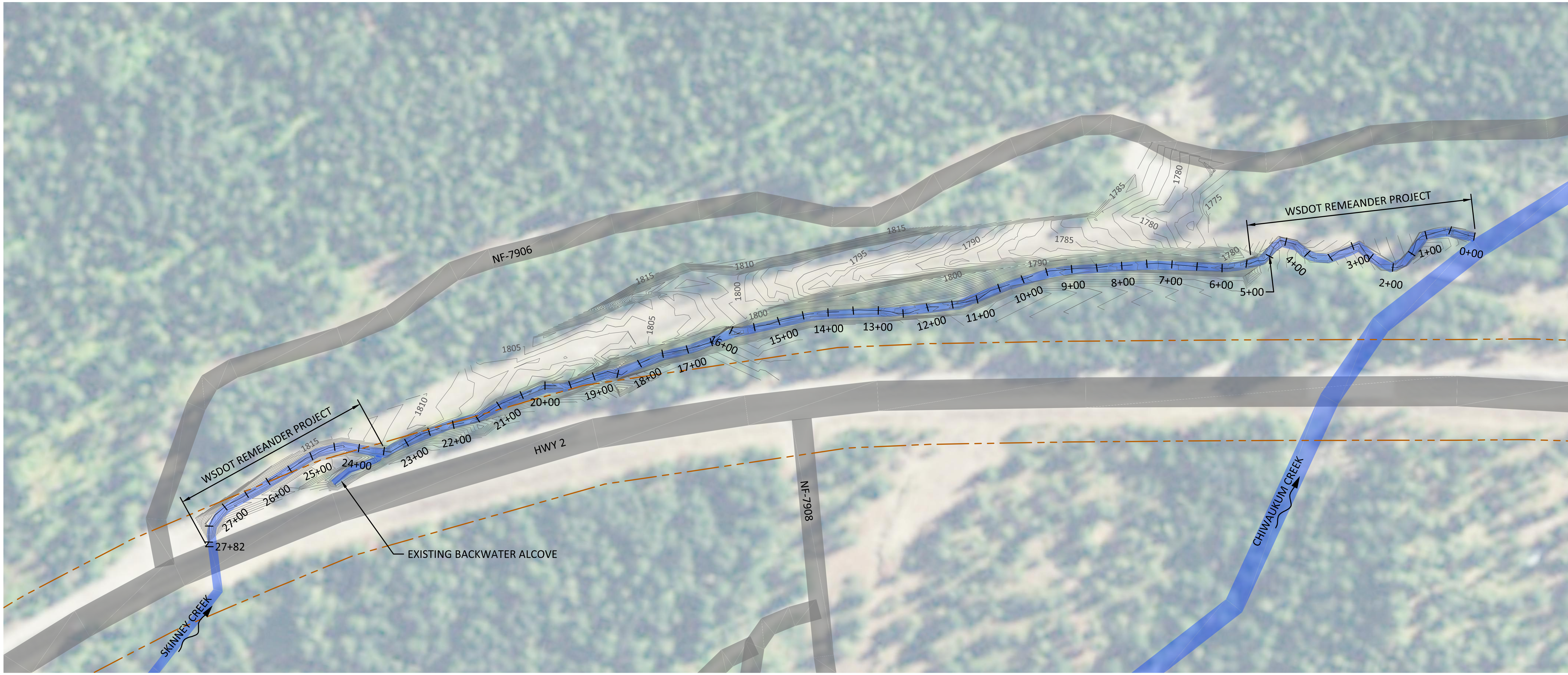
COVER, SHEET INDEX AND VICINITY MAP

SHEET
1 OF 11



ESTIMATED QUANTITIES

	EXISTING CONDITIONS	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3
CHANNEL LENGTH (FT)	**2,780**	2,980	3,230	3,480
CHANNEL SLOPE (%)	**2.1**	1.9	1.8	1.7
FLOODPLAIN BENCH AREA (MSF)	**0**	9.3	13.3	21.5
EXCAVATION QUANTITY (CY)	**0**	4,600	8,200	13,300
LOG PLACEMENT (EA)	**0**	111	123	116

Preliminary
Not for Construction

LEGEND

EXISTING CONTOURS (1FT)
EXISTING CHANNEL
EXISTING ROAD
5+00 EXISTING ALIGNMENT AND STATIONING
APPROX RIGHT OF WAY, FOR REFERENCE ONLY

NOTE:
SITE TOPOGRAPHY BASED ON INTER-FLUVE APRIL 18-20, 2016 SURVEY WITH TOTAL STATION AND RTK GPS.

HORIZONTAL DATUM: NAD 83 WASHINGTON STATE PLANE NORTH, US FEET
VERTICAL DATUM: NAVD 88

0 200 400
SCALE IN FEET

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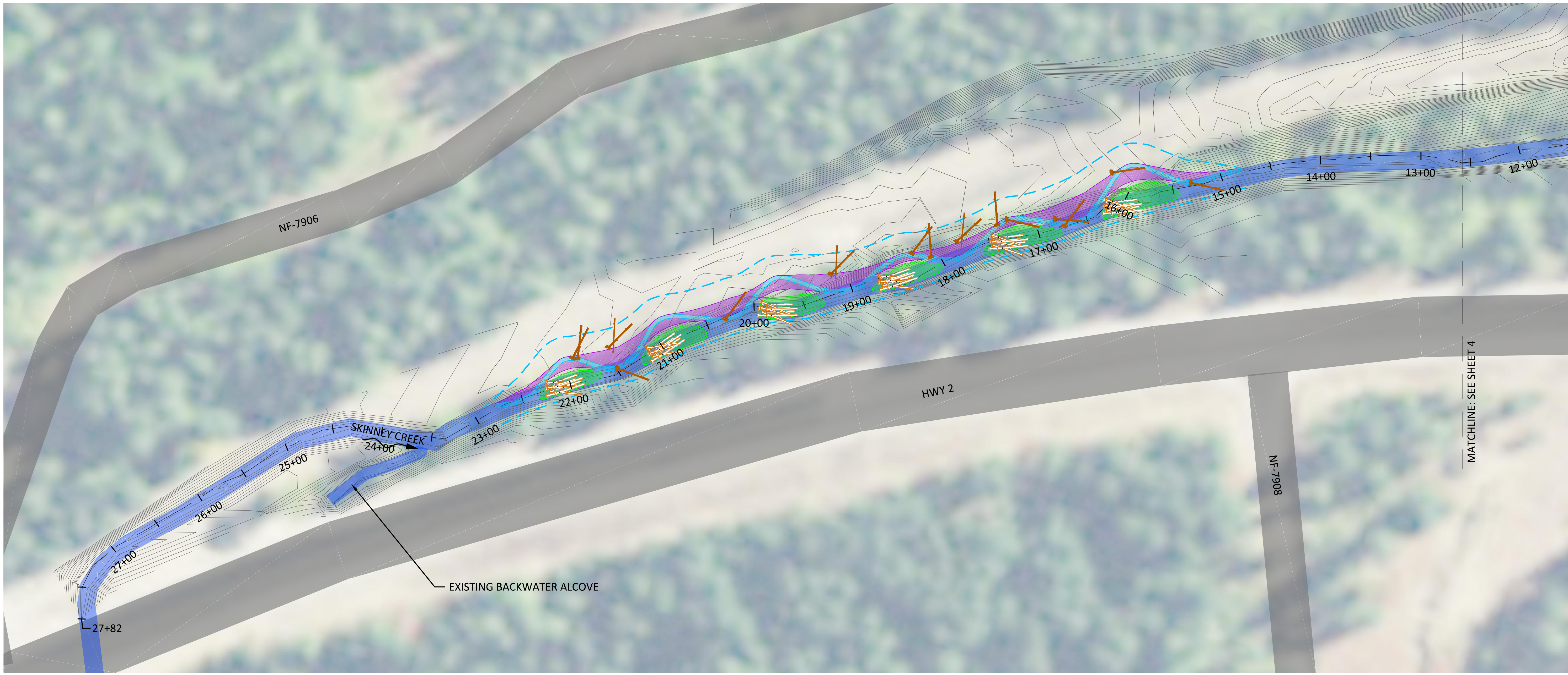
EXISTING CONDITIONS



LEGEND

- EXISTING CONTOURS (1FT)
- EXISTING CHANNEL
- EXISTING ROAD
- 5+00 EXISTING ALIGNMENT AND STATIONING
- PROPOSED CHANNEL
- PROPOSED DAYLIGHT LINE
- PROPOSED FILL PLACEMENT
- PROPOSED FLOODPLAIN BENCH
- LARGE WOOD JAM, SEE 1/11
- FLOODPLAIN ROUGHNESS WOOD, SEE 3/11
- INDIVIDUAL LOG PLACEMENT, SEE 1/9

Preliminary
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QUANTITIES ESTIMATE

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SCALE IN FEET

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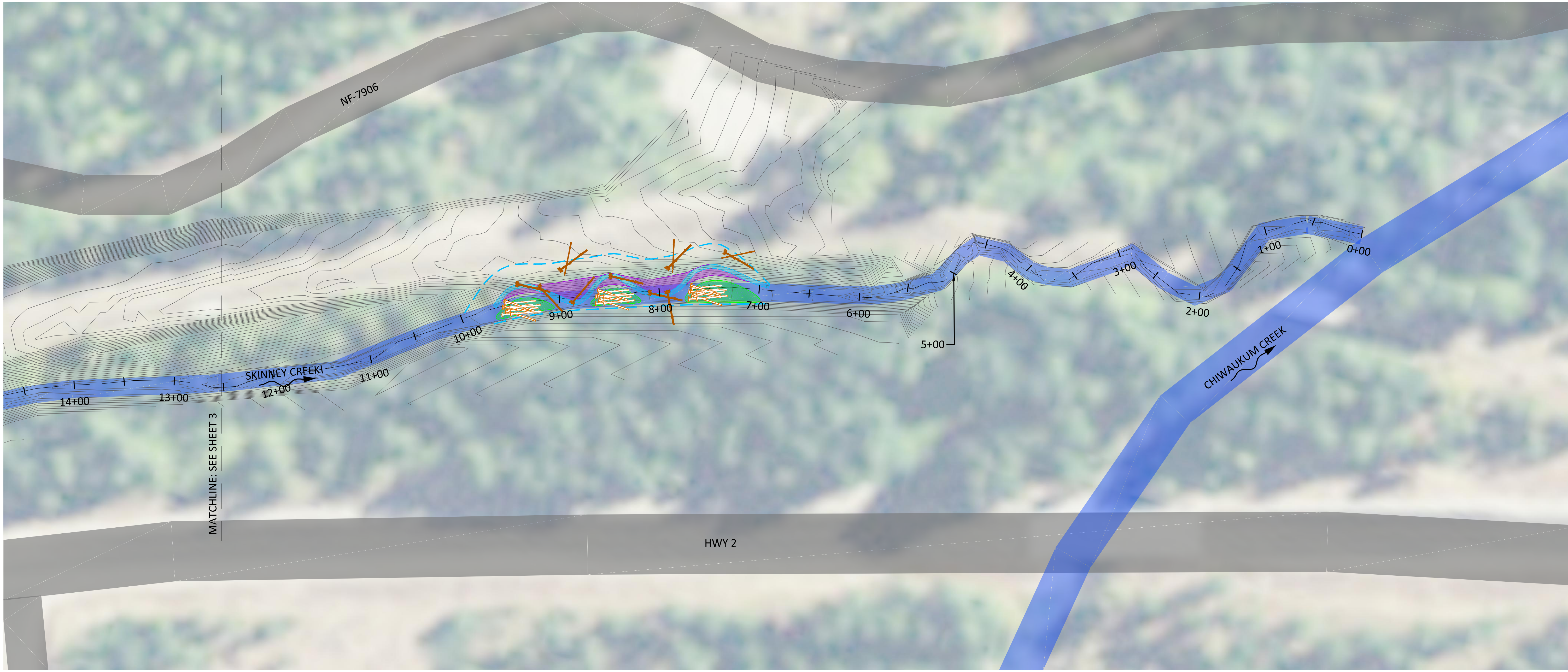
PROPOSED CONDITIONS
ALTERNATIVE 1 - STA 12+00 - 28+00



LEGEND

EXISTING CONTOURS (1FT)

EXISTING CHANNEL

EXISTING ROAD

5+00

EXISTING ALIGNMENT AND STATIONING

PROPOSED CHANNEL

PROPOSED DAYLIGHT LINE

PROPOSED FILL PLACEMENT

PROPOSED FLOODPLAIN BENCH

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LARGE WOOD JAM, SEE 1/11

FLOODPLAIN ROUGHNESS WOOD, SEE 3/11

INDIVIDUAL LOG PLACEMENT, SEE 1/9

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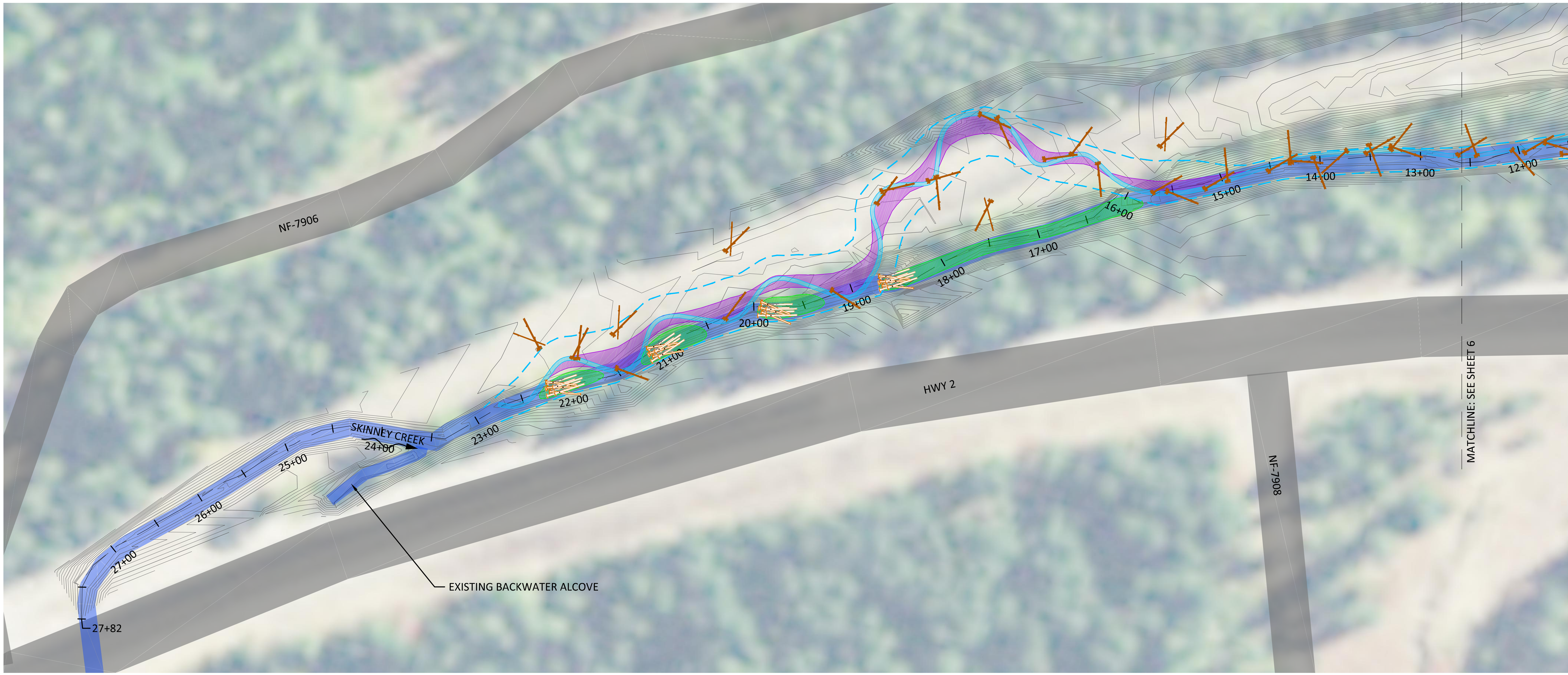
PROPOSED CONDITIONS
ALTERNATIVE 1 - STA 0+00 - 15+00



LEGEND

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- EXISTING CHANNEL
- EXISTING ROAD
- 5+00 EXISTING ALIGNMENT AND STATIONING
- PROPOSED CHANNEL
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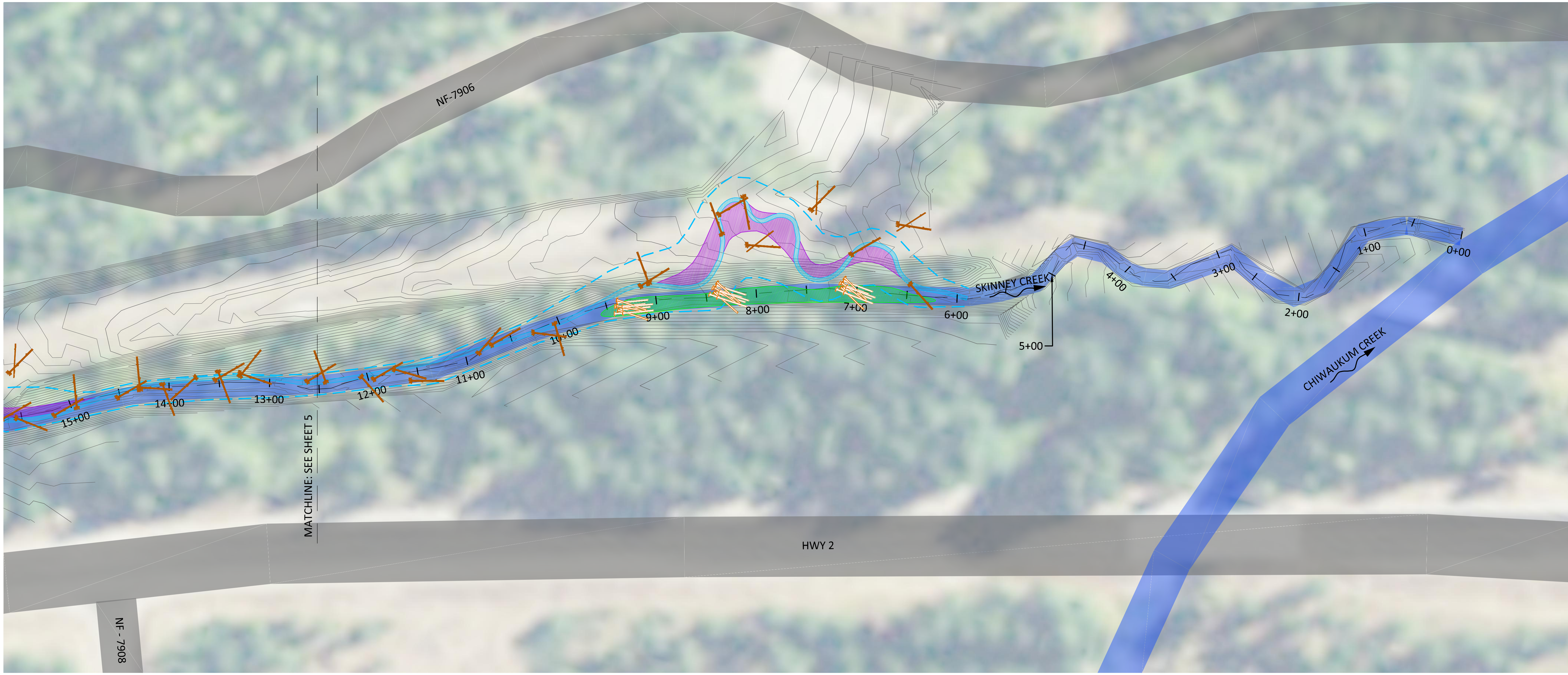
PROPOSED CONDITIONS
ALTERNATIVE 2 - STA 12+00 - 28+00



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LEGEND

EXISTING CONTOURS (1FT)
EXISTING CHANNEL
EXISTING ROAD
5+00 EXISTING ALIGNMENT AND STATIONING
PROPOSED CHANNEL
PROPOSED DAYLIGHT LINE
PROPOSED FILL PLACEMENT
PROPOSED FLOODPLAIN BENCH

LARGE WOOD JAM, SEE 1/11
FLOODPLAIN ROUGHNESS WOOD, SEE 3/11
INDIVIDUAL LOG PLACEMENT, SEE 1/9

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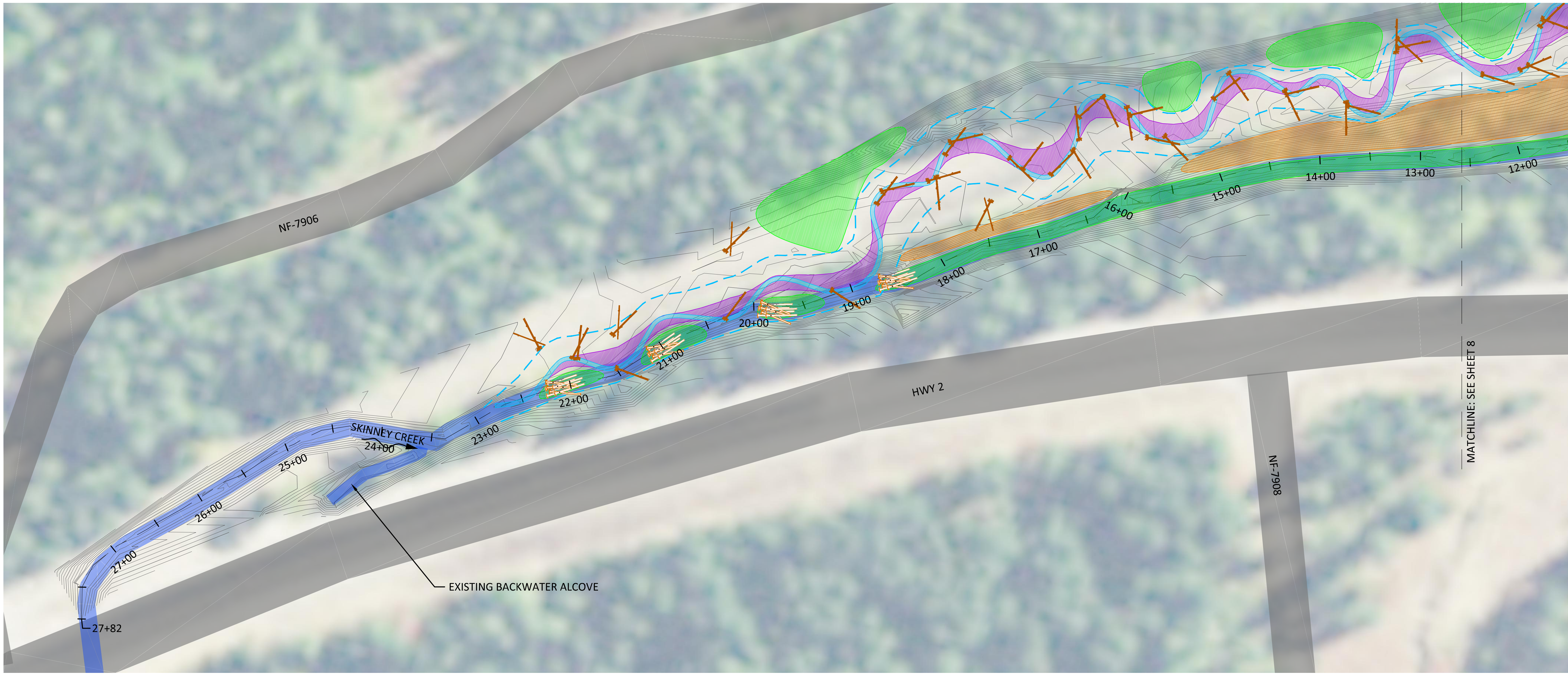
PROPOSED CONDITIONS
ALTERNATIVE 2 - STA 0+00 - 15+00

SHEET
6 OF 11



LEGEND

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- EXISTING CHANNEL
- EXISTING ROAD
- 5+00 EXISTING ALIGNMENT AND STATIONING
- PROPOSED CHANNEL
- PROPOSED DAYLIGHT LINE
- PROPOSED FILL PLACEMENT
- PROPOSED FLOODPLAIN BENCH
- PROPOSED LEVEE REMOVAL AREA
- LARGE WOOD JAM, SEE 1/11
- FLOODPLAIN ROUGHNESS WOOD, SEE 3/11
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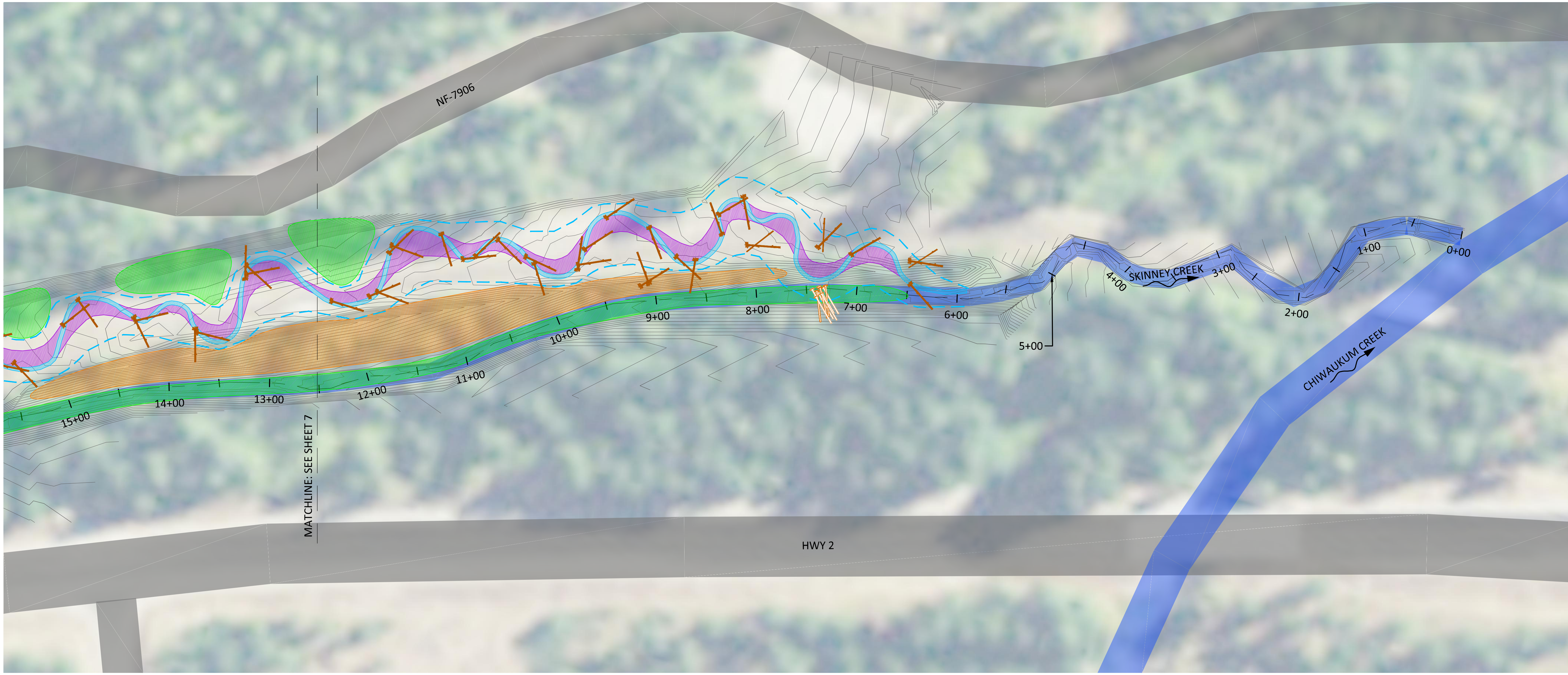
PROPOSED CONDITIONS
ALTERNATIVE 3 - STA 12+00 - 28+00

SHEET 7 OF 11



LEGEND

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- EXISTING CHANNEL
- EXISTING ROAD
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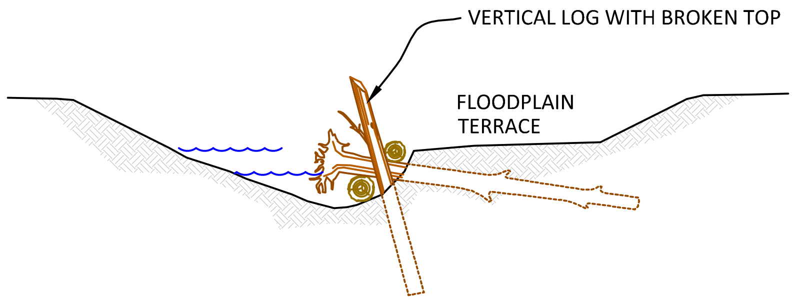
PROPOSED CONDITIONS
ALTERNATIVE 3 - STA 0+00 - 15+00

NOTES:

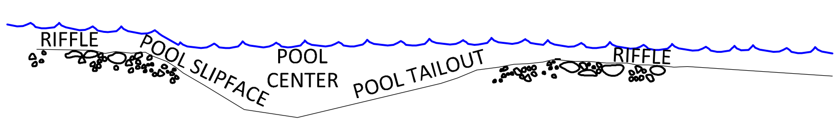
1. TREES AND SHRUBS WITHIN CLEARING LIMITS SHALL BE SALVAGED AND REUSED AS LOGS AND SLASH IN HABITAT STRUCTURES. TO THE EXTENT PRACTICABLE, PRESERVE BRANCHES AND ROOTS ON TREES REMOVED DURING CLEARING AND GRUBBING.

2. WOOD STRUCTURES SHALL BE STABILIZED. STABILIZATION METHODS INCLUDE PARTIAL BURIAL, BRACING AGAINST STANDING TREES, OR USE OF VERTICAL LOGS.



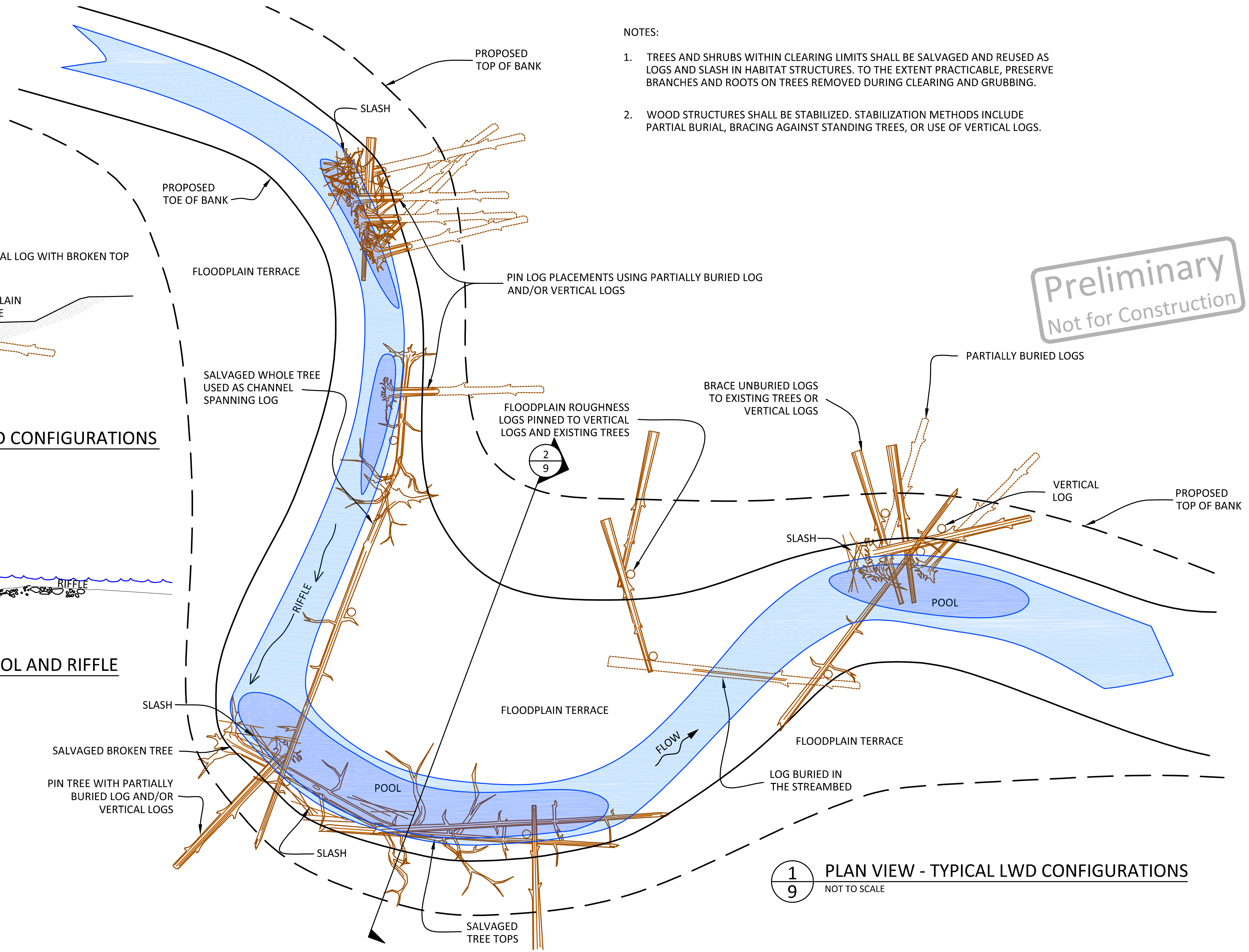
2/9 SECTION VIEW - TYPICAL LWD CONFIGURATIONS

NOT TO SCALE



3/9 PROFILE VIEW - TYPICAL POOL AND RIFFLE

NOT TO SCALE



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1/9 PLAN VIEW - TYPICAL LWD CONFIGURATIONS

NOT TO SCALE

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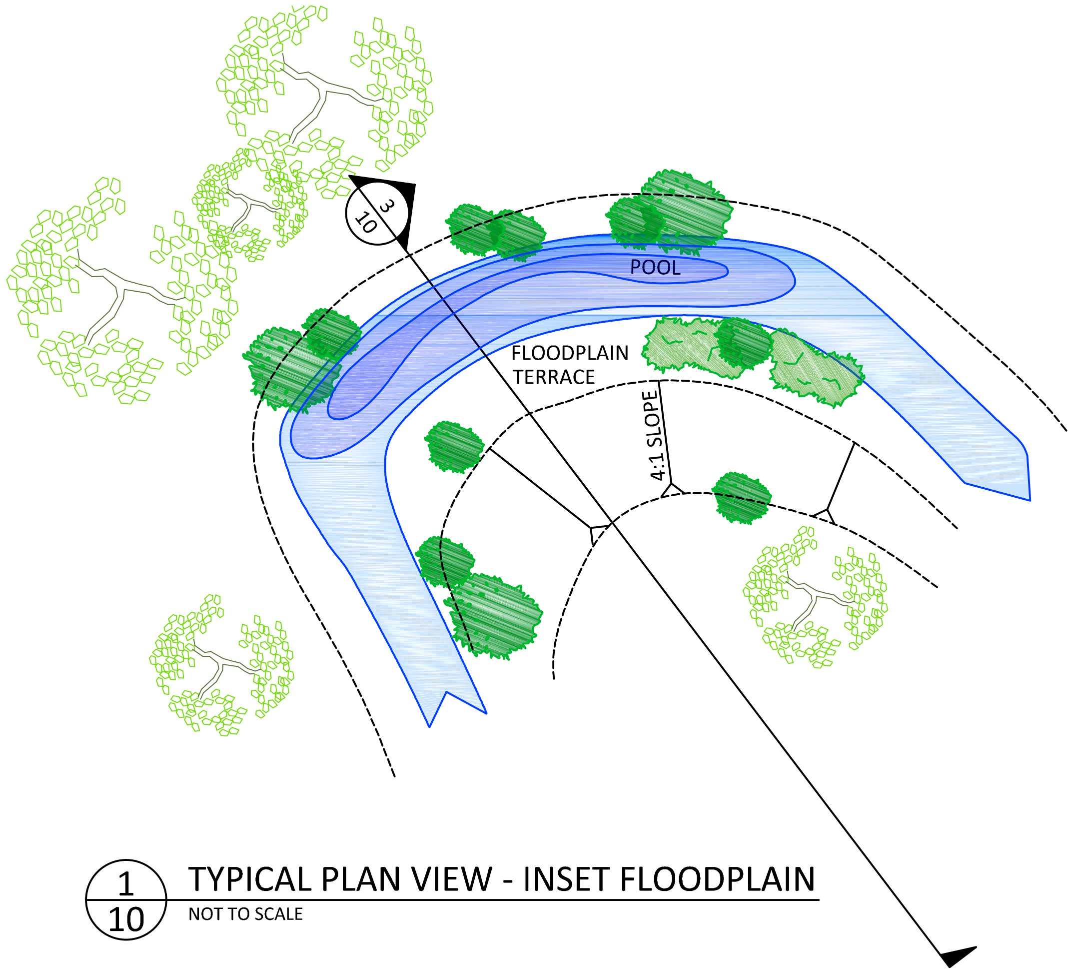
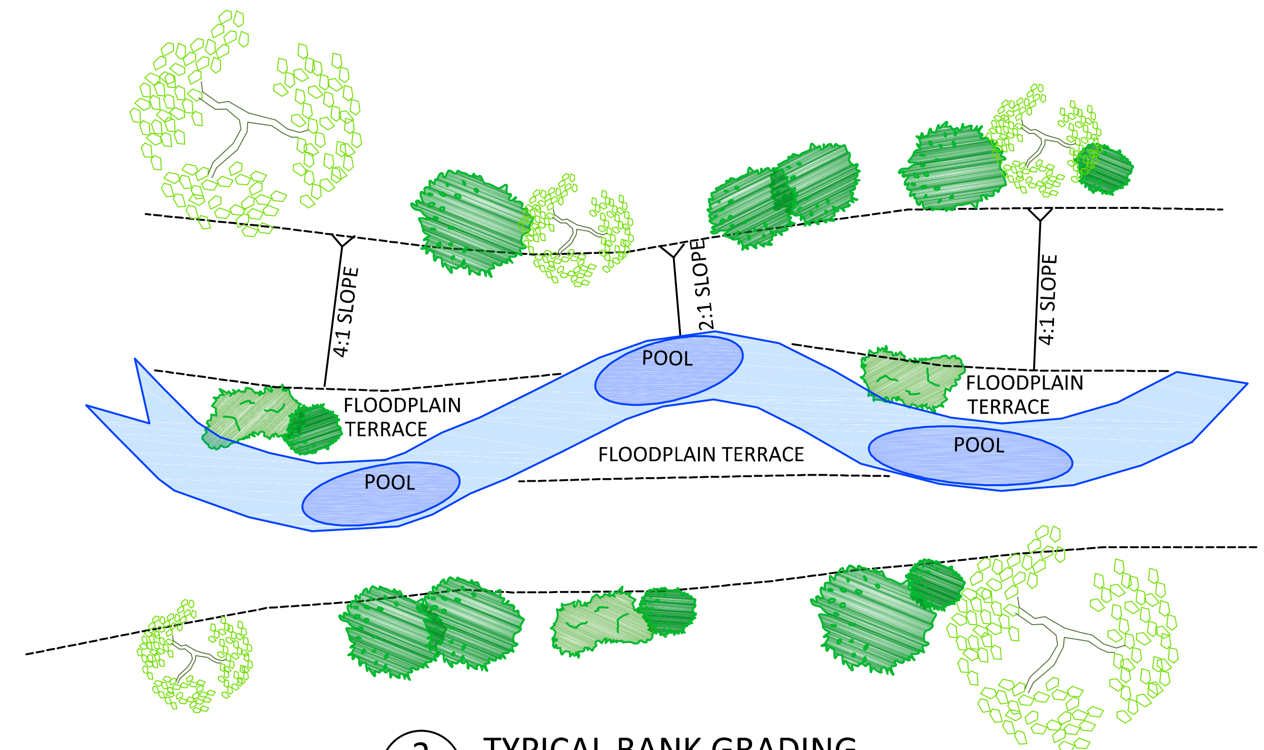
TYPICAL DETAIL - PROPOSED CHANNEL AND LARGE WOOD CONFIGURATIONS

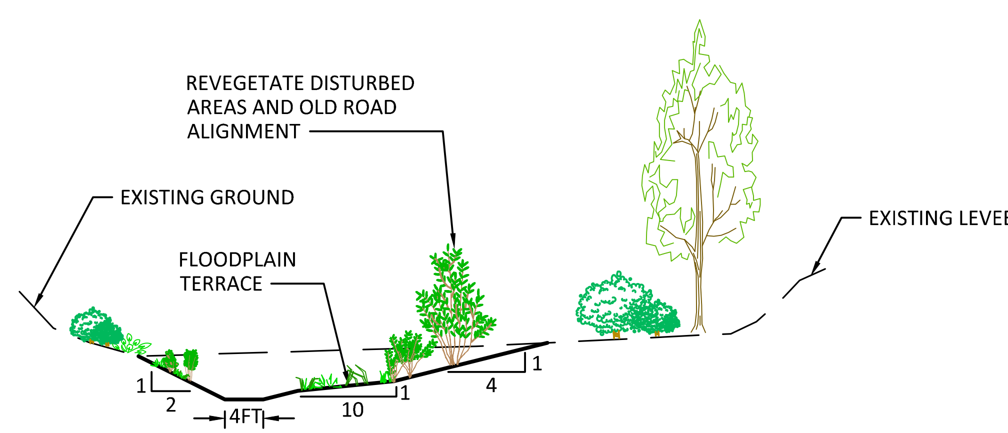
SHEET 9 OF 11



1/10 TYPICAL PLAN VIEW - INSET FLOODPLAIN
NOT TO SCALE



2/10 TYPICAL BANK GRADING
NOT TO SCALE



3/10 TYPICAL SECTION - CHANNEL REMEANDER
NOT TO SCALE

NOTE:
STREAM BED, BANK AND FLOODPLAIN TERRACE STABILITY DETAILS TO BE COMPLETED FOLLOWING INVESTIGATION OF SOILS PITS INFORMATION ON EXISTING SOILS CONDITIONS.

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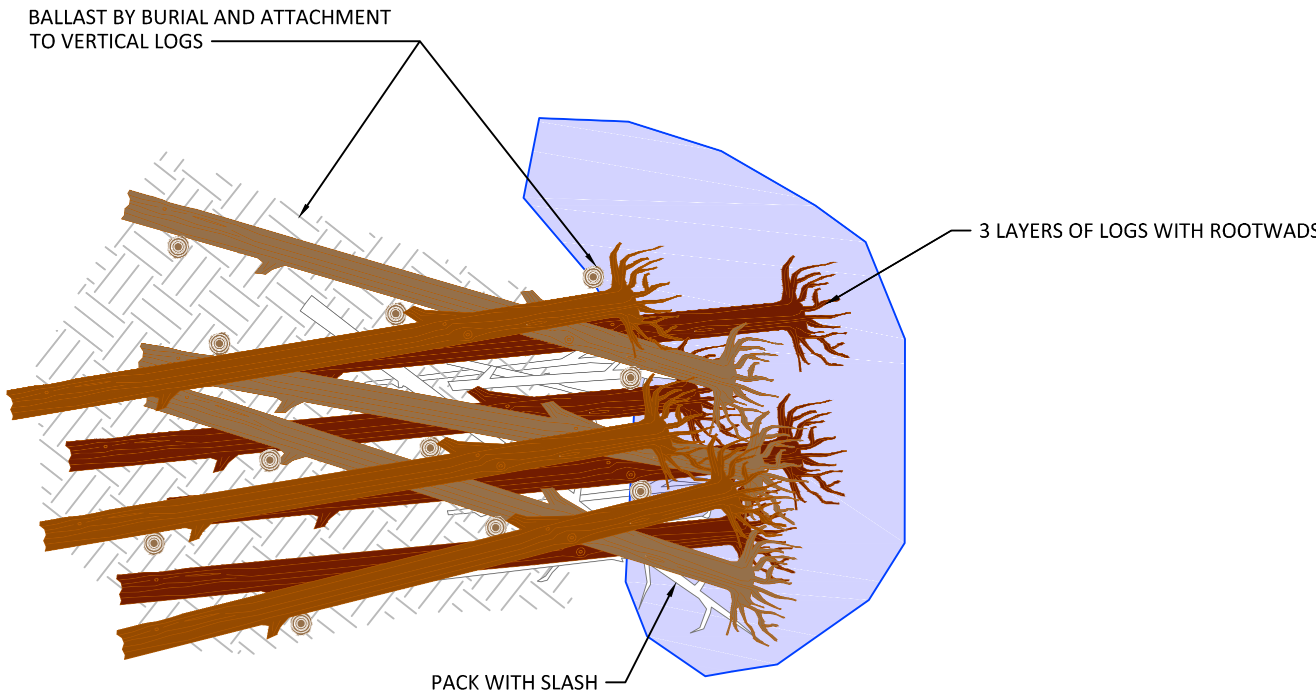
TYPICAL DETAIL - BANK TREATMENT

NOTES

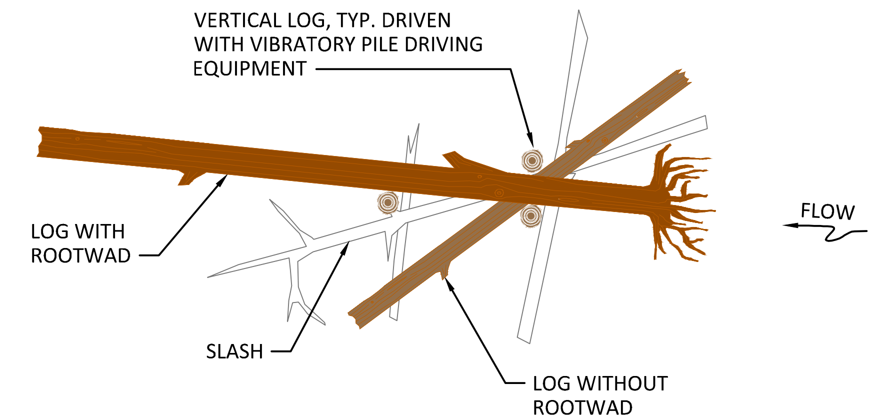
SPECIFIC ORIENTATION OF LOGS AND BALLAST MATERIALS MAY VARY FROM TYPICAL DRAWINGS DEPENDING ON SIZE AND SHAPE OF MATERIAL DELIVERED OR SALVAGED.

BRACING TO EXISTING TREES OR INSTALLED VERTICAL LOGS WILL OCCUR AT LOCATIONS IDENTIFIED IN THE FIELD TO PROVIDE HORIZONTAL STABILITY.

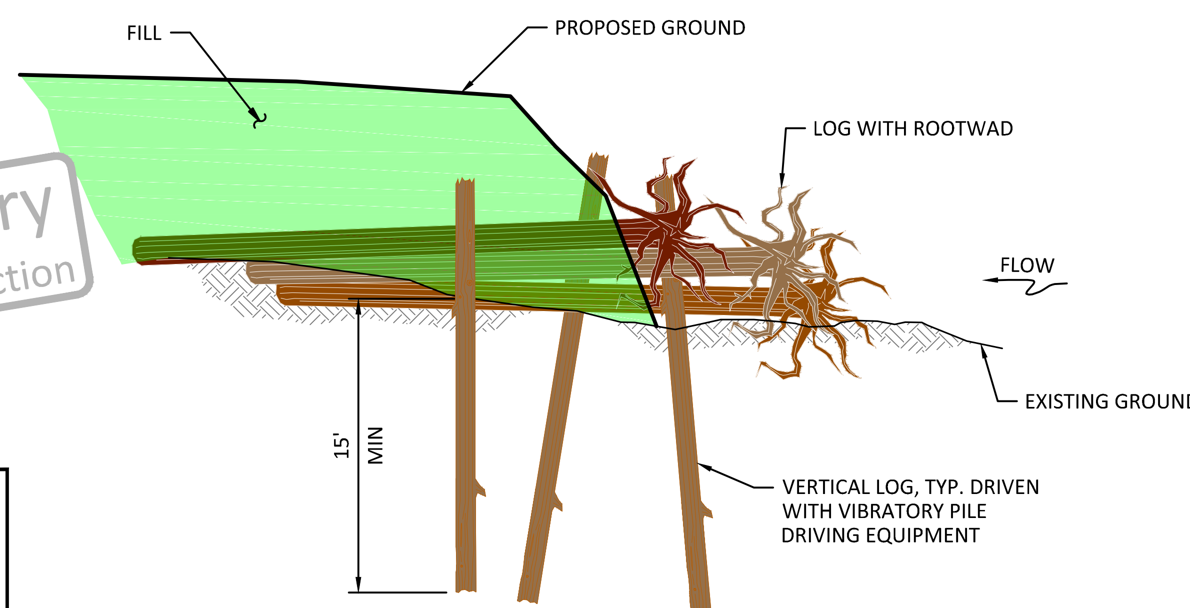
ACCEPTABLE VIBRATORY PILE DRIVING EQUIPMENT SHALL INCLUDE: HMC MOVAX SONIC SIDE GRIP VIBRATORY PILE DRIVER – MODEL SP80 OR EQUIVALENT. INSTALLATION BY EXCAVATION, HAMMERING OR VIBRATORY PLATE COMPACTOR SHALL NOT BE ALLOWED.



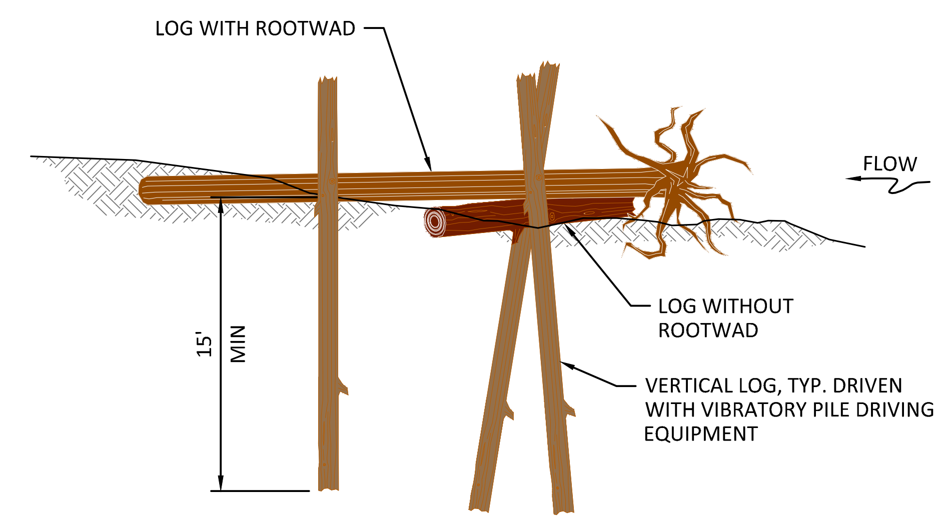
1/11 PLAN VIEW - TYPICAL LARGE WOOD JAM
NOT TO SCALE



3/11 PLAN VIEW - TYPICAL FLOODPLAIN ROUGHNESS WOOD
NOT TO SCALE



2/11 SECTION VIEW - TYPICAL LARGE WOOD JAM
NOT TO SCALE



4/11 SECTION VIEW - TYPICAL FLOODPLAIN ROUGHNESS WOOD
NOT TO SCALE

NO.	BY	DATE	REVISION DESCRIPTION

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TYPICAL LARGE WOOD DETAILS