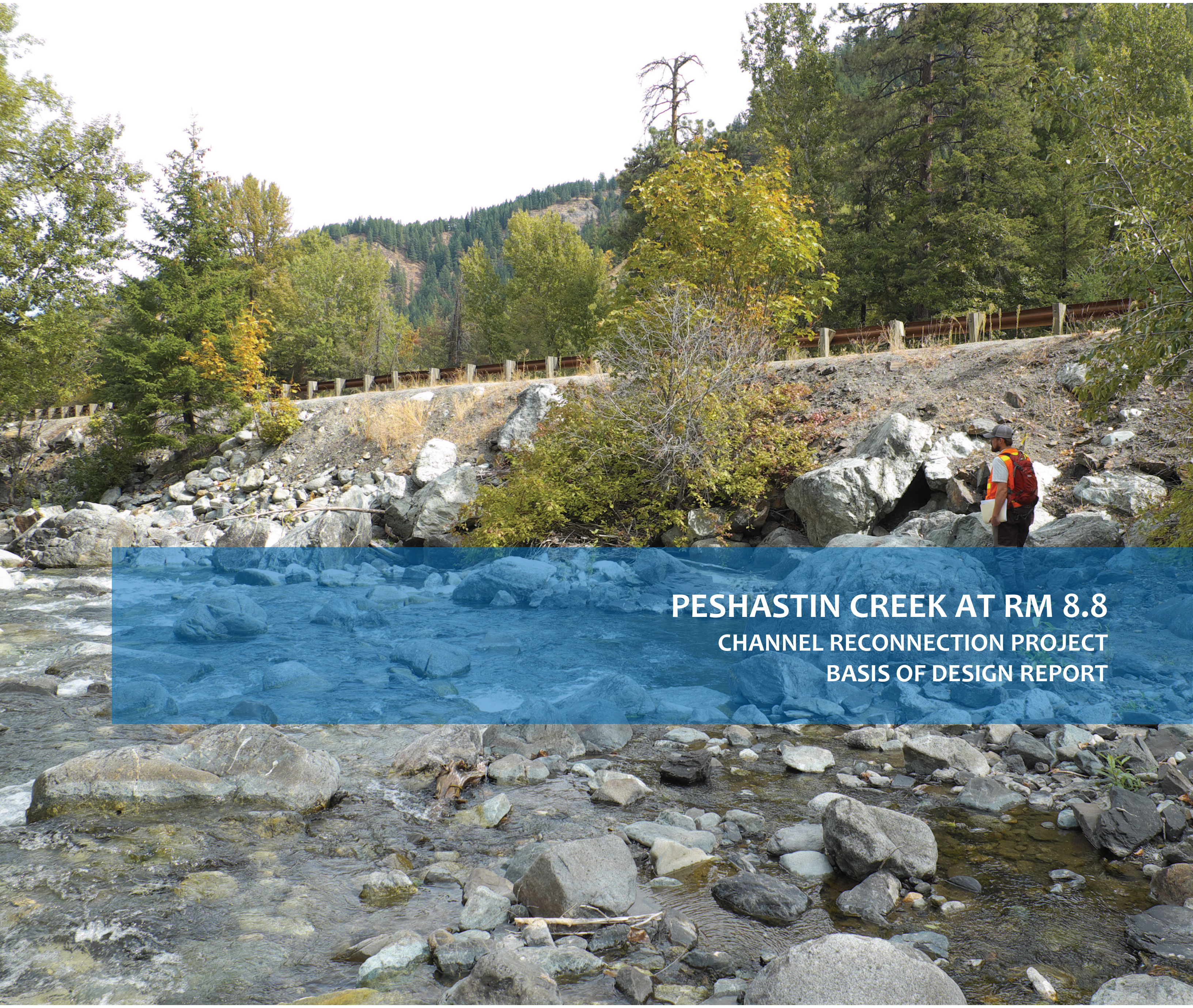

PESHASTIN CREEK AT RM 8.8

CHANNEL RECONNECTION PROJECT
BASIS OF DESIGN REPORT

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ATTACHMENTS

1. INTRODUCTION

This report presents the basis of conceptual-level design for the Peshastin Creek river mile (RM) 8.8 full channel reconnection alternative located in Chelan County, Washington (Figure 1). This alternative was selected as the preferred alternative as detailed in the Peshastin Creek RM 8.8 Site Alternatives Analysis (NSD 2015a). The conceptual plans are provided in Appendix A, along with a construction cost estimate (Appendix B). This design has been prepared for the Chelan County Natural Resource Department (CCNRD) with funding provided by the Salmon Recovery Fund Board (SRFB).

In 2009, the CCNRD met with WSDOT to discuss side channel and floodplain reconnection opportunities associated with SR 97 between RM 8.4 and 9.2. In 2010, the Peshastin Creek Tributary and Reach Assessment (TRA) (Interfluve 2010a) also identified the RM 8.8 channel reconnection project opportunity. In August 2010 the Yakama Nation completed a prioritization of all of the project sites identified in the TRA (Interfluve 2010). In this prioritization, projects that provided process-based restoration and addressed limiting biological factors for target salmonid species and life-history stages ranked highest. Within Peshastin Creek, the reconnection of floodplain and lengthening of the mainstem is a Biological Strategy Tier 1 action and top priority for addressing limiting habitat factors and the recovery and long-term viability of salmonids in Peshastin Creek (UCRTT 2014, UCSRB 2007). The top-tier projects as ranked in the Yakama Nation prioritization were all projects that provided side channel reconnection, which included the RM 8.8 project site.

In 2013 the CCNRD received a grant from the Salmon Recovery Fund Board to analyze project alternatives and develop conceptual designs at the RM 8.8 site. This report presents the basis of design for the preferred alternative. Additional analysis and data is presented in the following reports:

- Peshastin Creek RM 8.8 Project Site Alternatives Analysis (NSD 2015a)
- Baseline Reach Characteristics: Peshastin Creek at RM 8.8 Project Site (NSD 2015b)

2. GOALS AND OBJECTIVES

The Lower Peshastin Creek Tributary and Reach Assessment (TRA) (Interfluve 2010) summarizes the short-term and long term objectives for Peshastin Creek. These objectives are based on the Upper Columbia Spring Chinook Salmon and Steelhead Recovery Plan (UCSRB 2007) and are consistent with the updated Biological Strategy (UCRTT 2014), and the Priority Reaches Actions Plan (UCRTT 2009). In addition, the restoration of Peshastin Creek habitat is identified as one of the top priorities in the Upper Columbia Biological Strategy (UCRTT 2014).

Short-Term Objectives

- Protect existing areas where high ecological integrity and natural ecosystem processes persist.
- Restore connectivity (access) throughout the historic 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., LWD, rocks, etc.) where appropriate.
- Protect and restore riparian habitat along spawning and rearing streams and identify longterm 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.

Goals Specific to the Peshastin Creek Basin

- Re-establish connectivity throughout the assessment unit by removing, replacing, or fixing artificial barriers.
- Reduce water temperatures by increasing stream flows and restoring riparian vegetation along the stream.
- Increase habitat diversity and quantity by restoring riparian vegetation, adding instream structures and large woody debris, and reconnecting side channels and the floodplain with the stream.

Goals Specific to the RM 8.8 Project Site

The primary goal at the RM 8.8 site is to reconnect stream channel process to the disconnected stream channel and floodplain. Based on this goal, the restoration strategies for the RM 8.8 site are listed below in order of providing the greatest benefit to stream process and biological benefit for listed species:

1. Full channel realignment into the historic channel through the installation of two large bridges in SR 97.
2. Abandonment of the existing main channel (constructed as part of the SR 97 realignment in 1950s) as the primary flow pathway.
3. Removal of existing infrastructure within the new channel floodplain to allow for the greatest improvement of habitat and floodplain function, and to allow for future channel process.
4. Expansion of floodplain capacity within the new channel alignment.
5. Utilization and preservation of existing habitat and channel features within the new channel alignment to the greatest extent possible while maximizing channel and floodplain function.
6. Creation of multiple side channel elements similar to the historical side channels mapped prior to highway construction.
7. Construction methods that allow continued use of SR 97.

3. DESIGN CRITERIA

The following sections describe the detailed design criteria supporting the basis of the conceptual-level designs as provided in Appendix A.

3.1 Channel Alignment

The new channel alignment is critical for creating high-functioning habitat features and floodplain for the project. As the upstream and downstream tie-in elevations at the existing channel are fixed, the alignment and its resultant length will determine the channel gradient. In naturally-functioning stream channels, steeper reaches (>2%) tend to be more confined, higher-energy channel segments with less floodplain refuge area, while gentler reaches (< 2%) tend to be less confined, lower-energy and greater adjacent floodplain refuge area. The current channel, aligned adjacent to the roadway is extremely confined, with a sinuosity of 1.0, high-energy as evidenced by the large cobble/boulder substrate, 2.4% gradient with no adjacent floodplain of significance (2D modeling of existing conditions showed that the 100-year flow is currently contained within the channel). This project strives to restore the channel to its historical alignment to the degree feasible within the constraints of preserving the alignment of State Route 97.

3.1.1 Historical

The existing channel was created by the construction of State Route 97 in the 1950's, and is shown as "channel change" design detail in the historical maps (Figure 2)

Evaluation of the historical maps of the channel yield some key information used in the design:

- The channel predominantly was located to the east of SR 97
- In the lower third of the project area, the channel crossed under SR 97 to the west, then returned to the east side of SR 97 – this segment of the historical channel is fully buried under the SR 97 road prism.
- The channel varied in width along its length.
- At the upstream end, the historic channel tied in just downstream of the confluence of Ingalls and Peshastin creeks.
- The channel tied in at the downstream end just upstream of the Ingalls creek road bridge
- Side channels were mapped in two locations, with a width of approximately half the width of the main channel
- The upper side channel was fully filled in by the WSDOT materials storage area
- Overall channel sinuosity (ratio of channel length to valley length) was 1.15, so channel length was approximately 15% longer than valley length

An overlay of the historical channel alignment with the existing topography revealed additional details (Figure 3). The historical alignment was adjusted slightly to integrate with topographic features; it is believed that the historical alignment was not surveyed, but rather sketched as a reference feature in the original drawings, as opposed to the boundary markers and roadway alignment which was likely surveyed.

Evaluation of this overlay produced the following additional insights:

- Significant portions of the historical mainstem channel are still visible on the landscape.
- The confluence of Ingalls and Peshastin Creeks was shifted downstream and re-oriented, such that the historical alignment of Peshastin creek no longer matches the historical alignment on the east side of SR 97.
- Fill was placed within much of the historical floodplain along the upper and middle reaches.
- In the downstream middle of the historical channel, the mainstem and side-channel segment passing under SR 97 was fully filled, and a ditch was excavated along the east edge of the roadway to convey runoff flows.
- Relic channel threads are still present in the lower third of the project area.
- The lowest portion of the channel still aligns with the historical tie-in upstream of Ingalls Road bridge.

A more detailed alignment of a segment of the historical channel upstream of the Ingalls/Peshastin confluence was found and reviewed (Figure 4), with the following observations:

- Channel width varied, with the widest sections occurred along bends (likely pools), with the channel width being as much as 3 X wider than the narrower straight sections (likely riffle sections).
- Channel sinuosity was low, generally less than 1.15, reflecting the laterally-confined nature of this segment of the canyon.
- Split flow was evidenced, with water flowing around both sides of a center island.

3.1.2 Proposed

The proposed channel alignment was laid out to follow the historical alignment east of SR 97 as possible. Refer to the design drawings for the proposed alignment. Key design decisions included the following:

- Overall sinuosity of 1.15 of the mainstem channel to match the historical channel sinuosity.
- Creation of three side-channels where technically feasible to mimic historical conditions, improve floodplain connectivity, and provide a diversity of habitats. The upstream side channel was laid out in the historical side channel alignment. Two additional side channels were laid out in the lower half of the project
- Upstream tie-in between the existing and proposed main channel was shifted downstream from the historical location along SR 97 to better align with the current confluence of Ingalls and Peshastin Creeks. An advantage of this location is also better constructability; the proposed location is located along a straight segment of roadway to better allow construction of a bypass roadway adjacent to the road while a bridge is installed in Hwy 97 over the proposed channel. This allows for continued traffic flow during bridge construction.
- Reconnection of the lower middle of the historical channel that now lies under SR 97 road fill was assumed not feasible. To compensate for this loss of channel, the proposed mainstem channel was re-routed to the east of SR 97 for sufficient length to tie back into the historical channel in the lower third of the project. Channel location was influenced by local topography, selecting landform features in this segment which was likely terrace in recent geologic history.
- Assumption of having all properties available for use in channel restoration between the upstream and downstream tie-in points. No buildings or facilities were assumed to be retained.
- No intermediate stream crossings were assumed – local traffic is assumed to be re-routed around the project area along the hillside to the east of the project.

3.2 Channel Geometry

Channel geometry was determined based on examination of the existing channel segment approximately 200 ft. downstream of the confluence of Ingalls and Peshastin Creeks. This riffle segment is laterally-unconfined, with connected floodplain on both sides of the channel, is straight, has no influence of large boulders or wood, contains all the flow from both Ingalls and Peshastin creeks and is immediately upstream of the project area. This segment is anticipated to likely represent a restored riffle section for purposes of hydraulic geometry, as in addition to the above considerations it is outside of the influence of modern anthropogenic hydraulic constraints, being at least two channel widths upstream of the confined segment of channel along Hwy 97. Hydraulic analysis of this channel section reveals a bankfull flow capacity approximately equal to the 2-year flow of 900 cfs, which was selected as the design flow for the proposed bankfull channel. Detailed cross-section survey data was collected, as well as pebble count data (see Baseline Conditions report).

3.2.1 Proposed

The reference cross-section was simplified to "typical" channel cross-section for purposes of the concept design of 63' wide top width, channel side slope of 1:1 and 2' average depth. Side channels were assumed to be 30' wide top width and 2' average depth. For the purpose of creating concept topography of the channel network the following assumptions were used:

- A 6" deep thalweg was used for a simplified bottom shape
- Uniform channel width and depth for all segments of mainstem and side channels

Future design steps will incorporate a more complex channel geometry as appropriate.

3.2.2 Hydraulic Capacity

The proposed mainstem channel has a minimum hydraulic capacity of the 2-year flow of 900 cfs. For concept design purposes the mainstem channel retains the same cross-section through reaches where there is an adjacent side channel. The channel cross-section and width does not vary along its length; this will be refined during design development to account for the varying cross-section, width and depth that would be present for pools, riffles and side-channel capacity. Floodplain grading was designed to provide additional sufficient hydraulic capacity for the 100-year flood.

3.2.3 Proposed Condition 2-D Hydraulic Model

The primary objective of NSD's proposed condition (PC) hydraulic analysis was to evaluate flow patterns, hydraulic parameters, and inundation extents to characterize the hydraulic impact of the proposed design within the project area and to compare with existing conditions model simulations completed in the baseline assessment. The PC hydraulic analysis was conducted for the 2- and 100-year peak flow discharges. All model runs were performed in steady state (discharge does not vary with time) with a non-deformable bed (no adjustments for scour, sediment transport or deposition). Hydraulic models were created representative of PC using Hydronia's RiverFlow-2D Plus GPU and Aquaveo's Surface-water Modeling System (SMS) v11.2 computer software. RiverFlow-2D is a two-dimensional finite volume computer model that provides depth-averaged hydraulic parameters at nodes within a triangular model mesh domain by solving the shallow water equations resulting from integration of the Navier-Stokes equation. The Navier Stokes equation is derived from applying Newton's Second Law (Force = mass*acceleration) to fluid motion, and is generally expressed as:

$$\overbrace{\rho\Big(\underbrace{\frac{\partial \mathbf{v}}{\partial t}}_{\substack{\text{Unsteady}\\ \text{acceleration}}} + \underbrace{\mathbf{v}\cdot\nabla\mathbf{v}}_{\substack{\text{Convective}\\ \text{acceleration}}}\Big)}^{\text{Inertia (per volume)}} = \overbrace{\underbrace{-\nabla p}_{\substack{\text{Pressure}\\ \text{gradient}}} + \underbrace{\mu\nabla^2\mathbf{v}}_{\text{Viscosity}}}^{\text{Divergence of stress}} + \underbrace{\mathbf{f}}_{\substack{\text{Other}\\ \text{body}\\ \text{forces}}}.$$

Where ρ = fluid density

μ = dynamic viscosities

p = pressure

∇ = del operator (abbreviation for derivative (gradient) of 3D vector field)

f = term representing body forces acting on the fluid (per unit volume)

SMS is a GIS-based program that creates the triangular model mesh, model input files, and displays model results. The following sections provide more in-depth information on specific components of our PC hydraulic analysis, data development, and results. Mapped model results are provided in Appendix C.

Methods

Model Topography

The existing conditions models utilized the October 2006 LiDAR data collected by Watershed Sciences to represent the existing channel and floodplain topography. The existing conditions surface was then modified in AutoCAD Civil3D to match design elevations for main and side channel grading, the bankfull plug, and floodplain enhancements (Appendix A). The horizontal and vertical datum of all data utilized and referenced in the hydraulics is NAD 1983 Washington State Plane North feet and NAVD88 feet, respectively.

Mesh

A mesh or wireframe is a key component to any 2D hydraulic model. The model derives one depth-averaged flow velocity (direction and magnitude) at each node of the 2D (x-y) mesh. To predict vertical variations in flow within the water column would require a 3D model. The mesh is composed of nodes and elements that are coded with elevation and roughness values needed to run the computational routine. RiverFlow-2D utilizes a flexible tri-angular mesh to solve for volume conservation and momentum in the x and y directions at each node (representing depth average). The model mesh begins near the confluence with Ingalls Creek and extends approximately 0.9 miles downstream to RM 8.2. The model domain also includes the proposed channel complex to the east of SR 97. For this project the model mesh utilized 80,755 triangular elements and 40,971 nodes. The governing equations are applied at each node in an iterative routine until converging on a solution that achieves conservation of mass and energy to within an acceptable error.

To create the model mesh, a map consisting of arcs and regions delineating the channel, side channels, floodplain features, and material types was developed using Aquaveo's SMS software. Arcs were drawn along significant topographic features (top of bank, bars, and roadways) and changes in roughness (ground cover type, logjams, etc.). Arcs function as breaklines during the mesh creation process to ensure the model mesh is an accurate representation of the channel/floodplain topography and to create regions within the map to which different roughness values can be assigned.

Roughness

Hydraulic analyses require an assessment of the resistance (drag force) the ground surface and other physical features exert against the movement of water. This drag force is commonly referred to as roughness. The most accepted method to assess roughness uses the Manning's n resistance factor (Chow, 1959). Common factors that affect roughness values include: channel sediment size, gradation, and shape; channel shape, channel meandering, bank and floodplain vegetation, obstructions to flow, flow depth, and flow rate. 2D hydraulic models explicitly calculate momentum losses caused by channel shape, meandering, and floodplain topography not normally accounted for in 1D hydraulic models. As such, Manning's n values in 2D models can generally be lower (up to 30%) than those normally used for 1D hydraulic models (Hydronia, 2012). Manning's n values for this project were assigned to different roughness types using a hillshade image derived from the proposed conditions surface, design locations for logjams, and 2015 aerial imagery from Google Earth and in accordance with standard hydraulic reference manuals (Chow, 1959; Barnes, 1967; Hicks and Mason, 1998). An adjustment for hydraulic radius was then applied for variability between the 2- and 100-year flows according to the Limerinos equation. Model roughness values are shown in Table 1 below.

Table 1. Model Roughness Values

Roughness Type	Manning's N Value	
	2 year	100 year
Building	0.2	0.2
Main channel	0.046	0.041
Side channel	0.046	0.041
Logjam	0.15	0.15
Forest	0.12	0.12
Gravel bar	0.046	0.041
Gravel bar-vegetated	0.09	0.09
Road-gravel	0.014	0.014
Road-pavement	0.01	0.01
Shrub	0.09	0.09
Slough	0.02	0.02

Boundary Conditions

All hydraulic models require the user to input a known boundary condition at the upstream and downstream extents to begin the computational routine. The upstream boundary condition for all model runs was set to the corresponding peak flow rate described in the hydrology section of this assessment for the 2- and 100-yr recurrence interval flows. The downstream boundary condition for all model runs was set to a free outflow, which enables the model to calculate velocities and WSE based on the same iterative routines applied throughout the model domain. Model boundary condition values are shown in Table 2.

Table 2. Model Boundary Conditions

Recurrence Interval	Discharge (cfs)	Downstream Boundary Condition
2 year	900	Free Outflow
100 year	3310	Free Outflow

Proposed Condition Model Results

Results from the PC model simulations are attached to this report in Appendix C. Completed model runs were initially reviewed in SMS to verify accuracy of results and then exported to a GIS compatible data file. GIS files include data for each node and hydraulic parameter within the model mesh (bed elevation, water surface, flow depth, velocity, shear stress, etc.) to facilitate development of raster grids representing the model results. Key results from the PC model are summarized in Tables 3 and 4 below. Minimum, maximum, and average values presented were extracted from the channel thalweg or side channel centerlines. Shallow, slow moving flow inundates the edges of channels and low-lying floodplain areas at both the 2- and 100-year flows but are not representative of the overall in-channel hydraulic conditions. The overall hydraulic effect of the proposed design is a reduction in flow velocities upstream of large wood placements, with areas of increased velocity adjacent to and between structures. These areas are expected to lead to the formation of pools as scour mobilizes bed material, creating quality habitat with complex cover. Total channel length is increased by more than a half mile, with an additional 5.9 acres of inundated area for the 2-year flood and an additional 12.4 acres for the 100-year event, relative to existing conditions.

During the 2-year flood the entirety of flow is deflected down the proposed channel complex at the bankfull plug. Approximately 7 percent (63 cfs) of this flow enters side channel 1, however flow in the channel is discontinuous, with backwater from the proposed mainstem channel inundating the lower portion of this channel. Side channel 2 receives approximately 32 percent of flow (286 cfs), with flow depths and velocities up to 3 ft. and 6.7 ft/s, respectively. 45 percent (403 cfs) of total discharge enters side channel 3, with flow depths and velocities up to 2.8 ft. and 8.4 ft/s. The enhanced floodplains to the west of the main channel near the downstream confluence with side channel 2 and the left bank floodplain between the main channel and side channel 3 are inundated with flow up to 2 ft. in depth and velocities up to 3 ft/s.

For the 100-year flood, 24 percent (2516 cfs) of total discharge flows down the existing channel alignment, with the remaining 76 percent entering the proposed channel complex. Of this flow, 6 percent (151 cfs) enters side channel 1, with flow depths and velocities up to 3.1 ft. and 8.5 ft/s, respectively. The left bank floodplain is inundated with shallow flow immediately downstream of side channel 1. Approximately 31 percent (780 cfs) of flow entering the proposed channel complex is deflected into side channel 2, with flow depths up to 4.6 ft. and velocities up to 8.5 ft.s. The flow split between the proposed main channel and side channel 3 is roughly even, with 47 percent entering the side channel and overtopping the enhanced floodplain between the two channels. Flow depths and velocities in this side channel reach 4.7 ft. and 11.1 ft/s.

Tables 3 and 4 below the existing conditions hydraulics compared to the proposed conditions hydraulics.

Table 3. Existing Condition Hydraulics

	Discharge		Depth (ft.)			Velocity (ft./s)			Shear Stress (lbs./ft^2)		
	Ft/s	% of Total	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
2 year – Mainstem	900	100	0.7	4.5	2.9	4.5	12.5	8.8	1.5	7.5	3.4
100 year - Mainstem	3310	100	3	8.4	5.7	9.4	19.5	14.7	3.0	10.8	6.1

Table 4. Proposed Condition Hydraulics

	Discharge		Depth (ft.)			Velocity (ft./s)			Shear Stress (lbs./ft^2)		
	Ft/s	% of Total	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
2 year	0.2	0.2									
Existing Mainstem	-	-	-	-	-	-	-	-	-	-	-
Proposed Mainstem	895	100	1.5	5	2.6	3.4	12.7	7.4	0.4	7.5	2.8
Side Channel 1	63	7*	0.7	1.6	1	2.7	5.4	4.3	0.5	4	1.4
Side Channel 2	286	32*	1.1	3	2.4	3.7	6.7	4.9	0.6	4.6	1.4
Side Channel 3	403	45*	1.1	2.8	2.1	3.4	8.4	5.3	0.5	5.2	1.7
100 year											
Existing Mainstem	794	24	1	6.9	3.4	5.1	17.5	10.2	0.7	10	3.6
Proposed Mainstem	2516	76	2.4	7.5	4.4	5.1	17.5	11.1	0.7	14.9	4.3
Side Channel 1	151	6**	1.1	3.1	1.8	3.5	8.5	6.3	0.4	11.6	2.3
Side Channel 2	780	31**	2	4.6	3.7	4.7	9.9	7	0.7	8.1	2
Side Channel 3	1183	47**	1.9	4.7	3.4	5.1	11.1	7.2	0.8	8.7	2.2

*Calculated as percentage of flow at location of split in proposed mainstem.
**Calculated as percentage of flow entering proposed mainstem at location of side channel splits.

During future design iterations the flow splits between the existing and proposed mainstem channels can be modified through changes in the channel plug. The floodplain inundation extent within the proposed project area can also be modified through modifications in site grading. A discussion about floodplain design is presented below.

3.2.4 Bed Material

Bed material is assumed to be native ground, which consists of a cobble-gravel substrate with 10-30% boulders varying in size from 2 - 15 ft. No material is presumed to be imported to augment existing native materials.

3.3 Floodplain Enhancement

3.3.1 Created Floodplain

Empirical relationships between channel bankfull width and channel belt width (represented here as floodplain width) yield an expected floodplain width between 300 – 500 ft. in a laterally-unconfined reach. Review of topography in unfilled segments of the channel at the upstream and downstream ends of the project reach, both of which are laterally-confined by adjacent hillslopes, indicates floodplain widths of approximately 300 ft. For this concept design, floodplain grading was developed to achieve a minimum floodplain width of 300 ft. through the majority of the project reach, as the project is laterally confined in most segments by the eastern hillslope and SR97. Under the bridges, floodplain width was reduced to 100 ft. to minimize bridge length. This floodplain and channel cross-sectional area yielded a total flow depth of approximately 6 ft. in the 100-year storm, which provided nearly 6 ft. of freeboard to the bottom cord of the upstream bridge deck, and 3 ft. of freeboard at the downstream bridge deck. Floodplain width was expanded through the upper reach (WSDOT property) because of more available land and observed significant fill within the historic floodplain. The proposed concept floodplain grading has a uniform grading varying from approximately 30:1 – 40:1 (horizontal:vertical) sloping up from the channel margins. Examination of portions of relic floodplain within the project area indicate the topography is undulating, with relic flood channels creating swales in the landscape. For future design a more complex floodplain grading will be developed that is more similar to the relic topography. Test trenches would be dug concurrent with design development to identify the elevation and lateral extent of the historic floodplain in filled areas.

3.3.2 Side Channels

Three side channels are shown in the proposed grading plan. The upper side channel is in approximately the same location as a historical channel, and relic topography exists in small portions of the side channel, though the majority of the side channel was filled. Accounting for stream evolution on the landscape, it is assumed a possibility that the mainstem channel may occupy a side-channel alignment due to flux of incoming woody material and/or sediment that could occupy portions of a mainstem channel to varying degrees over time. The two downstream side channels were located in low points of the existing topography to the east of the mainstem channel. If the mainstem flow shifts to these side channels, this will put the flow further away from SR 97 and will not present an increase in risk of flow adjacent to the roadway.

The side channels would be expected to be fully engaged at the 2-year flow to provide lower-velocity floodplain refuge for fish as shown in the proposed conditions hydraulic modeling. For concept design, the side channel grading has the thalweg matching that of the adjacent mainstem channel at inlet and outlet, with lengths as long or longer than the mainstem channel such that they do not provide an avulsion risk; side channel gradients are equal to or less steep than adjacent mainstem channel gradients. The concept grading of side channels has a uniform cross-sectional area through the length. This will be refined in future final design iterations.

3.4 Large Woody Material

In this setting, large wood would be expected to be present in undisturbed channels as whole trees partially occupying the channel and locally-diversifying hydraulics, accumulations of wood on large boulders contributing to split-flow conditions and/ or racked up on outsides of bends providing cover over pools and increasing pool depth through scour during storm conditions. For detailed design, the overall wood loading will be compared to reference conditions for this landscape setting.

For the purposes of this conceptual design three types of wood structures are presented in this concept design:

ELJ 1 – a post-stabilized apex jam located predominantly at the head end of flow splits between the proposed mainstem and side channels. This will create a local scour pool and influence flows into both channels; sometimes paired with a second structure to limit flows into a side channel and reduce risk of avulsion.

EJJ2 – a collection of wood buried into the bank on the outside of the channel, to enhance pool formation and/or to reduce risk of channel migration towards SR 97.

ELJ3 – a small collection of large and small wood intended to provide localized hydraulic diversity and provide numerous dispersed locations where incoming small and large wood could accumulate.

3.5 Plant Community Restoration

NSD staff conducted field work to assess existing habitat conditions on September 15, 2015. During this site visit, three main vegetation areas were identified: a) forested riparian edge and floodplain, b) fringe wetland, and c) upland. In general, the plant community restoration design will mimic these existing plant communities to promote canopy cover over aquatic habitat and create conditions for a healthy riparian forest and forested upland.

The proposed planting plan approach is as follows:

- Riparian Planting Areas
  - Riparian planting will occur in graded areas within 10-ft of restored mainstem and associated side channels. The islands between the proposed side channels and the mainstem, and proposed low areas along river right.
  - These riparian edges will be planted with small deciduous trees, such as speckled alder (Alnus incana), coyote willow (Salix exigua), and pacific willow (Salix lucida var lasiandra),
  - and hydroseed with a diverse mix of wet-adapted grasses, rushes, and wildflowers including small-fruited bulrush (Scirpus microcarpus), slender rush (Juncus tenuis), pearly everlasting (Anaphalis margaritacea), slender cinquefoil (Potentilla gracilis), fireweed (epilobium angustifolium), and others.
- Floodplain Planting Areas
  - A proposed floodplain area is created in between the upland slopes and riparian planting area long the graded channels. This area will be planted with the following:
    - coniferous trees, such as Douglas fir (Pseudotsuga menziesii),

    - deciduous trees, such as speckled alder (Alnus incana), big leaf maple (Acer macrophylla), black cottonwood (Populus balsamifera ssp. Trichocarpa), sitka willow (Salix sitchensis), and pacific willow (Salix lucida var lasiandra),
    - deciduous shrubs such as red osier dogwood (Cornus sericea)
    - hydroseeded with a diverse mix of wet-adapted grasses, rushes, and wildflowers including small-fruited bulrush (Scirpus microcarpus), slender rush (Juncus tenuis), pearly everlasting (Anaphalis margaritacea), slender cinquefoil (Potentilla gracilis), fireweed (epilobium angustifolium), and others.
- Upland Planting Area
  - The upland planting area is the graded slope from existing high-ground, down to the created floodplain and creek channels. The upland planting area also extends into areas that are currently disturbed but will not be graded. This area will be planted with the following:
    - coniferous trees, such as Pondersosa pine (Pinus ponderosa), and Douglas fir (Pseudotsuga menziesii),
    - deciduous trees, such as big leaf maple (Acer macrophylla), serviceberry (Amelanchier anlifolia),
    - deciduous shrubs such as snowbrush (Ceanothus velutinus), snowberry (Symphoricarpos albus), Nootka rose (Rosa nutkana)
    - hydroseeded with a diverse mix of dry-adapted grasses, and wildflowers including indian ricegrass (Achinatherm hymenoides), bluebunch wheatgrass (Agropyron spicatum), slender wheatgrass (Elymus trachycaulus), Idaho fescue (Festuca idahoensis), western yarrow (Achillea millefolium), pearly everlasting (Anaphalis margaritaceae), barestem biscuitroot (Lomatium nudicaule), silky lupine (Lupiinus sericeus), and others.

The plant communities in the project area will be preserved and enhanced wherever possible. Areas that are cleared during construction. If possible, this restoration would be conducted using a phased approach, mimicking and possibly accelerating natural plant community succession processes. Overall, this design approach is developed to promote canopy cover over aquatic habitat and create conditions for a healthy riparian forest and forested upland. A detailed planting plan, species list and typical cross section can be found in the associated design drawings for this project (see Appendix A).

3.6 Treatments on Existing Channel

A channel plug will be installed on the upstream end of the existing Peshastin Creek channel consisting of logs and boulders as shown in the drawing detail (See Appendix A). This plug will route all flows below the 2-year flow into the restored channel. Flows above the 2-year will overtop the plug and flow down the structure into the current channel. The plug will be constructed predominantly of boulders sized between 3-6 ft. diameter, with interstitial space filled with cobble and gravel, creating a roughened channel surface for the overtopping flows. The plug will be buried into the adjacent banks and keyed into the channel bed.

The channel will be free-draining at the downstream end and would not be expected to maintain flows of any significant depth between storms. Existing boulders in the channel will provide nominal velocity refuge during flood flows, and over time vegetation would likely become established in this channel to provide additional limited flood refuge. Some nominal flow will exist due to hyporheic inputs and flows from Hansel Creek in the lower third of the channel.

3.7 Bridges

Bridge lengths were selected to provide full span over the creek and floodplain. Length was increased to account for the skew angle between the creek and roadway and a layback slope of 2:1 (horizontal:vertical) proceeding upward from the floodplain edges to the top of the abutment. A precast concrete bridge was assumed, with minimum roadway width of 12 ft per lane, 3 lanes wide and with adjacent shoulders. Deck height was set equal to the existing roadway. An estimated minimum 3 ft. of vertical clearance is anticipated between the bottom cord of the bridge and the 100-year flood height, assuming a total bridge deck depth of 4 ft.

3.8 Road Removal

All roads are assumed to be removed from within the project area, including three existing crossings of the historic channel.

3.9 Retention of Existing Features

3.9.1 Boulders

Boulders larger than 4 ft. diameter found within the existing project area would be left in place and grading would be locally adjusted to accommodate the boulders. Numerous boulders were found in field investigations with diameters as large as 15 ft.; these were not surveyed and were not incorporated into the concept design.

3.9.2 Riparian

Some portions of the project area has mature conifers with diameters exceeding 2 ft. For detailed design, these larger trees would be individually surveyed. Where possible, the grading would be locally adjusted to accommodate and retain them. For the concept design, the grading does not indicate these local adjustments.

3.10 Quantities

Quantities of materials presented in Table 5 were generated based on the October 2015 conceptual plans presented in Appendix A.

Table 5. Construction Quantities.

ITEM	QUANITY	UNIT
Erosion/Water Pollution Control	1	Lump Sum
Stream Bypass	1	Lump Sum
Traffic Control & Bypass	1	Lump Sum
Removal of Structures and Obstructions	1	Lump Sum
Upstream Bridge (150’ span)	1	Each
Downstream Bridge (195’ span)	1	Each
Clearing and Grubbing	1	Lump Sum
Common Excavation	162,336	Cubic Yards
Structural Excavation	3,799	Cubic Yards

ITEM	QUANITY	UNIT
Channel Excavation	64,577	Cubic Yards
Wood Structure Type 1	5	Each
Wood Structure Type 2	9	Each
Wood Structure Type 3	10	Each
Partial Channel Plug	1	Lump Sum
Wood Chips	1,866	Cubic Yards
Revegetation – Riparian	6	Acre
Revegetation – Floodplain	7	Acre
Revegetation – Upland	12	Acre
Revegetation – Hydroseed Dry Mix	19	Acre
Revegetation – Hydroseed Wet Mix	6	Acre

4. COST ESTIMATION

A construction cost estimate was generated to reflect the proposed conceptual designs (Appendix C). Quantities were generated based on the conceptual design details shown in the concept design plans and the construction assumptions discussed above. Unit costs were based on costs recently observed within North Central Washington, and through internet research. Due to the conceptual nature of the designs an allowance for indeterminates of 50% was added to the amount column. In addition an inflation of 9% was added to the subtotal to reflect construction pricing in 2018 (the assumed construction date). A local sales tax of 8.2% was also applied to the sub-total. The construction cost estimate is provided in Appendix B.

5. FIGURES

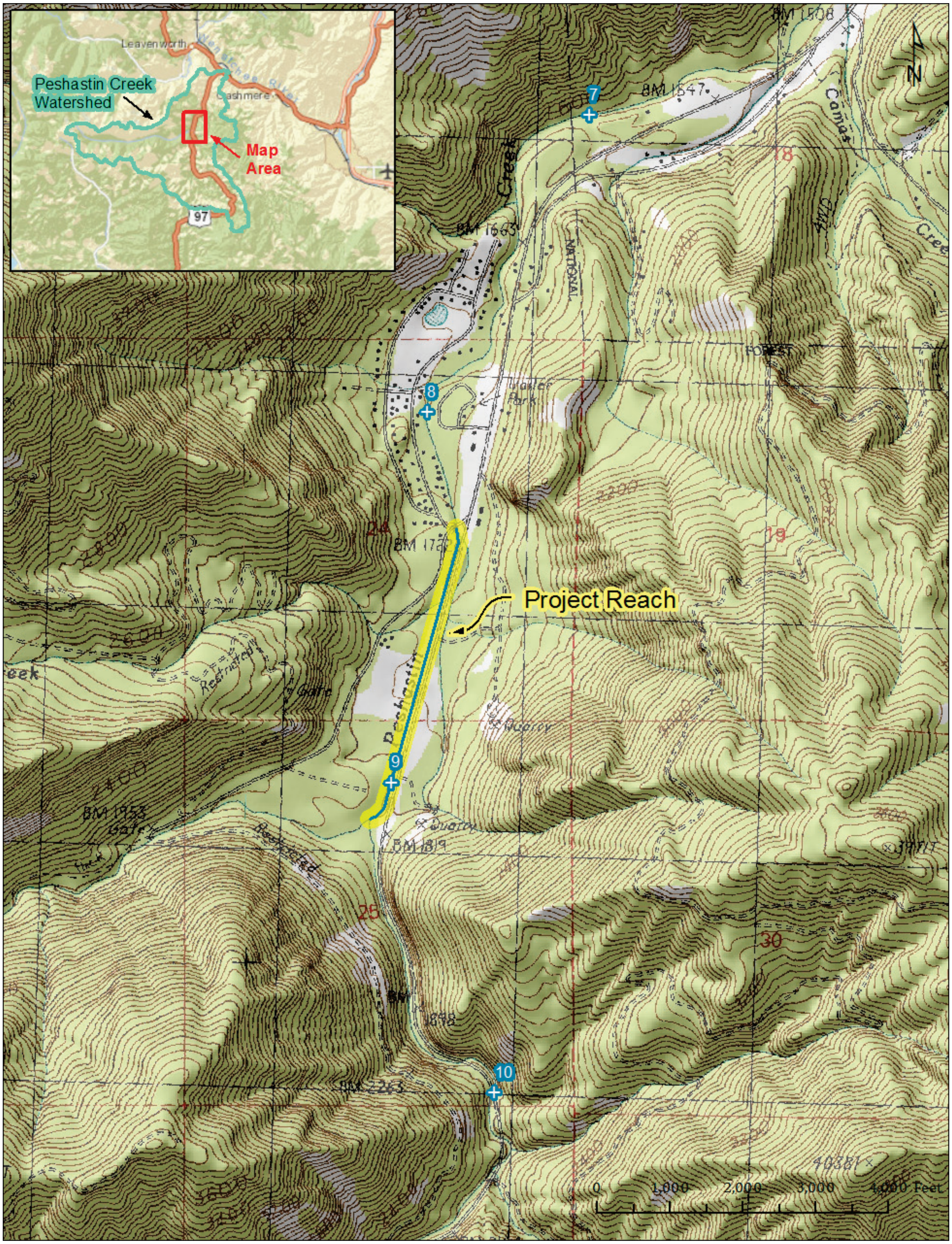

Figure 1. Project Location.

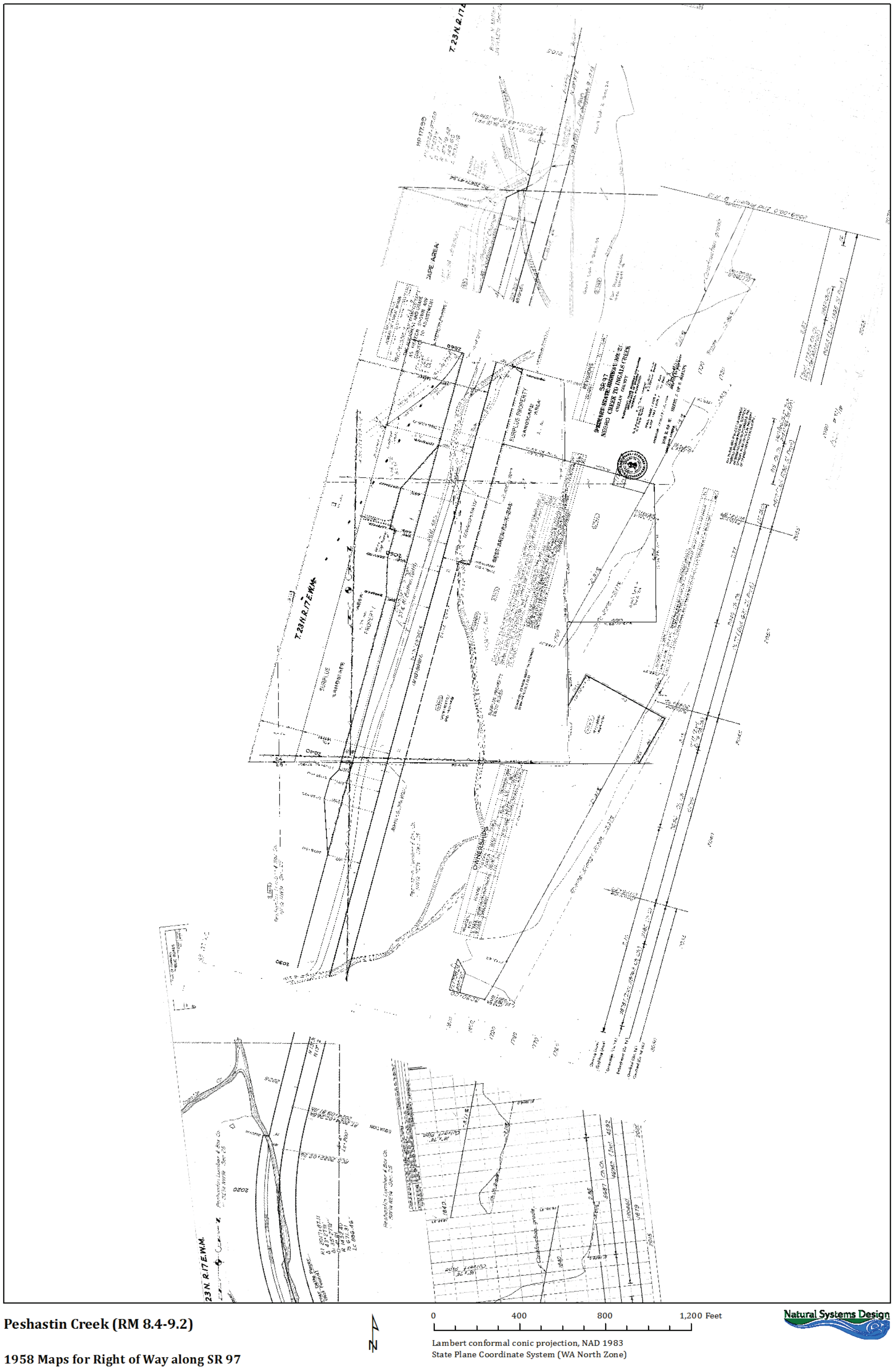

Figure 2. 1958 Maps for Right of Way along SR 97.

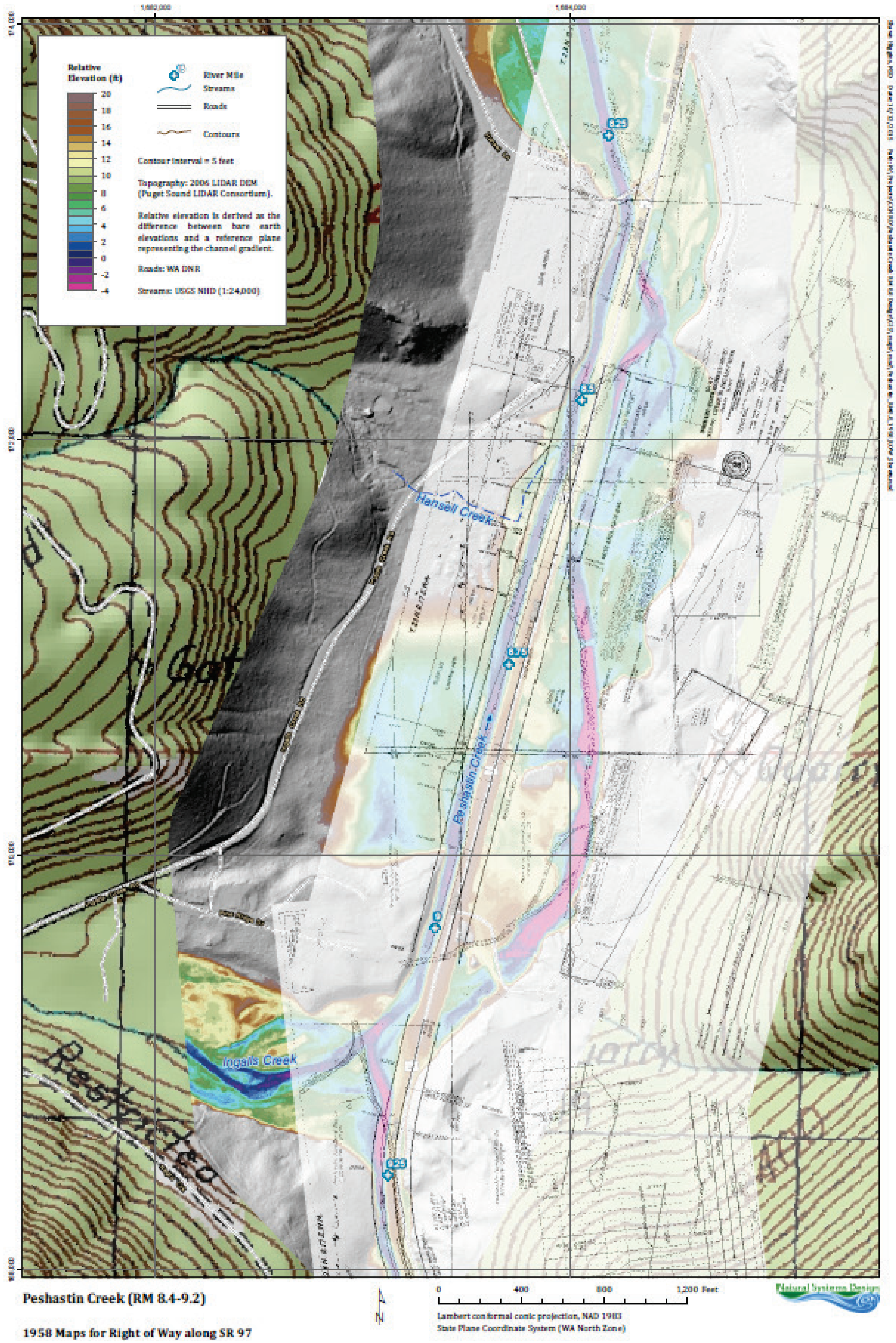

Figure 3. Current Relative Elevation Map with 1958 Right of Way Mapping for Reference.

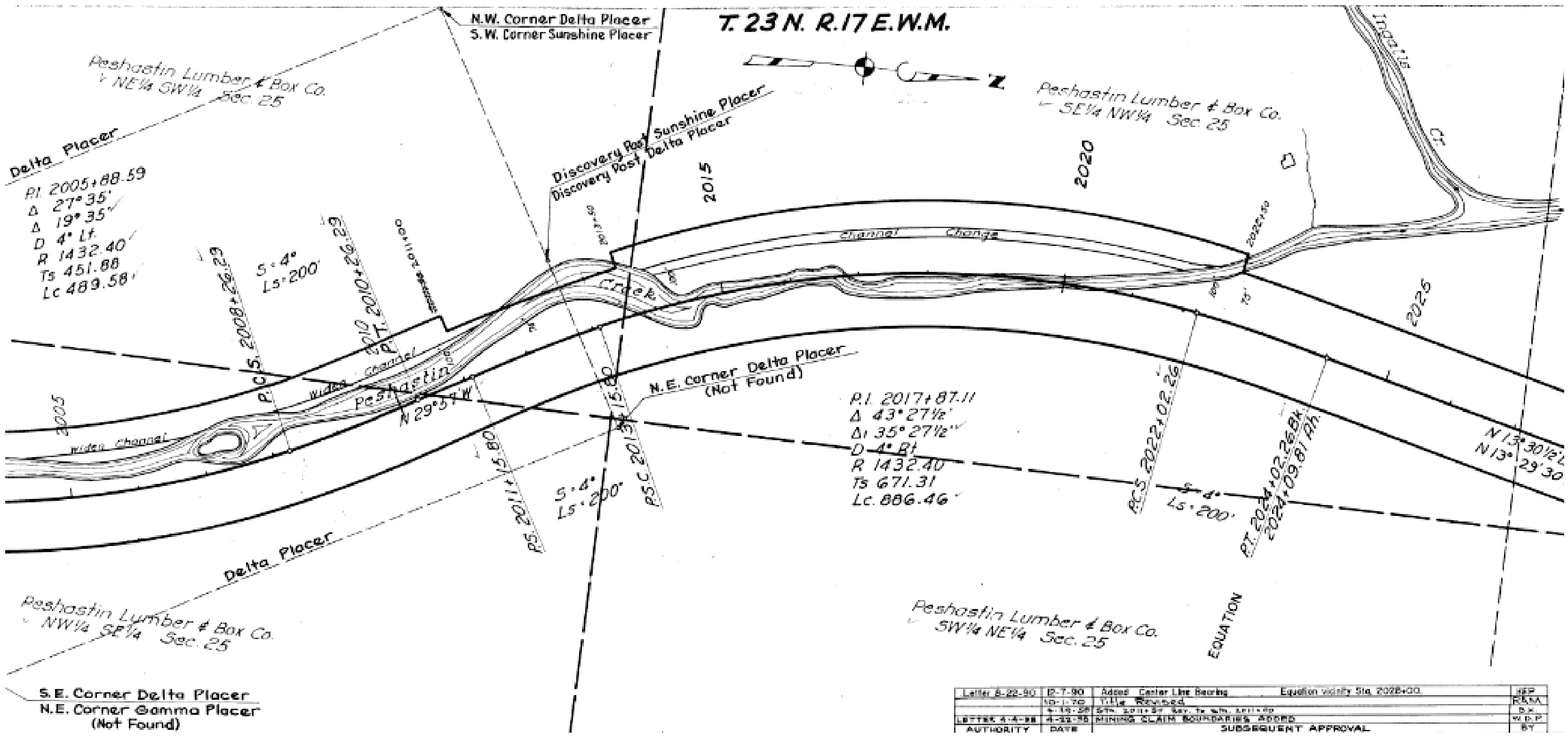

Figure 4. 1958 Right of Way Map Showing Peshastin Creek Immediately Above the RM 8.8 Project Area.

6. REFERENCES

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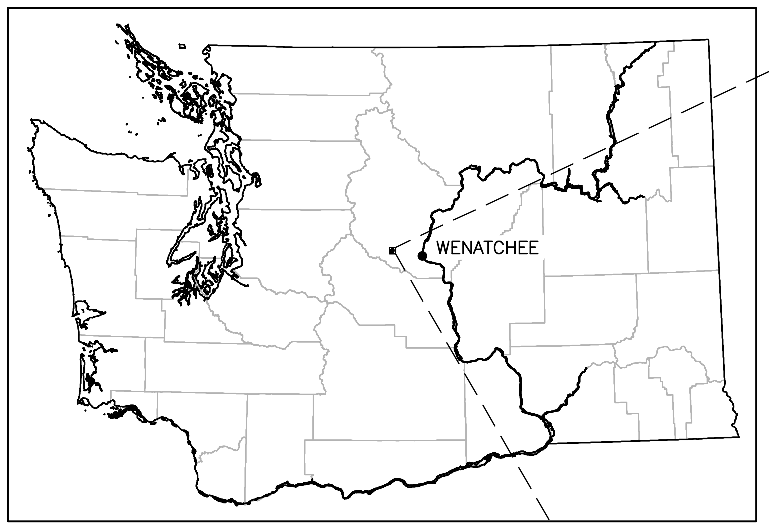
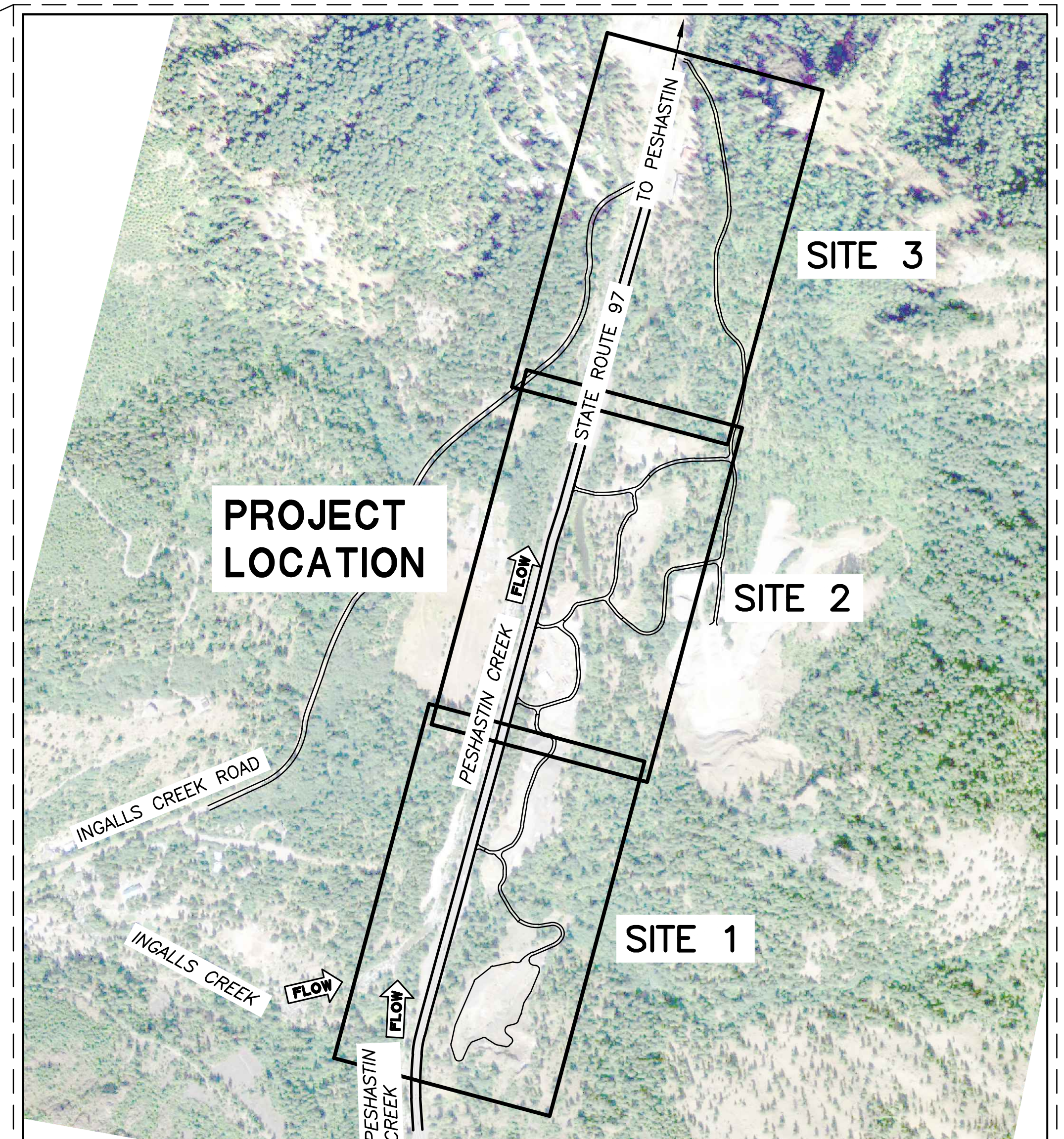
APPENDIX A
CONCEPTUAL DESIGNS

PESHASTIN CREEK RM 8.8 DESIGN

CHELAN COUNTY NATURAL RESOURCES DEPARTMENT



WASHINGTON STATE
SCALE: 1" = 50 MILES
50 25 0 50 100



VICINITY MAP
SCALE: 1" = 500'

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DRAWING LIST

Sheet Number	Sheet Title
1	COVER SHEET
2	GENERAL NOTES
3	GENERAL QUANTITIES
4	LEGEND
5	EXISTING CONDITIONS
6	PROJECT OVERVIEW
7	ACCESS, STAGING & DEMOLITION PLAN
8	PROPOSED CONDITIONS – SITE 1
9	PROPOSED CONDITIONS – SITE 2
10	PROPOSED CONDITIONS – SITE 3
11	PROFILE
12	CROSS–SECTIONS 1
13	CROSS–SECTIONS 2
14	TYPE 1 ELJ
15	TYPE 2 ELJ
16	TYPE 3 ELJ
17	PARTIAL CHANNEL PLUG
18	BRIDGE DETAILS
19	PLANTING PLAN
20	PLANT SCHEDULE

CONTACT INFORMATION

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SEATTLE, WA 98103
(206) 834–0175

CHELAN COUNTY NATURAL RESOURCES DEPARTMENT
316 WASHINGTON ST, #401
WENATCHEE, WA 98801
(509) 667–6625

Oct 23, 2015 CONCEPT DESIGN NOT FOR CONSTRUCTION

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LONGITUDE	122°19'9.75"W
TN/SC/RG	T23N/S25/R17E
DATE	–

PESHASTIN CREEK RM 8.8 DESIGN

COVER SHEET

1

PLACEHOLDER

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SUMMARY OF QUANTITIES

Item #	Item Description	Quantity	Unit
SITE PREPARATION			
1	Mobilization/ Demobilization (10% Maximum)	1	LS
2	Erosion/ Water Pollution Control Measures	1	LS
3	Stream Bypass	1	LS
4	Traffic Control & Bypass	1	LS
5	Removal of Structures and Obstructions	1	LS
8	Clearing and Grubbing	1	LS
BRIDGES			
6	Upstream Bridge [150 ft]	1	EA
7	Downstream Bridge [195 ft]	1	EA
EARTHWORK			
9	Common Excavation	162,336	CY
10	Structural Excavation	3,799	CY
11	Channel Excavation	64,577	CY
15	Partial Channel Plug	1	LS
HABITAT STRUCTURES			
12	Wood Structure [Type 1]	5	EA
13	Wood Structure [Type 2]	9	EA
14	Wood Structure [Type 3]	10	EA
LANDSCAPING			
16	Wood Chips	1,866	CY
17	Revegetation [Riparian]	6	ac
18	Revegetation [Floodplain]	7	ac
19	Revegetation [Upland]	12	ac
20	Revegetation [Hydroseed - Dry Seedmix]	19	ac
21	Revegetation [Hydroseed - Wet Seedmix]	6	ac

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DATE	–

PESHASTIN CREEK RM 8.8 DESIGN

GENERAL QUANTITIES

3

SHEET 3 OF 20

GENERAL LEGEND

- PROPERTY LINE
- RIGHT OF WAY LINE
- EXISTING ROAD
- ACCESS ROAD
- CL — CL CONSTRUCTION LIMIT
- GL — GL GRADING LIMIT
- -5- EXISTING MAJOR CONTOUR
- -1- EXISTING MINOR CONTOUR
- 5 PROPOSED MAJOR CONTOUR
- 1 PROPOSED MINOR CONTOUR
- EXISTING FLOW
- OHWM EXISTING OHWM
- OHWM PROPOSED OHWM
- 2-YR 2-YEAR FLOOD BOUNDARY
- 100-YR 100-YEAR FLOOD BOUNDARY
- WL — WL EXISTING WETLAND
- WL — WL PROPOSED WETLAND
- W — W — W EXISTING WATER
- W — W — W PROPOSED WATER
- DEMOLITION/REMOVAL AREA
- EXISTING FENCE
- EXISTING CONIFEROUS TREE
- EXISTING DECIDUOUS TREE
- CONTROL POINT LOCATION
- 2 PHOTO POINT LOCATION

- RACKING AND SLASH MATERIAL
- LARGE WOOD PIECE
- TYPE 1 ELJ, SEE SHEET 14
- TYPE 2 ELJ, SEE SHEET 15
- TYPE 3 ELJ, SEE SHEET 16
- NATIVE ALLUVIUM
- STREAMBED GRAVEL
- RIPRAP
- BOULDER CLUSTER
- STEEL CABLE

RESTORATION LEGEND

- FILL SLOPE LINE
- EXCAVATION SLOPE LINE

TEMPORARY EROSION CONTROL LEGEND

- SB — SB SILT BOOM
- BN — BN BLOCK NETS
- SF — SF SILT FENCE
- SW — SW STRAW WATTLE
- DEWATERING LINE DISCHARGE
- PROPOSED STAGING AREA
- BULK BAG COFFERDAM
- TEMPORARY ACCESS ROAD
- TEMPORARY ACCESS BRIDGE
- O PUMP DISCHARGE OUTLET
- P DEWATERING PUMP

DETAIL AND SECTION REFERENCING

- 1 NOTE REFERENCING NUMBER
- 4 / 6 DETAIL REFERENCE NUMBER; SHEET ON WHICH DETAIL APPEARS
- (TITLE) (SCALE) 4 / 2 DETAIL REFERENCE NUMBER; SHEET FROM WHICH DETAIL WAS TAKEN
- (TYP) SPECIFIES THAT DETAIL IS UNIFORMLY TYPICAL THROUGHOUT PROJECT EXCEPT WHERE OTHERWISE NOTED
- (VAR) SPECIFIES THAT DETAIL WAS TAKEN FROM SEVERAL SHEETS
- A A32 SECTION A-A IS SHOWN ON SHEET 32
- SECTION A-A 32 SCALE: NTS SECTION A-A IS SHOWN ON SHEET 32

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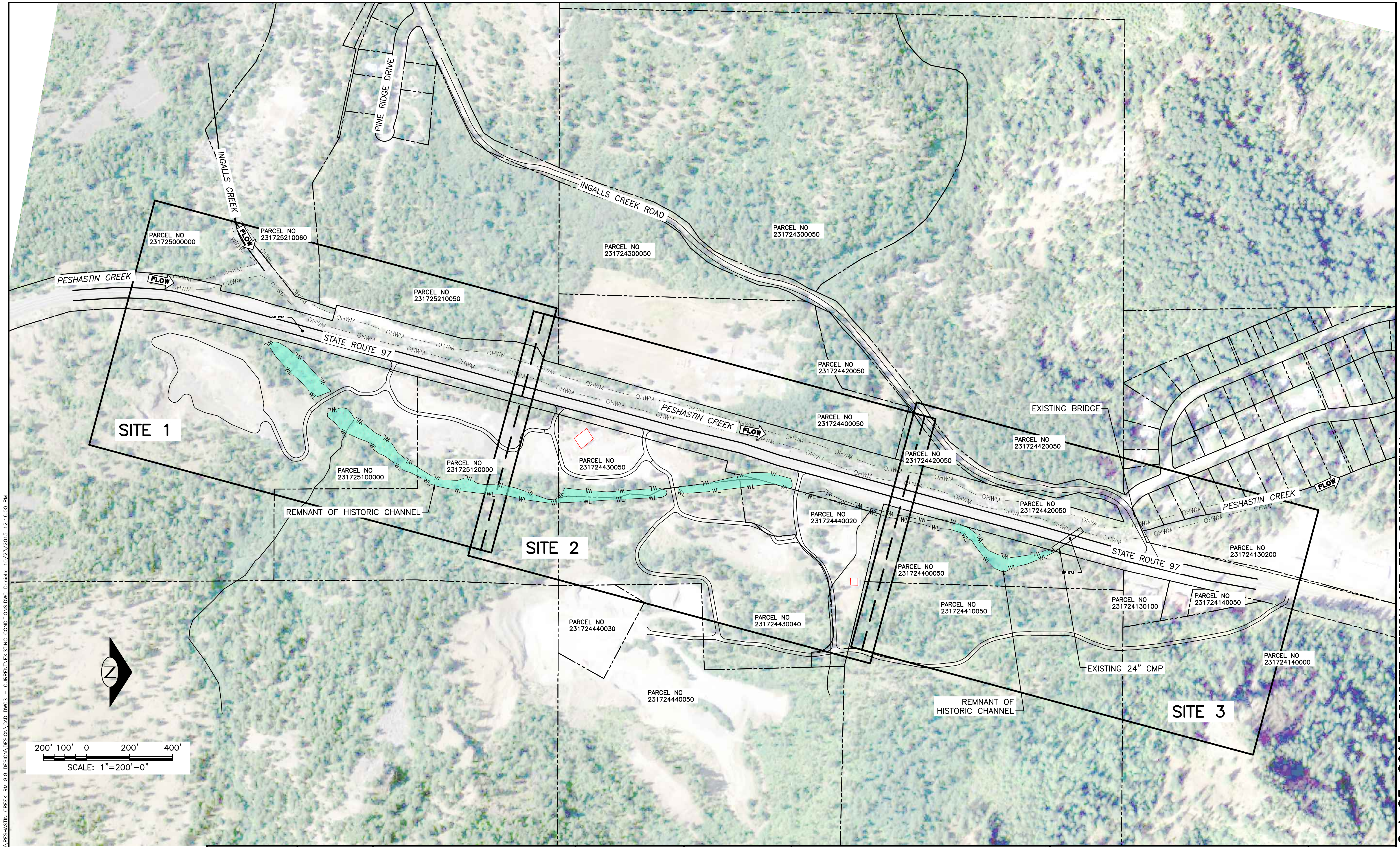
PESHASTIN CREEK RM 8.8 DESIGN

LEGEND



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TN/SC/RG	T23N/S25/R17E
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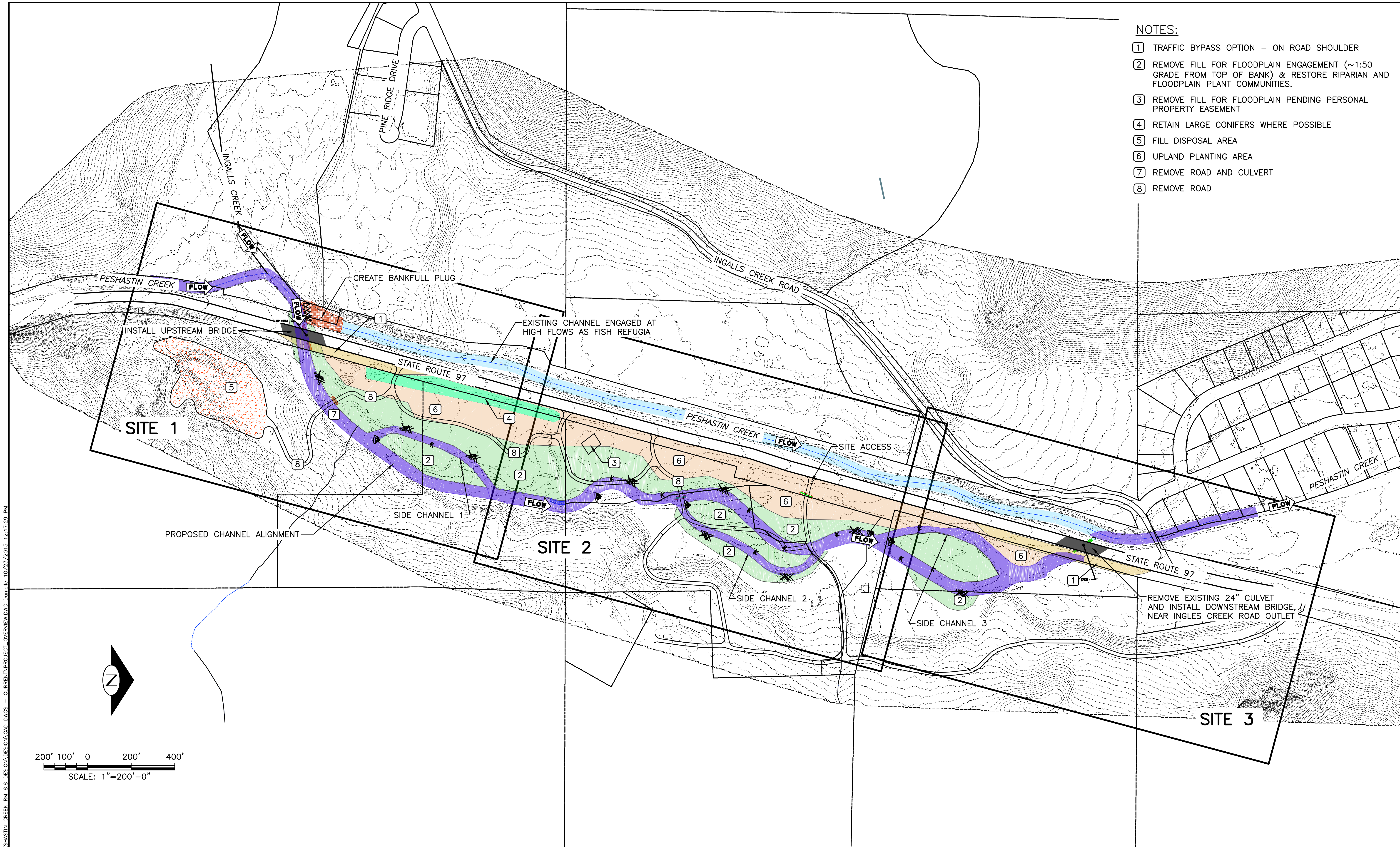
PESHASTIN CREEK RM 8.8 DESIGN

EXISTING CONDITIONS

5

SHEET 5 OF 20



NOTES:

1. TRAFFIC BYPASS OPTION – ON ROAD SHOULDER
2. REMOVE FILL FOR FLOODPLAIN ENGAGEMENT (~1:50 GRADE FROM TOP OF BANK) & RESTORE RIPARIAN AND FLOODPLAIN PLANT COMMUNITIES.
3. REMOVE FILL FOR FLOODPLAIN PENDING PERSONAL PROPERTY EASEMENT
4. RETAIN LARGE CONIFERS WHERE POSSIBLE
5. FILL DISPOSAL AREA
6. UPLAND PLANTING AREA
7. REMOVE ROAD AND CULVERT
8. REMOVE ROAD

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LONGITUDE	122°19'9.75"W
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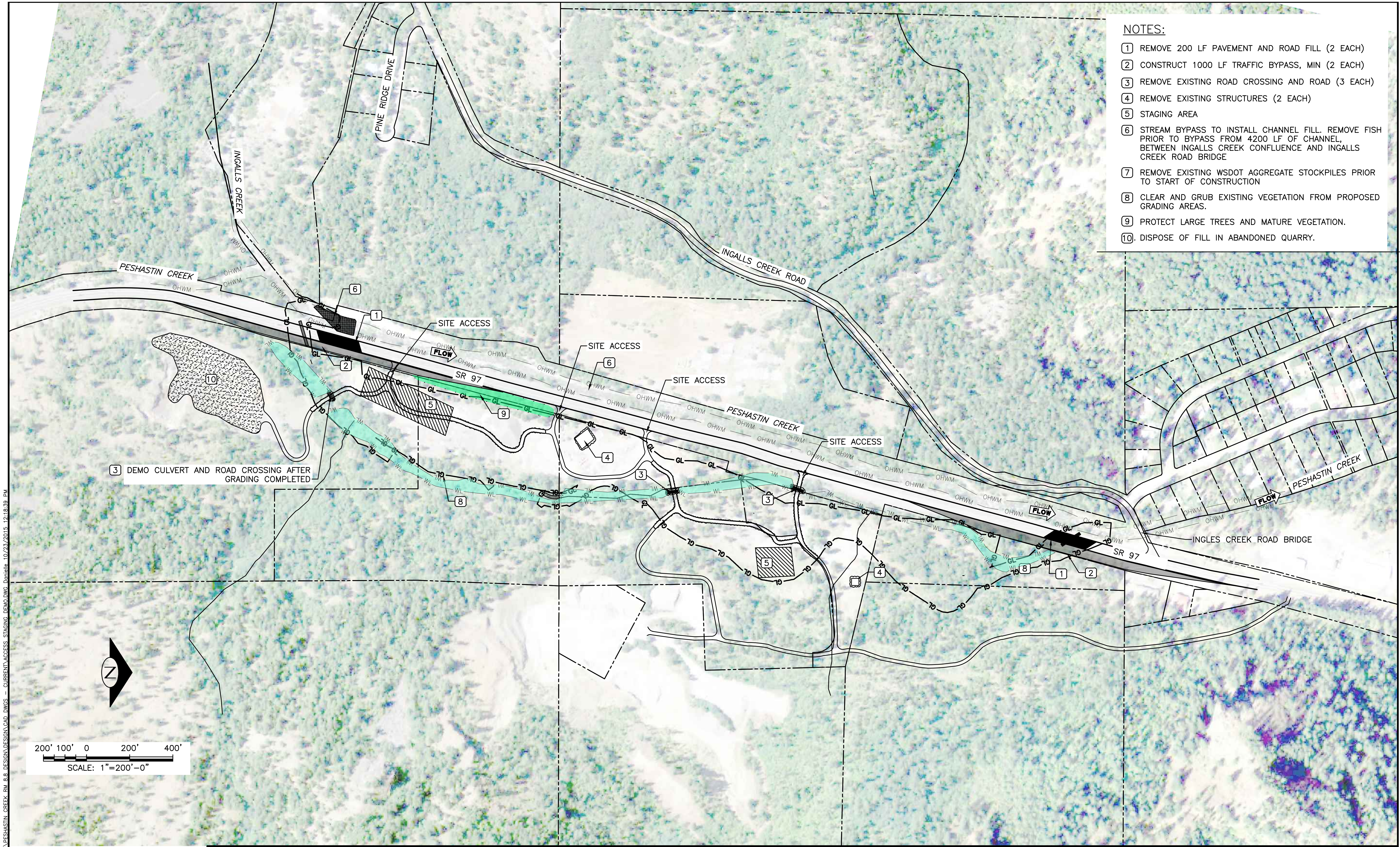
PESHASTIN CREEK RM 8.8 DESIGN

PROJECT OVERVIEW

6

SHEET 6 OF 20



NOTES:

1. REMOVE 200 LF PAVEMENT AND ROAD FILL (2 EACH)
2. CONSTRUCT 1000 LF TRAFFIC BYPASS, MIN (2 EACH)
3. REMOVE EXISTING ROAD CROSSING AND ROAD (3 EACH)
4. REMOVE EXISTING STRUCTURES (2 EACH)
5. STAGING AREA
6. STREAM BYPASS TO INSTALL CHANNEL FILL. REMOVE FISH PRIOR TO BYPASS FROM 4200 LF OF CHANNEL, BETWEEN INGALLS CREEK CONFLUENCE AND INGALLS CREEK ROAD BRIDGE
7. REMOVE EXISTING WSDOT AGGREGATE STOCKPILES PRIOR TO START OF CONSTRUCTION
8. CLEAR AND GRUB EXISTING VEGETATION FROM PROPOSED GRADING AREAS.
9. PROTECT LARGE TREES AND MATURE VEGETATION.
10. DISPOSE OF FILL IN ABANDONED QUARRY.

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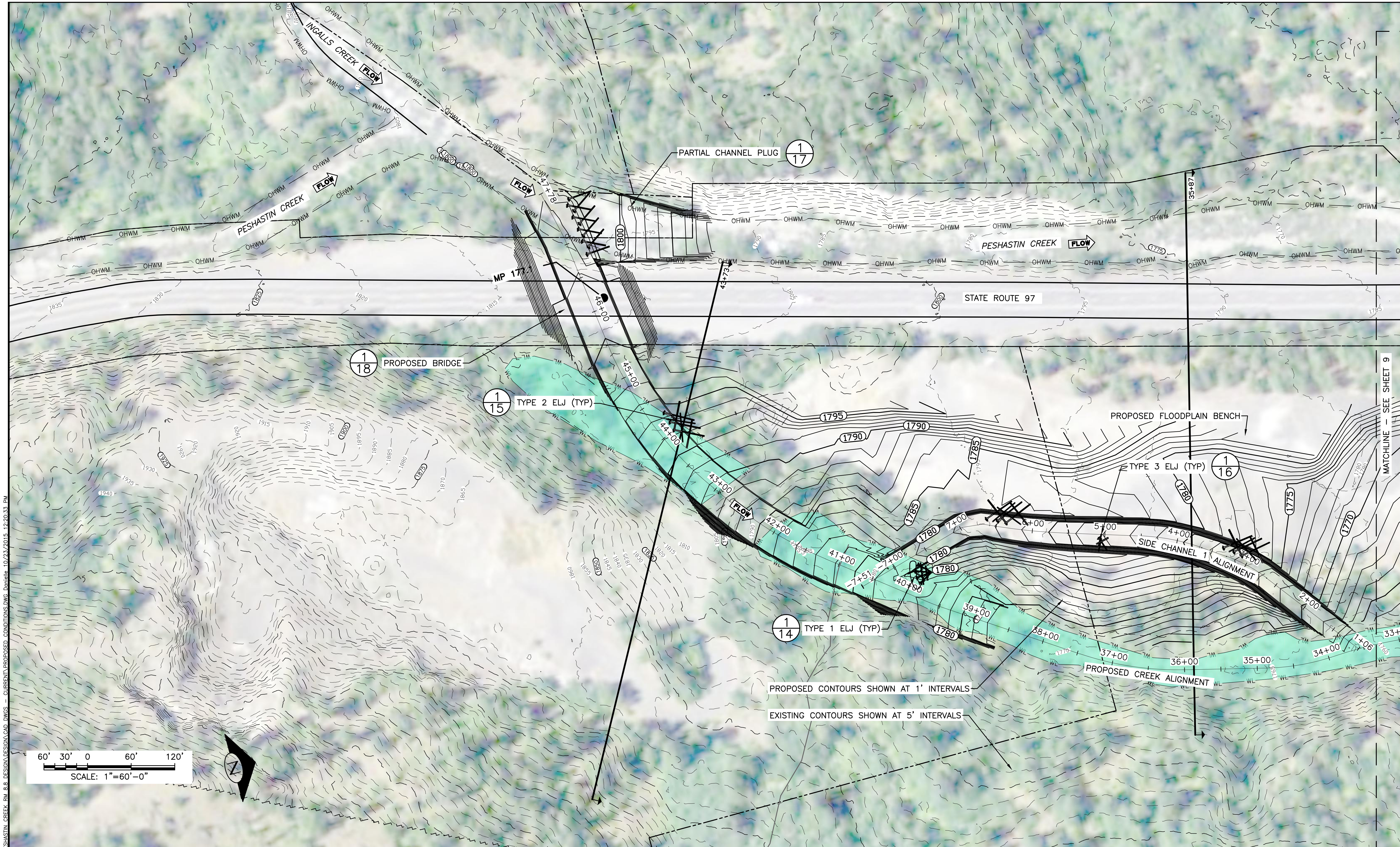
PESHASTIN CREEK RM 8.8 DESIGN

ACCESS, STAGING & DEMOLITION PLAN

7

SHEET 7 OF 20



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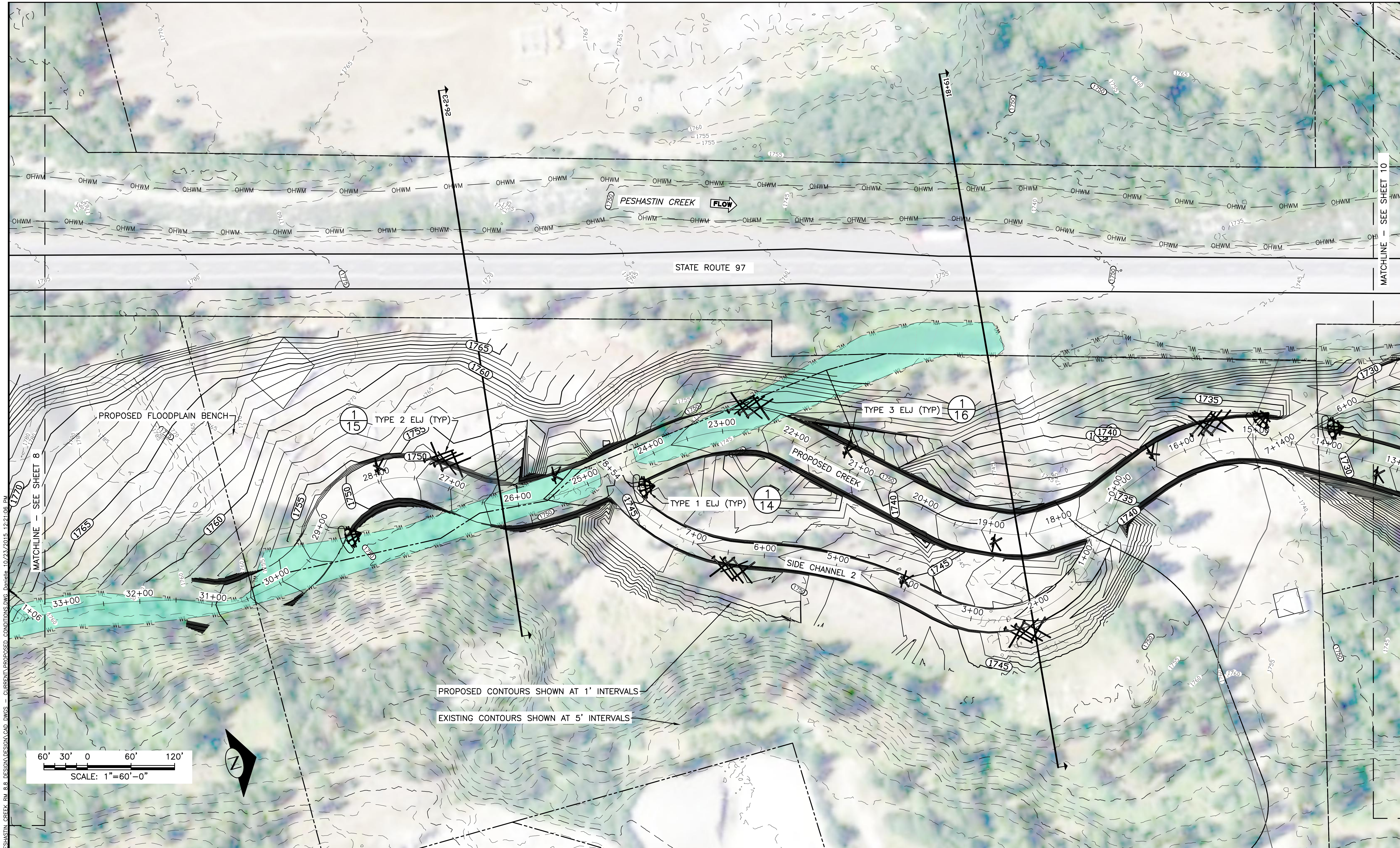
PESHASTIN CREEK RM 8.8 DESIGN

PROPOSED CONDITIONS – SITE 1

8

SHEET 8 OF 20



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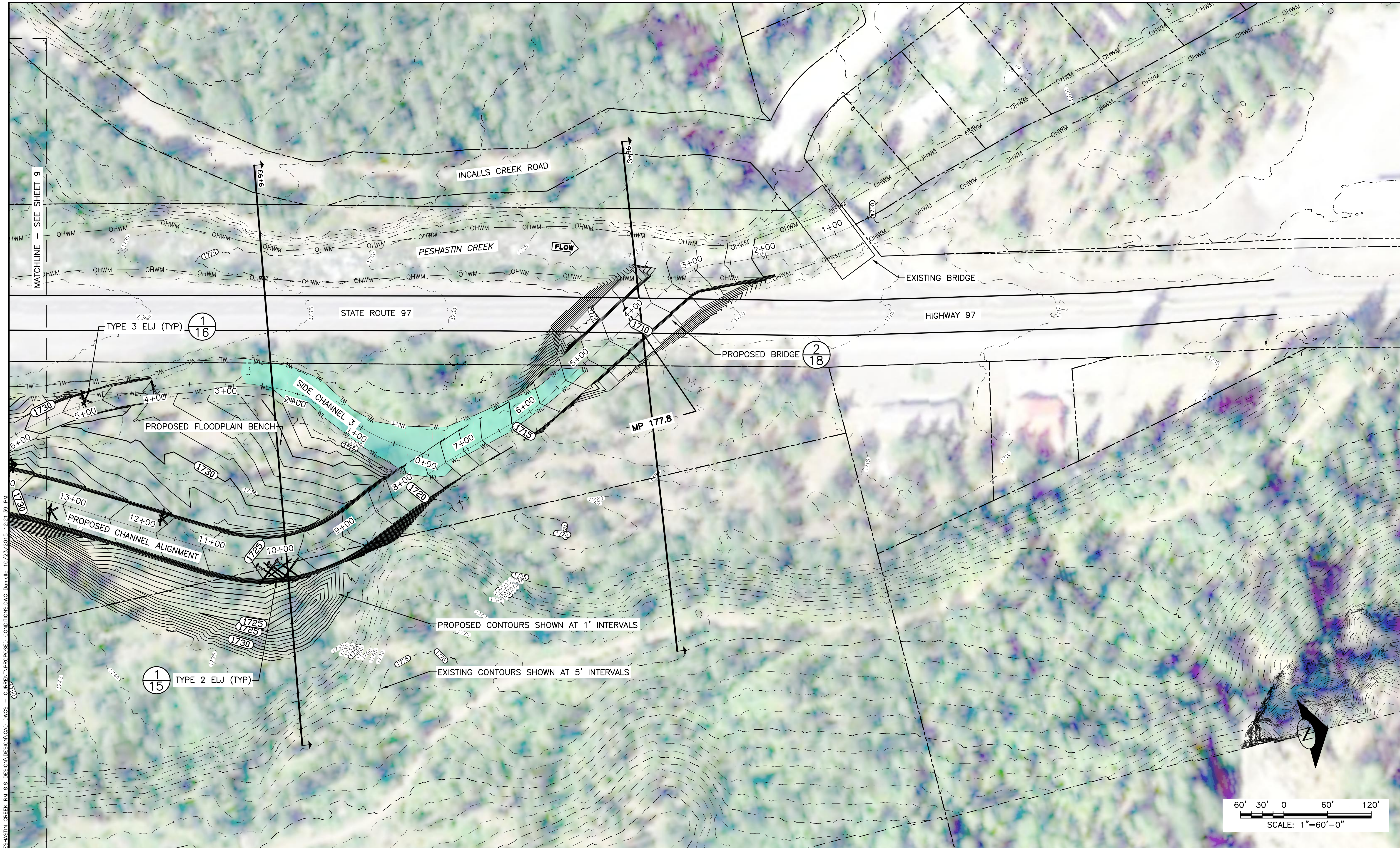
PROPOSED CONDITIONS – SITE 2

9

SHEET 9 OF 20



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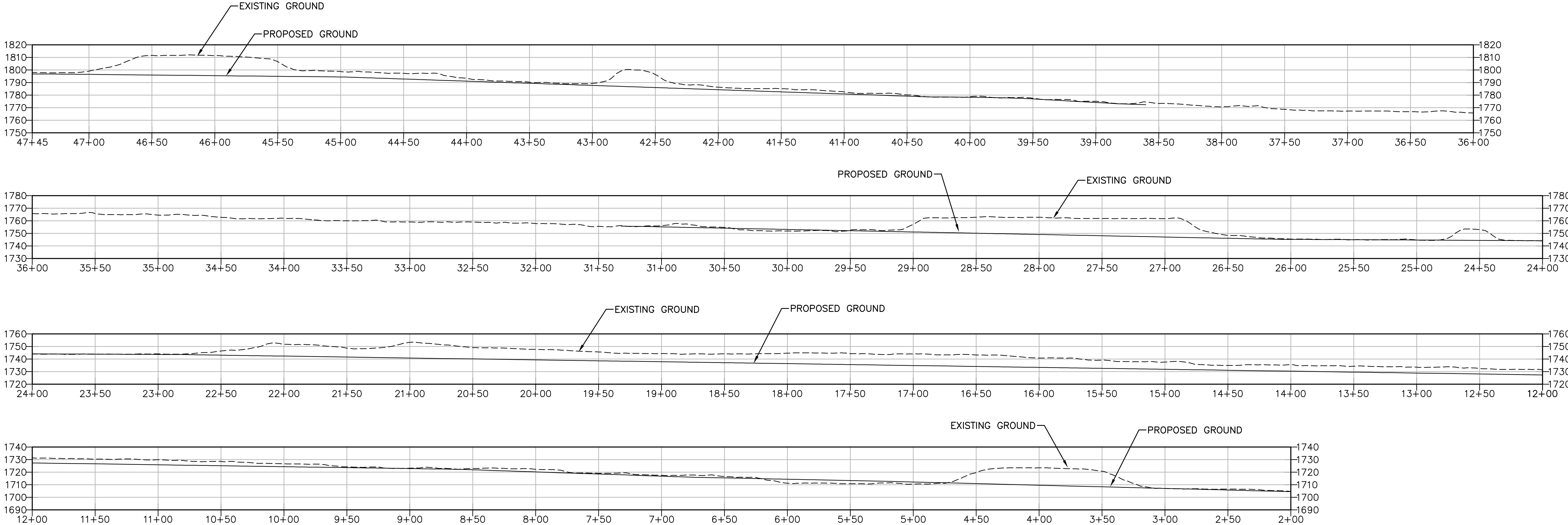
LONGITUDE	122°19'9.75"W
TN/SC/RG	T23N/S25/R17E
DATE	–

PESHASTIN CREEK RM 8.8 DESIGN

PROPOSED CONDITIONS – SITE 3

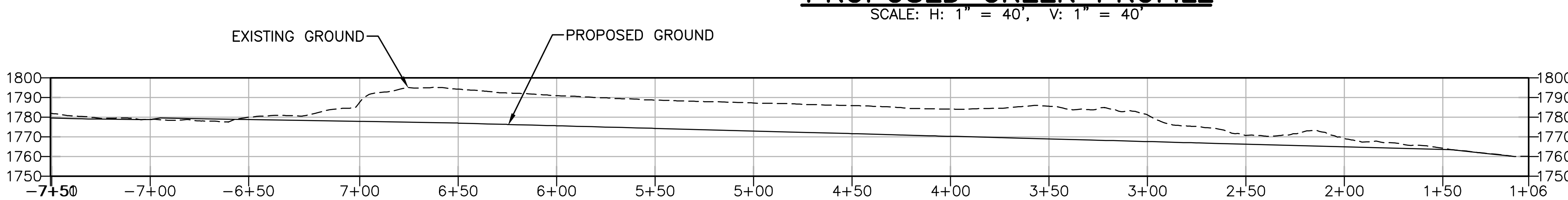
10

SHEET 10 OF 20



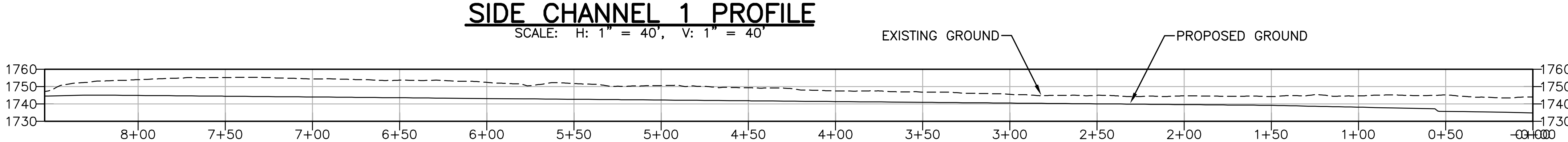
PROPOSED CREEK PROFILE

SCALE: H: 1" = 40', V: 1" = 40'



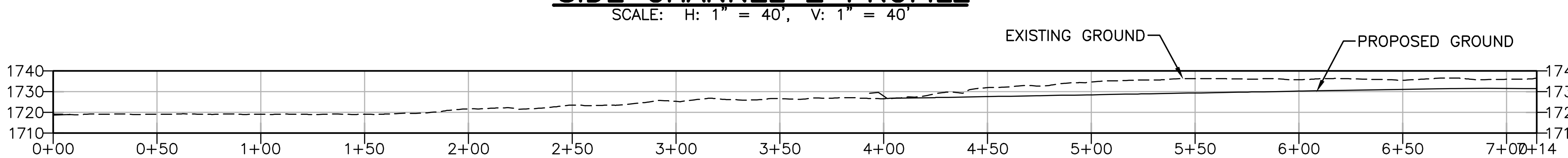
SIDE CHANNEL 1 PROFILE

SCALE: H: 1" = 40', V: 1" = 40'



SIDE CHANNEL 2 PROFILE

SCALE: H: 1" = 40', V: 1" = 40'



SIDE CHANNEL 3 PROFILE

SCALE: H: 1" = 40', V: 1" = 40'

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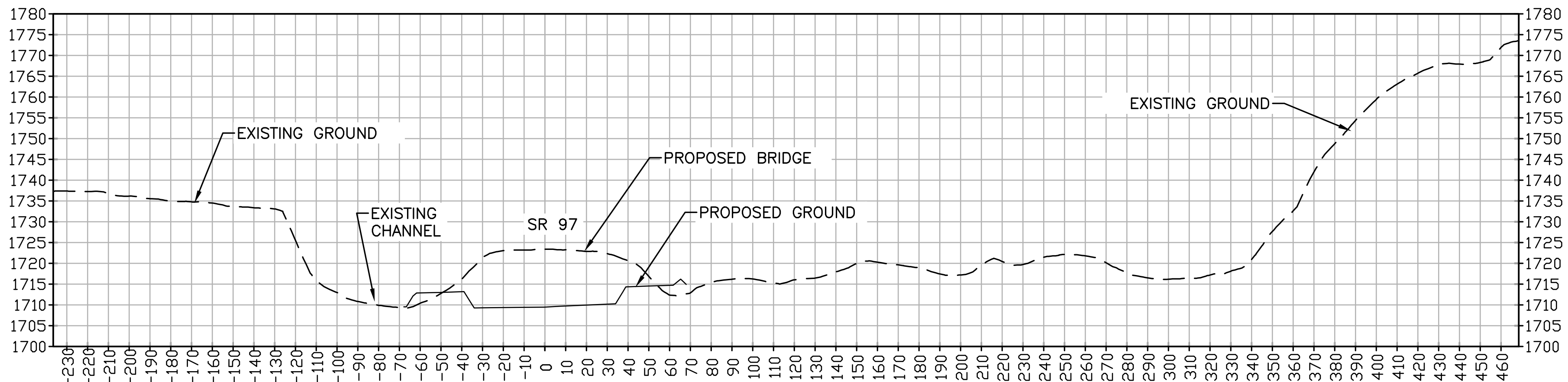
PESHASTIN CREEK RM 8.8 DESIGN

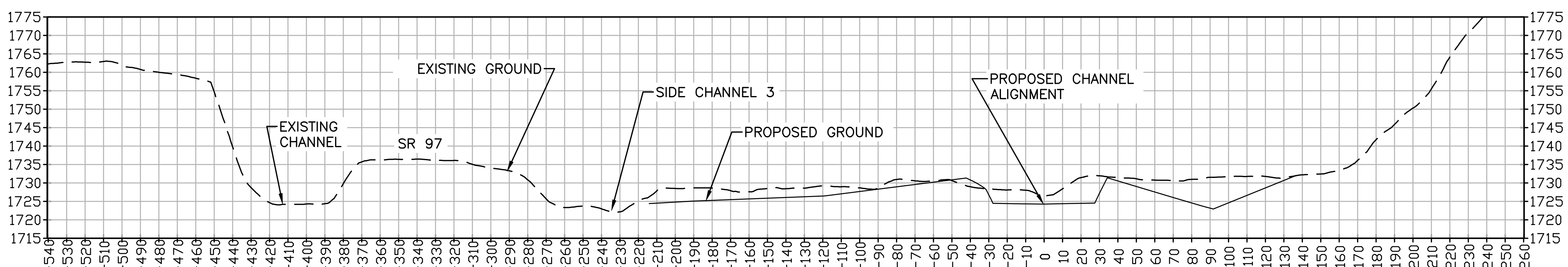
PROFILE

11

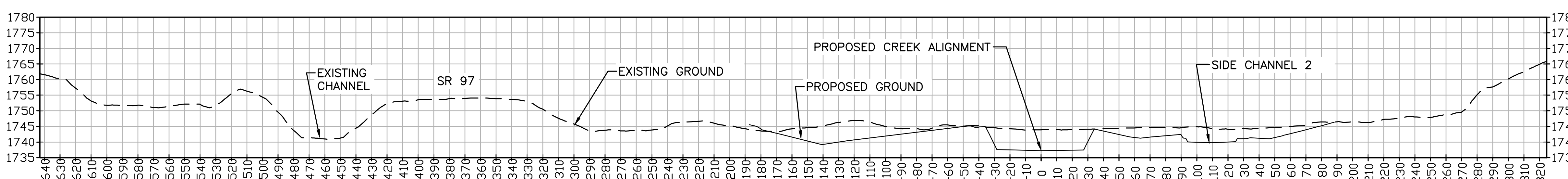
SHEET 11 OF 20



Cross–Section at Algn–ProposedCreek 3+96



Cross–Section at Algn–ProposedCreek 9+93



Cross–Section at Algn–ProposedCreek 18+61

SCALE: H: 1" = 40', V: 1" = 20'

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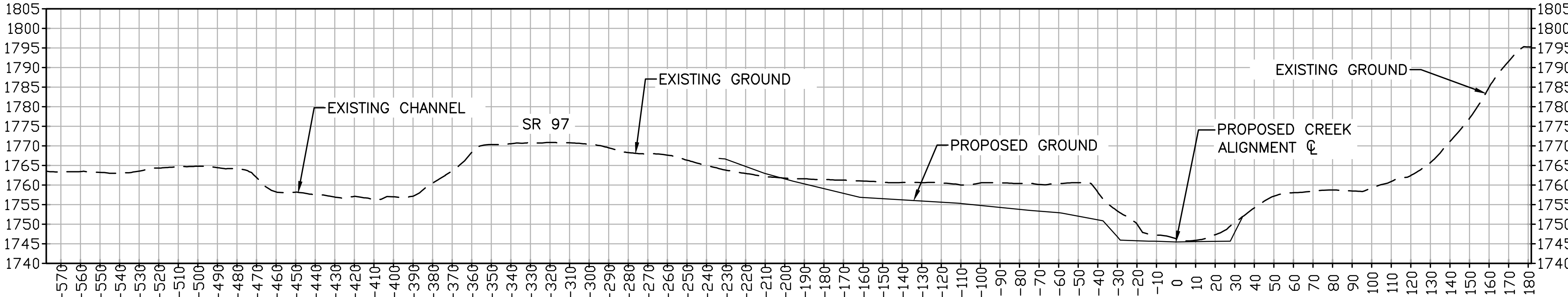
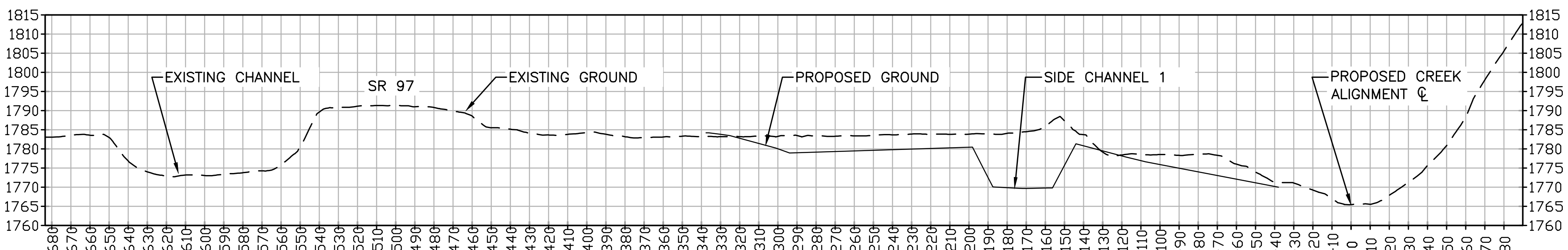
12

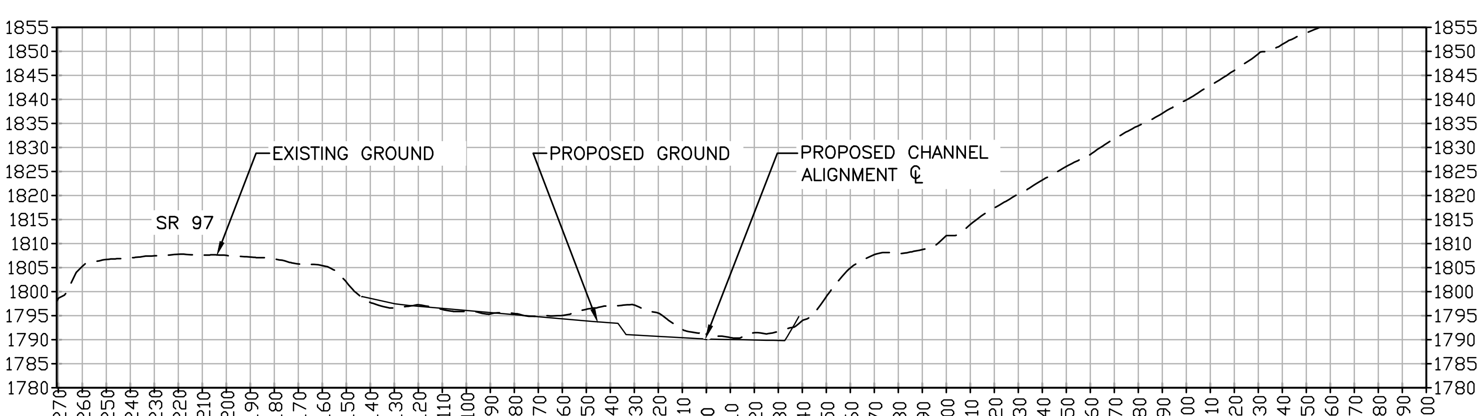
SHEET 12 OF 20



Cross–Section at Algn–ProposedCreek 26+23



Cross–Section at Algn–ProposedCreek 35+87



Cross–Section at Algn–ProposedCreek 43+73

SCALE: H: 1" = 40', V: 1" = 20'

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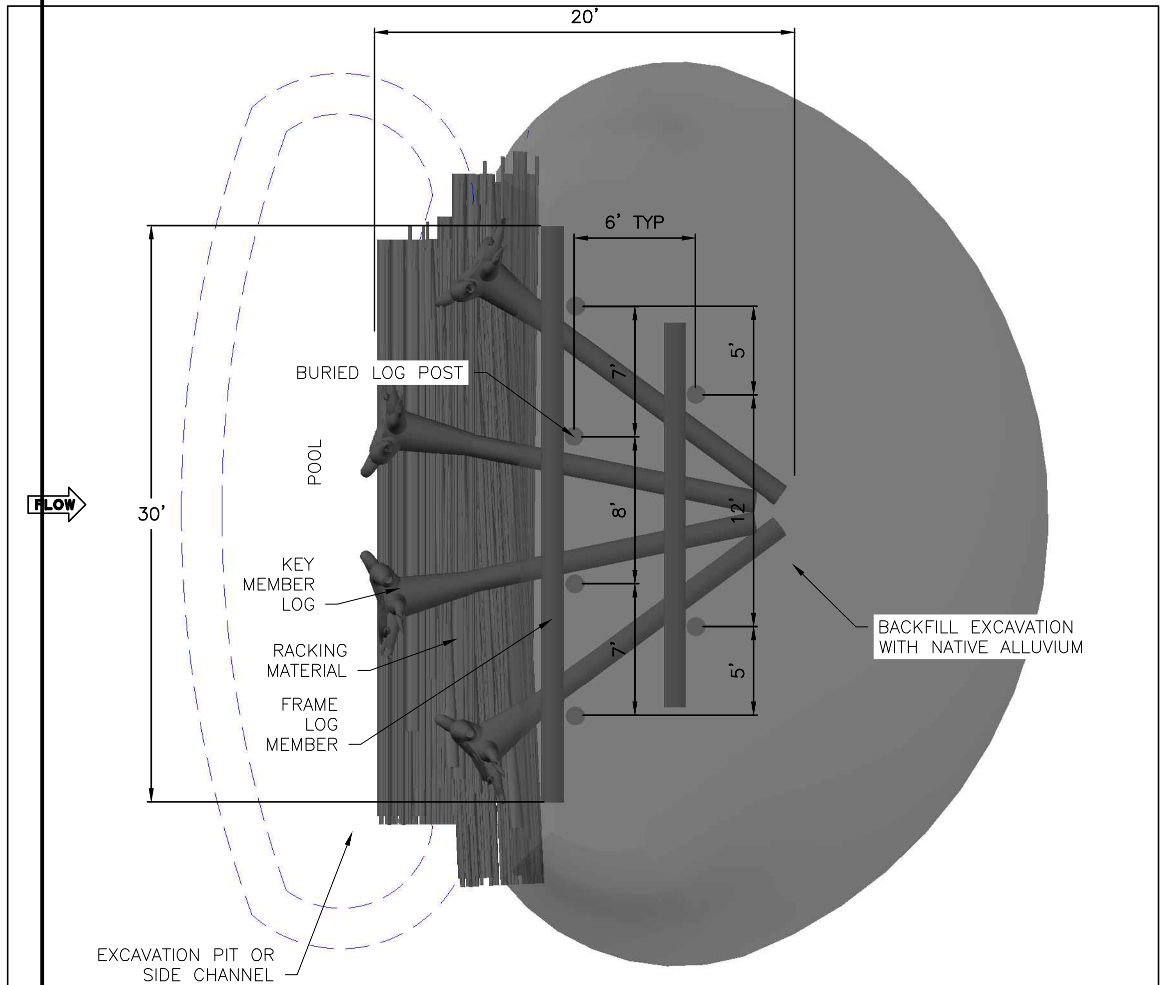
13

SHEET 13 OF 20



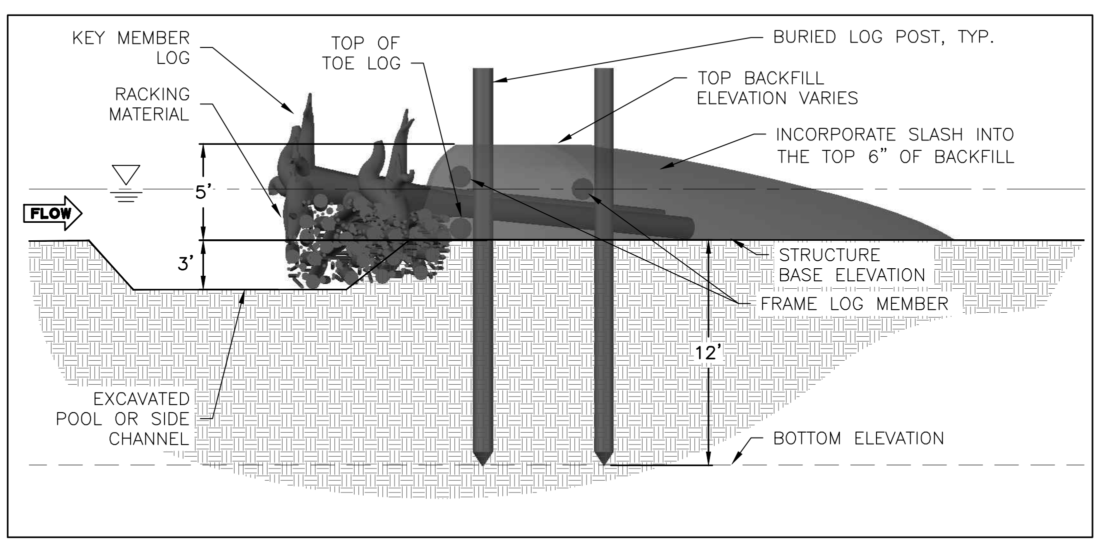
ELJ 1 STRUCTURE PLAN (1/14)
SCALE: 1"=5'

TYPE 1 STRUCTURE SCHEDULE

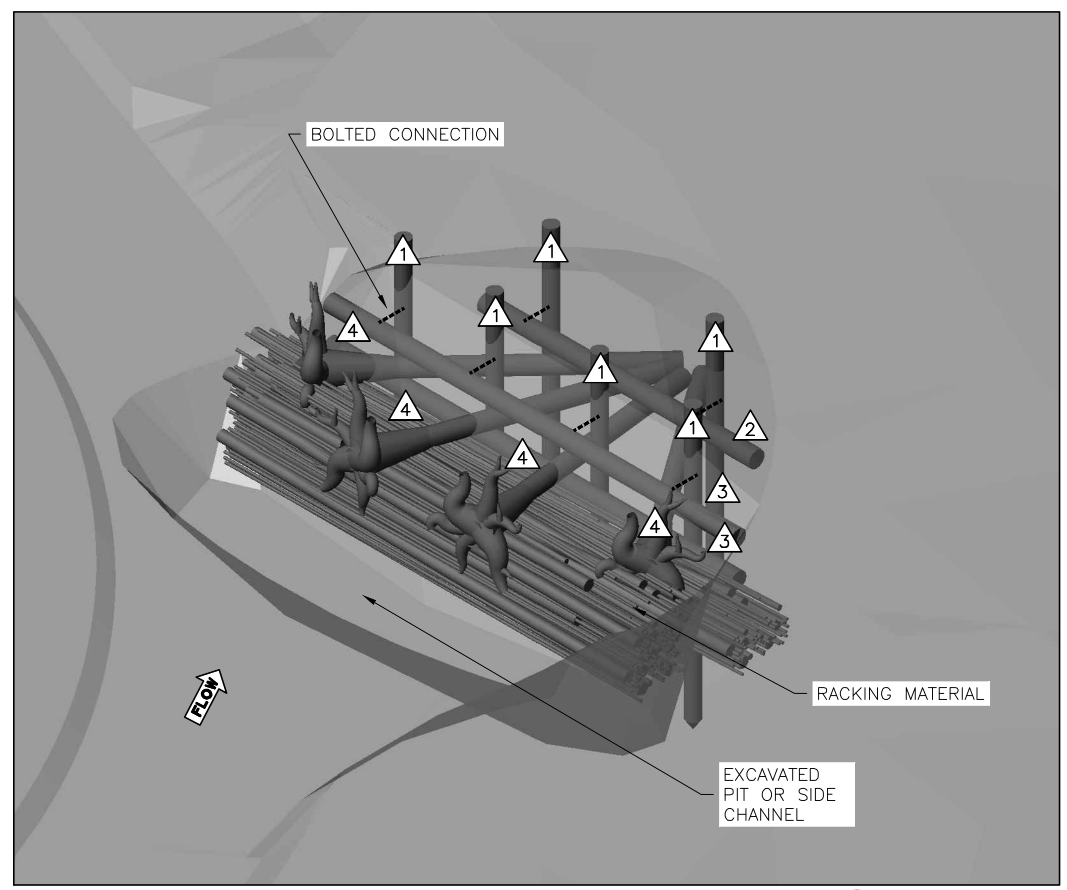
STRUCTURE LABEL	1–1–1
STRUCTURE WIDTH, (FT)	30
STRUCTURE LENGTH, (FT)	20
MINIMUM LOG DIAMETER, (IN)	14
TIMBER POST DIAMETER, (IN)	12
AVERAGE OCTOBER WATER SURFACE ELEVATION (ft–NAVD 88)	
STRUCTURE BASE ELEVATION (FT–NAVD 88)	
SCOUR HOLE ELEVATION (ft–NAVD 88)	
TOP OF TOE LOG ELEVATION (ft–NAVD 88)*	
MINIMUM PILE TIP ELEVATION (ft–NAVD 88)	
*TOP OF TOE LOG ELEVATION IS EQUAL TO ADJACENT CHANNEL THALWEG	

TYPE 1 ELJ – LOG SCHEDULE

LOG ID	DIA* (IN)	LENGTH** (FT)	ROOTWAD (Y/N)	QUANTITY PER STRUCTURE
1	12	20	N	6
2	14	20	N	1
3	14	30	N	2
4	14	20	Y	4
* MINIMUM DIAMETER AT BREAST HEIGHT (2" MAXIMUM TAPER)				
** TOTAL LENGTH INCLUDING ROOTWAD				



ELJ 1 STRUCTURE SIDE PROFILE (2/14)
SCALE: 1"=5'



ELJ 1 STRUCTURE PERSPECTIVE (3/14)
NOT TO SCALE

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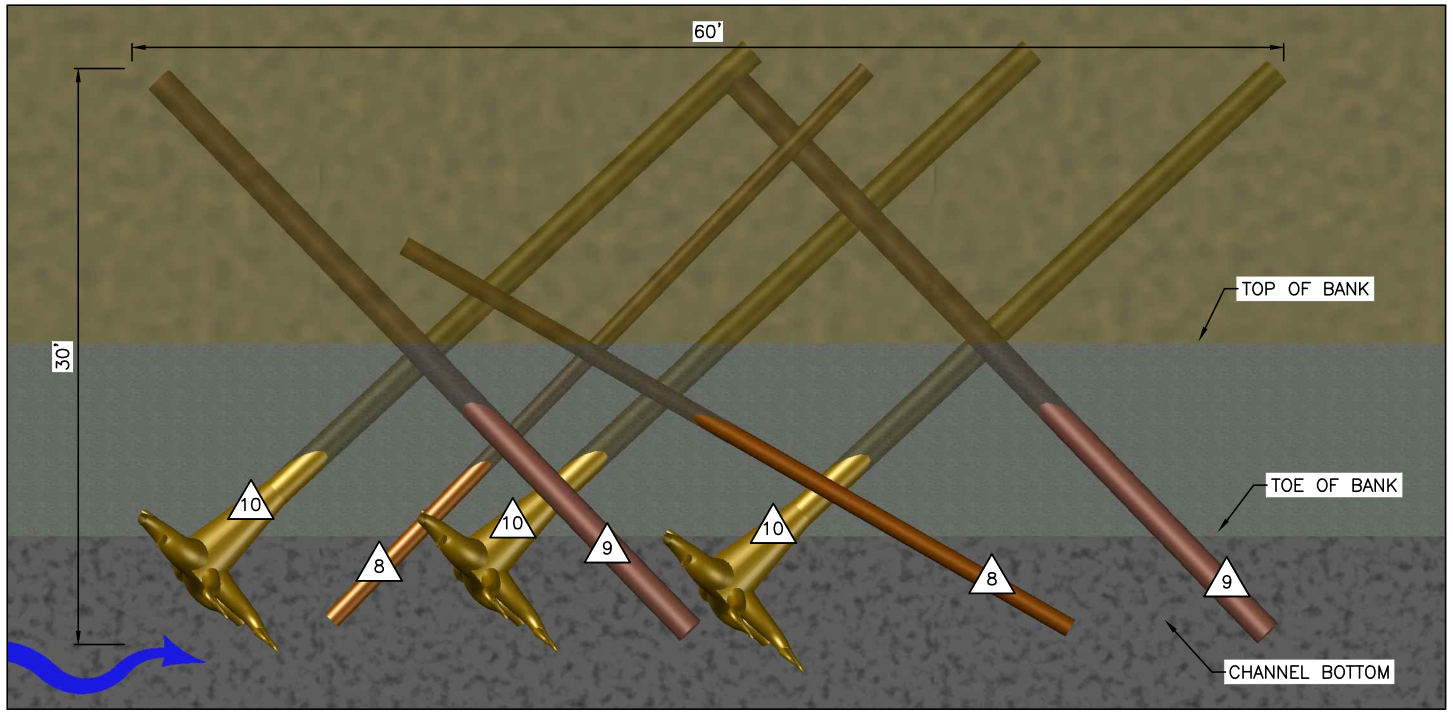
LONGITUDE	122°19'9.75"W
TN/SC/RG	T23N/S25/R17E
DATE	–

PESHASTIN CREEK RM 8.8 DESIGN

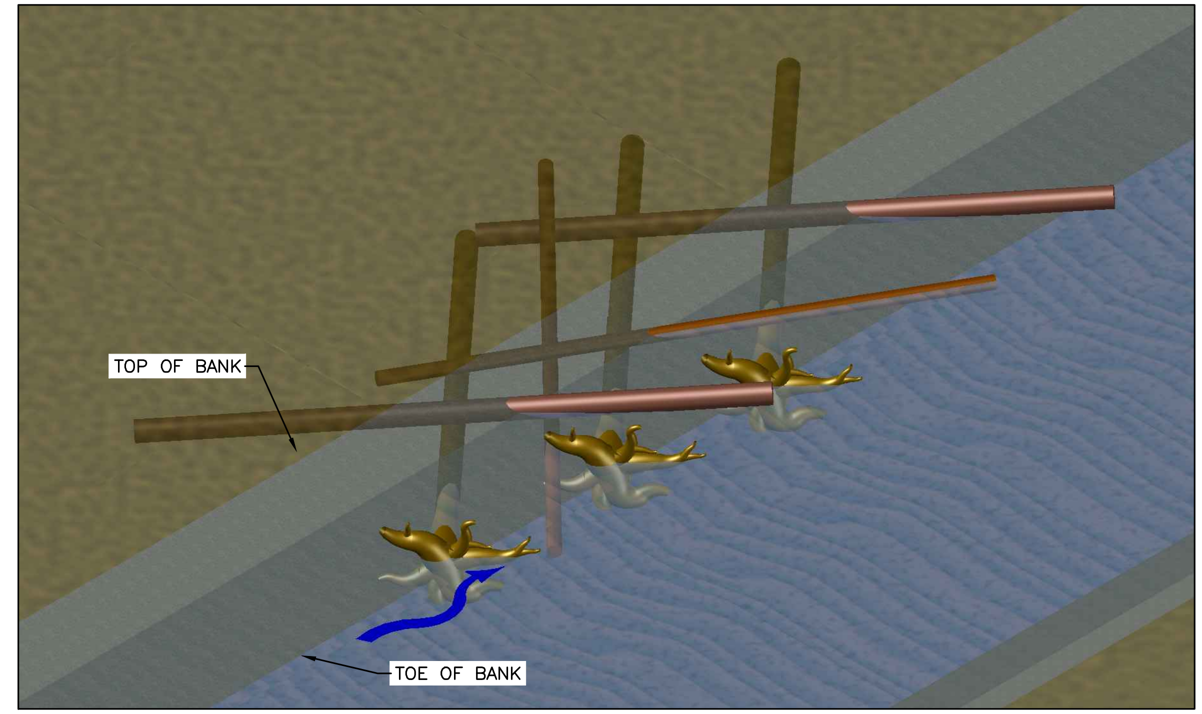
TYPE 1 ELJ

14

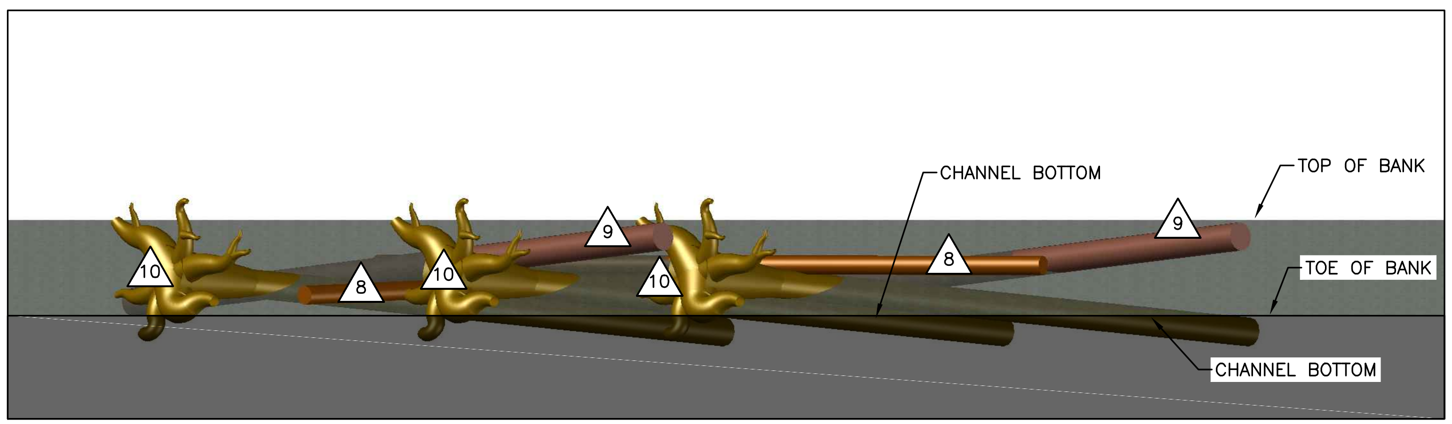
SHEET 14 OF 20



TYPE 2 ELJ PLAN
SCALE: 1" = 5'

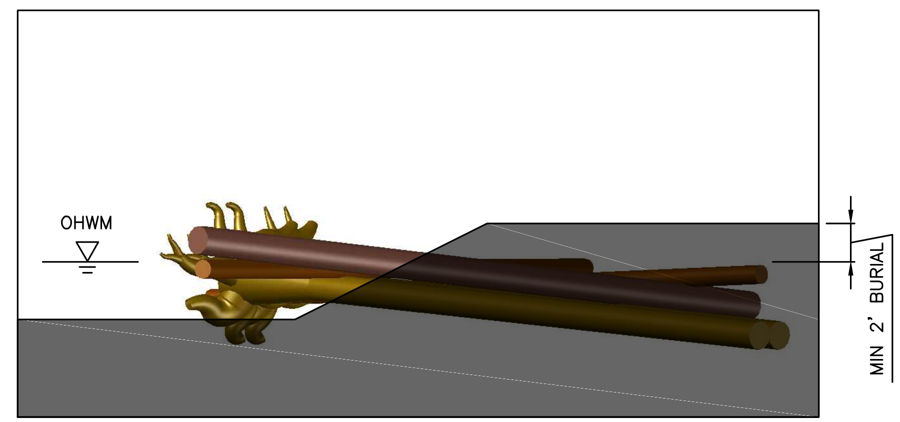


TYPE 2 ELJ PERSPECTIVE
NOT TO SCALE



5' 0 5' 10'
SCALE: 1"=5'-0"

TYPE 2 ELJ PROFILE (SIDE VIEW)
SCALE: 1" = 5'



TYPE 2 ELJ PROFILE (END VIEW)
SCALE: 1" = 5'

TYPE 2 ELJ LOG SCHEDULE

LOG ID	DIA* (IN)	LENGTH** (FT)	ROOTWAD (Y/N)	QUANTITY PER STRUCTURE	NOTES
8	12	40	N	2	
9	18	40	N	2	
10	18	40	Y	3	

* DIAMETER AT BREAST HEIGHT
** TOTAL LENGTH INCLUDING ROOTWAD

TYPE 2 ELJ
SCALE: AS NOTED

1
15

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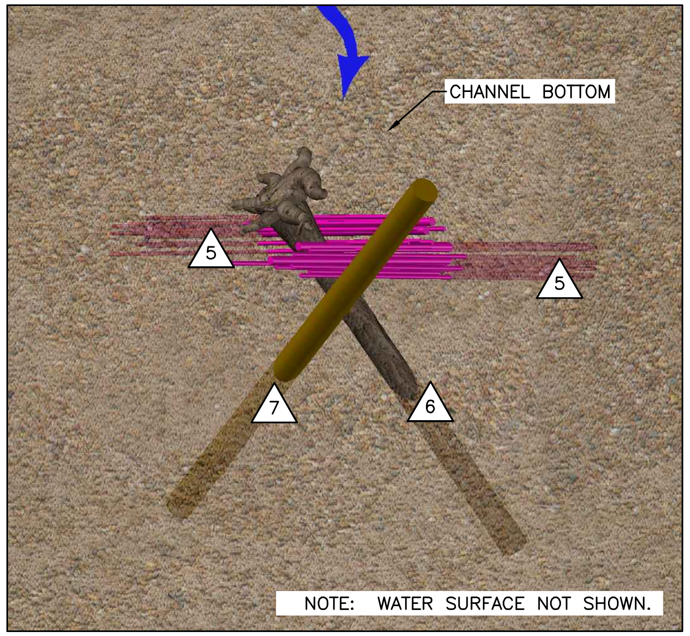
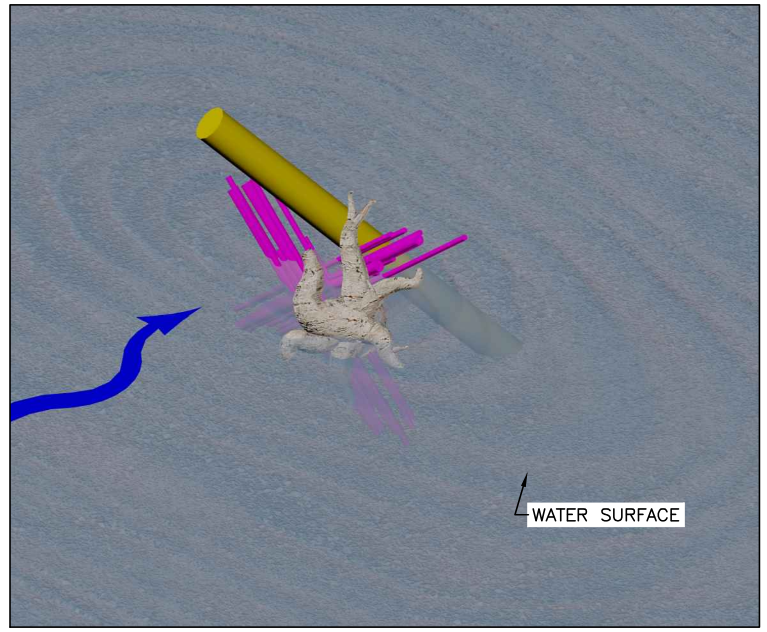


TYPE 3 ELJ PLAN
SCALE: 1" = 5'

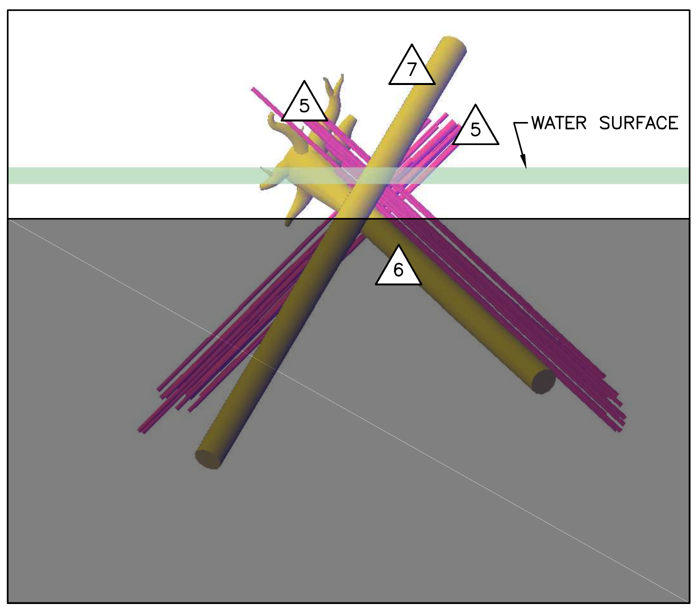


TYPE 3 ELJ PERSPECTIVE
NOT TO SCALE

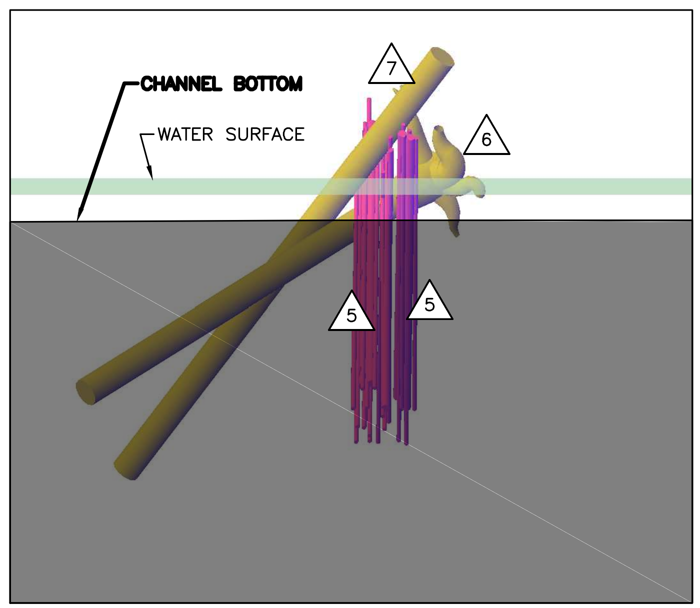
TYPE 3 ELJ LOG SCHEDULE

LOG ID	DIA* (IN)	LENGTH** (FT)	ROOTWAD (Y/N)	QUANTITY PER STRUCTURE	NOTES
5	4 TO 8	30	N	20	
6	18	25	Y	1	
7	18	25	N	1	

* DIAMETER AT BREAST HEIGHT
** TOTAL LENGTH INCLUDING ROOTWAD



TYPE 3 ELJ PROFILE (END VIEW)
SCALE: 1" = 5'



TYPE 3 ELJ PROFILE (SIDE VIEW)
SCALE: 1" = 5'

5' 0 5' 10'
SCALE: 1"=5'-0"

TYPE 2 ELJ
SCALE: AS NOTED

1
12

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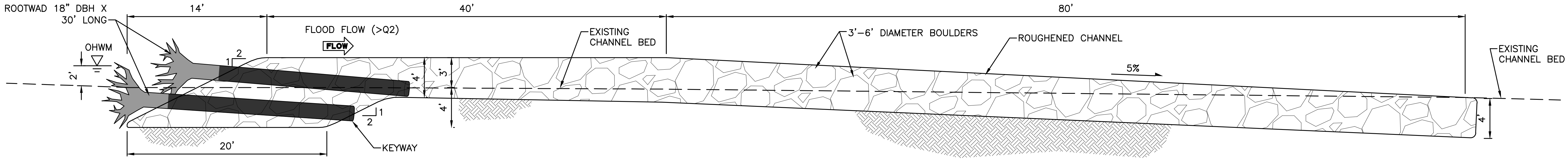
TN/SC/RG	T23N/S25/R17E
DATE	–

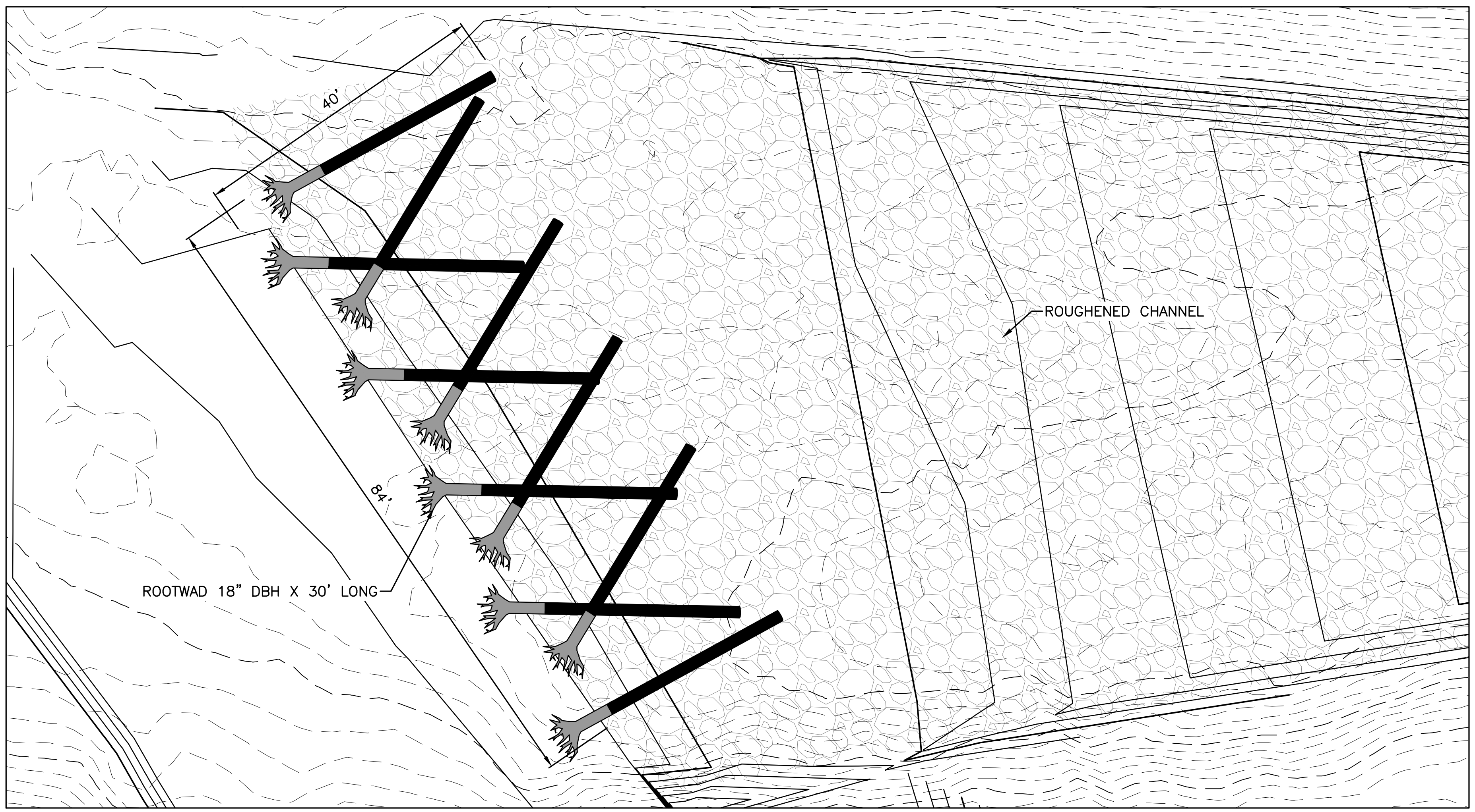
PESHASTIN CREEK RM 8.8 DESIGN

TYPE 3 ELJ

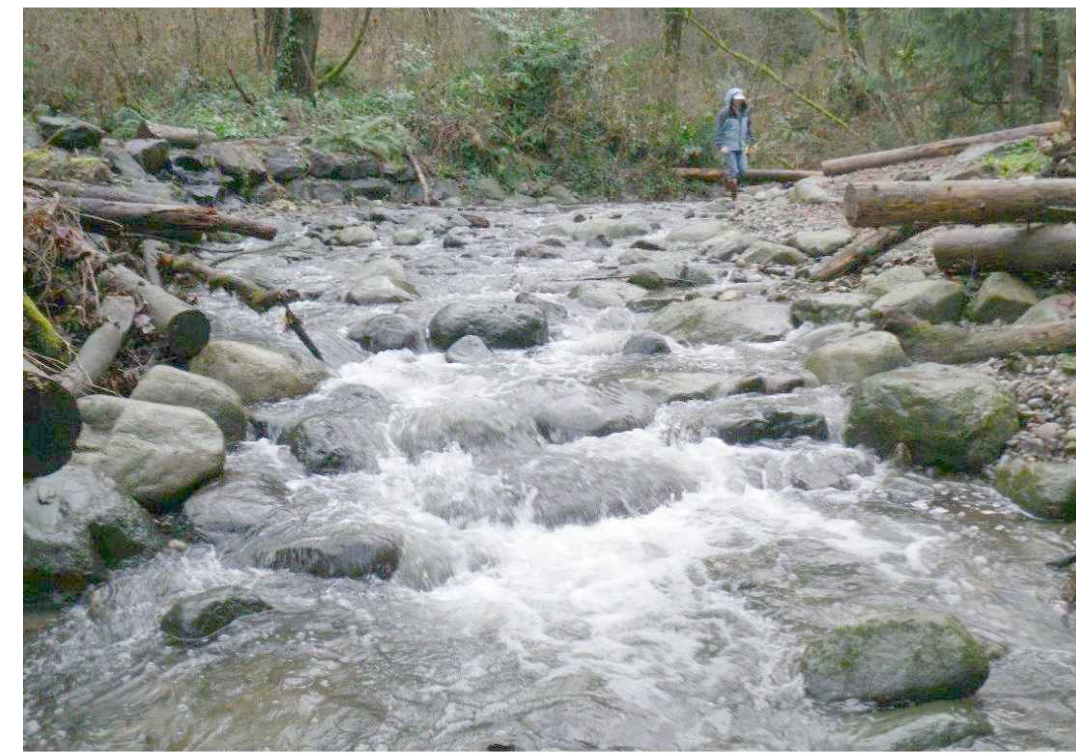
16
SHEET 16 OF 20



PARTIAL CHANNEL PLUG PROFILE (1/17)
SCALE: 1" = 5'



PARTIAL CHANNEL PLUG PLAN
SCALE: 1" = 10'



ROUGHENED CHANNEL

PARTIAL CHANNEL PLUG (1/17)
SCALE: AS NOTED

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GEOGRAPHIC INFORMATION	
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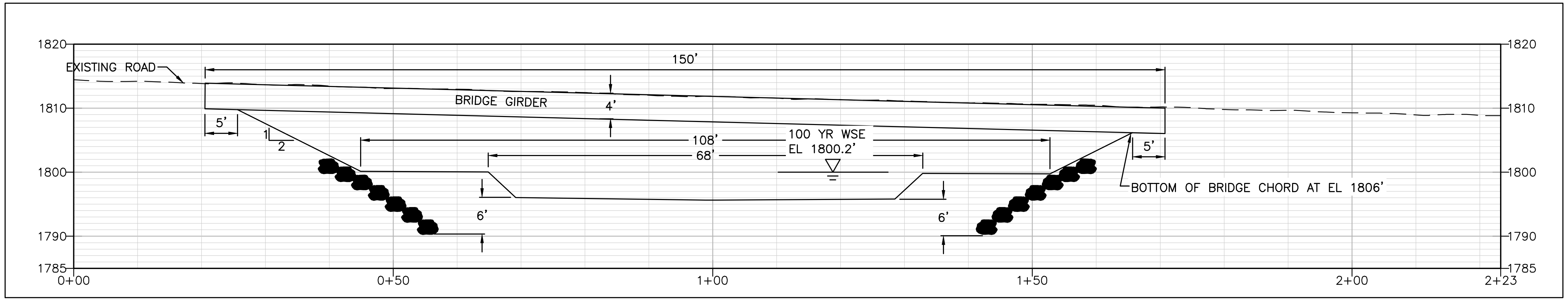
LONGITUDE	122°19'9.75"W
TN/SC/RG	T23N/S25/R17E
DATE	–

PESHASTIN CREEK RM 8.8 DESIGN

PARTIAL CHANNEL PLUG

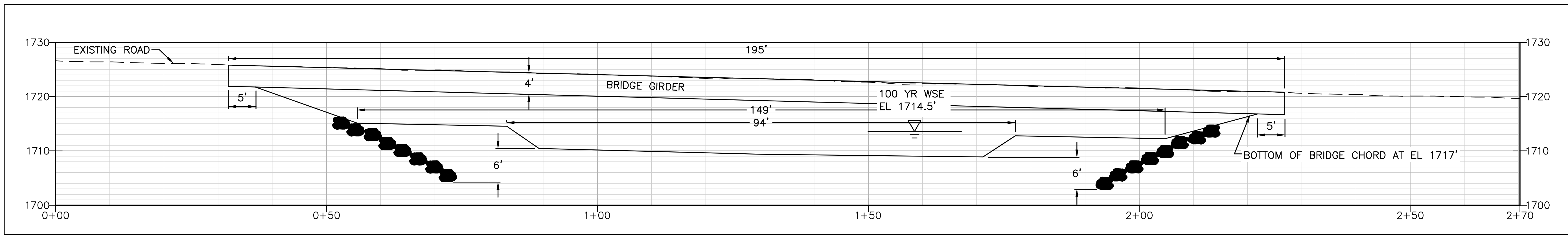
17

SHEET 17 OF 20



UPSTREAM BRIDGE CROSS SECTION 1/18

SCALE: 1" = 10'



DOWNSTREAM BRIDGE CROSS SECTION 2/18

SCALE: 1" = 10'

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BRIDGE DETAILS

18

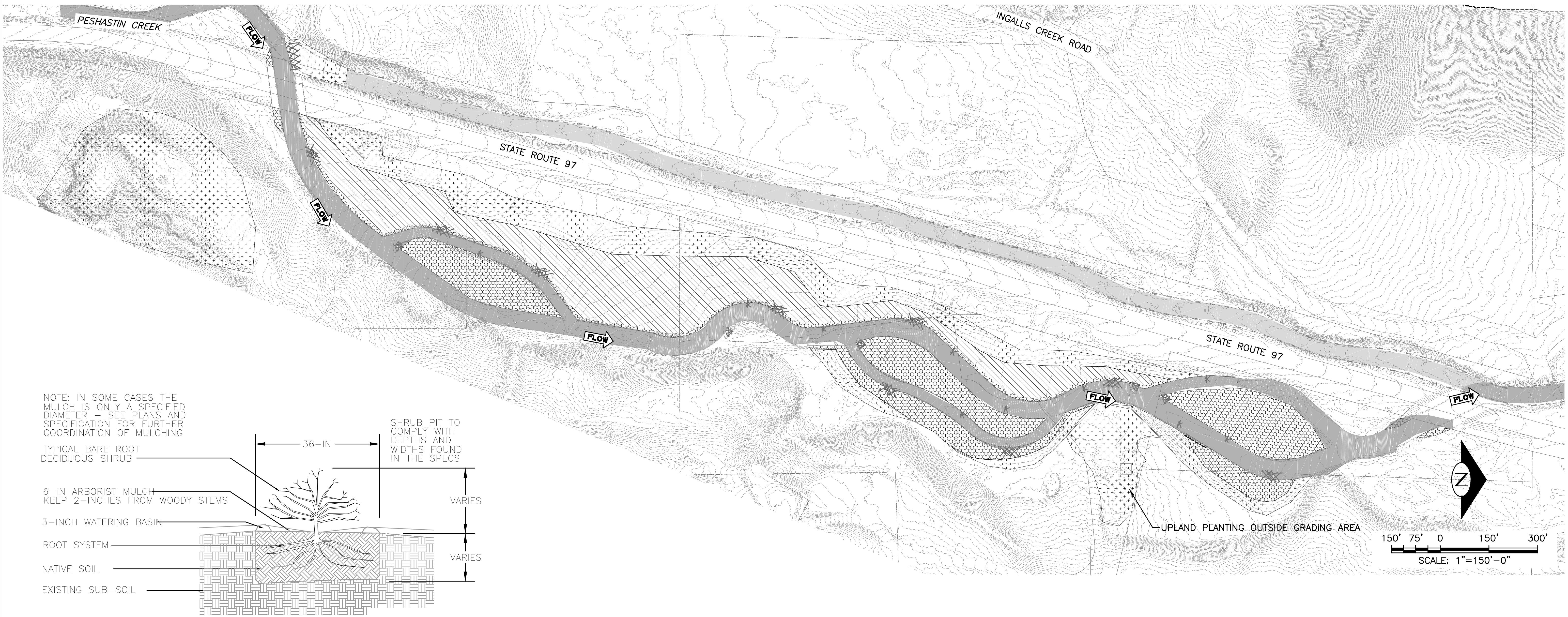
SHEET 18 OF 20

LEGEND:

- RIPARIAN PLANTING AREA (261,000 SF, 6 AC), SEE PLANTING NOTE 1
- FLOODPLAIN PLANTING AREA (289,000 SF, 6.6 AC), SEE PLANTING NOTE 1
- UPLAND PLANTING AREA (534,000 SF, 12 AC), SEE PLANTING NOTE 2

PLANTING NOTES:

1. HYDROSEED RIPARIAN PLANTING AREA AND FLOODPLAIN PLANTING AREA WITH WET SEED MIX, SEE PLANT SCHEDULE.
2. HYDROSEED UPLAND PLANTING AREA WITH DRY SEED MIX, SEE PLANT SCHEDULE.



BAREROOT PLANTING DETAIL
NOT TO SCALE

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TN/SC/RG	T23N/S25/R17E
DATE	–

PESHASTIN CREEK RM 8.8 DESIGN

PLANTING PLAN

19

SHEET 19 OF 20

PLANT SCHEDULE

RIPARIAN PLANTING AREA

LOCATION	LAYER	SPECIES	COMMON NAME	SIZE	AVG. SPACING* O.C.	QTY.	NOTES
261,000	DECID. SHRUB	ALNUS INCANA	SPECKLED ALDER	TREEPOT 4	10	1,305	
SQ. FT.	DECID. SHRUB	SALIX EXIGUA	COYOTE WILLOW	36-IN LIVESTAKE	5	2,610	
	DECID. SHRUB	SALIX LUCIDA var. LASSIANDRA	PACIFIC WILLOW	36-IN LIVESTAKE	5	2,610	
					DECID. SHRUB SUBTOTAL	5,220	

FLOODPLAIN PLANTING AREA

LOCATION	LAYER	SPECIES	COMMON NAME	SIZE	AVG. SPACING* O.C.	QTY.	NOTES
289,000	CONIF. TREE	PSEUDOTSUGA MENZIESII	DOUGLAS FIR	TREEPOT 4	10	723	
SQ. FT.					CONIF. TREE SUBTOTAL	723	
	DECID. TREE	ACER MACROPHYLLA	BIG LEAF MAPLE	TREEPOT 4	20	72	
	DECID. TREE	POPULUS BALSAMIFERA SSP. TRICHOCARPA	BLACK COTTONWOOD	TREEPOT 4	10	289	
					DECID. TREE SUBTOTAL	361	
	DECID. SHRUB	ALNUS INCANA	SPECKLED ALDER	TREEPOT 4	10	434	
	DECID. SHRUB	SALIX LUCIDA var. LASSIANDRA	PACIFIC WILLOW	TREEPOT 4	10	289	
	DECID. SHRUB	SALIX SITCHENSIS	SITKA WILLOW	36-IN LIVESTAKE	10	289	
	DECID. SHRUB	CORNUS SERICEA	RED OSIER DOGWOOD	TREEPOT 4	10	867	
					DECID. SHRUB SUBTOTAL	1,879	

UPLAND PLANTING AREA

LOCATION	LAYER	SPECIES	COMMON NAME	SIZE	AVG. SPACING* O.C.	QTY.	NOTES
534,000	CONIF. TREE	PINUS PONDEROSA	PONDEROSA PINE	TREEPOT 4	15	119	
SQ. FT.	CONIF. TREE	PSEUDOTSUGA MENZIESII	DOUGLAS FIR	TREEPOT 4	15	475	
					CONIF. TREE SUBTOTAL	593	
	DECID. TREE	ACER MACROPHYLLA	BIG LEAF MAPLE	TREEPOT 4	15	475	
					DECID. TREE SUBTOTAL	475	
	DECID. TREE	AMELANCHIER ALNIFOLIA	SERVICEBERRY	TREEPOT 4	10	801	
	DECID. SHRUB	CEANOTHUS VELUTINUS	SNOWBRUSH	TREEPOT 4	10	1,068	
	DECID. SHRUB	SYMPHORICARPOS ALBUS	SNOWBERRY	TREEPOT 4	10	1,068	
	DECID. SHRUB	ROSA NUTKANA	NOOTKA ROSE	TREEPOT 4	10	1,068	
					DECID. SHRUB SUBTOTAL	4,005	

HYDROSEED – WET AREA SEED MIX

LOCATION	LAYER	SPECIES	COMMON NAME	SIZE	LBS PLS / ACRE
261,000	GROUNDCOVER	AGROSTIS SCABRA	HAIR BENTGRASS	SEED	1.00
SQ. FT.	GROUNDCOVER	ANAPHALIS MARGARITACEA	PEARLY EVERLASTING	SEED	0.50
	GROUNDCOVER	DESCHAMPSIA CESPITOSA	TUFTED HAIRGRASS	SEED	2.00
	GROUNDCOVER	EPILOBIUM ANGUSTIFOLIUM	FIREWEED	SEED	0.25
NOTES:	GROUNDCOVER	ERIGERON SPECIOSUS	ASPEN FLEABANE	SEED	0.75
APPLY IN	GROUNDCOVER	FESTUCA RUBRRA VAR. RUBRA	RED FESCUE	SEED	4.00
ALL	GROUNDCOVER	JUNCUS TENUIS	SLENDER RUSH	SEED	1.00
RIPARIAN	GROUNDCOVER	POTENTILLA GRACILIS	SLENDER CINQUEFOIL	SEED	0.75
PLANTING	GROUNDCOVER	SOLIDAGO CANADENSIS	CANADA GOLDENROD	SEED	0.75
AREAS.	GROUNDCOVER	SCIRPUS MICROCARPUS	SMALL-FRUITED BULRUSH	SEED	1.00
	GROUNDCOVER	TRITICUM AESTIVUM X SECALE CREEALE	STERILE TRITICALE	SEED	60.00

HYDROSEED – DRY AREA SEED MIX

LOCATION	LAYER	SPECIES	COMMON NAME	SIZE	LBS PLS / ACRE
823,000	GROUNDCOVER	ACHILLEA MILLEFOLIUM	WESTERN YARROW	SEED	0.50
SQ. FT.	GROUNDCOVER	ACHINATHERM HYMENOIDES	INDIAN RICEGRASS	SEED	12.00
	GROUNDCOVER	AGROPYRON SPICATUM	BLUEBUNCH WHEATGRASS	SEED	12.00
NOTES:	GROUNDCOVER	ANAPHALIS MARGARITACEAE	PERLY EVERLASTING	SEED	0.50
APPLY IN	GROUNDCOVER	APOCYNUM ANDROSAEMIFOLIUM	SPREADING DOGBANE	SEED	
ALL	GROUNDCOVER	ELYMUS TRACHYCAULUS	SLENDER WHEATGRASS	SEED	8.00
FLOODPLAI	GROUNDCOVER	FESTUCA IDAHOENSIS	IDAHO FESCUE	SEED	6.00
N AND	GROUNDCOVER	LOMATIUM NUDICAULE	BARESTEM BISCUITROOT	SEED	
UPLAND	GROUNDCOVER	LUPINUS SERICEUS	SILKY LUPINE	SEED	20.00
PLANTING	GROUNDCOVER	POTENTILLA GRACILIS	SLENDER CINQUEFOIL	SEED	0.75
AREAS	GROUNDCOVER	TRITICUM AESTIVUM X SECALE CEREALE	STERILE TRITICALE	SEED	60.00
	GROUNDCOVER	POA SECUNDA	SANDBERG BLUEGRASS	SEED	4

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DATE	–

PESHASTIN CREEK RM 8.8 DESIGN

PLANT SCHEDULE

20

APPENDIX B
COST ESTIMATE

PESHASTIN RM 8.8 - CONCEPTUAL COST ESTIMATE

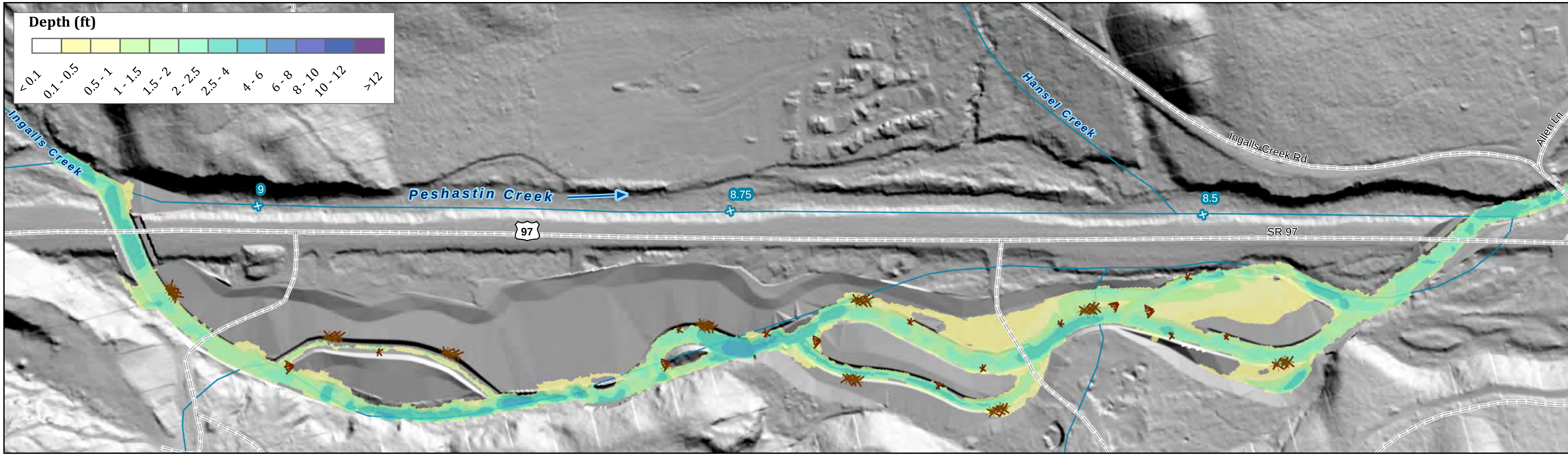
Natural Systems Design

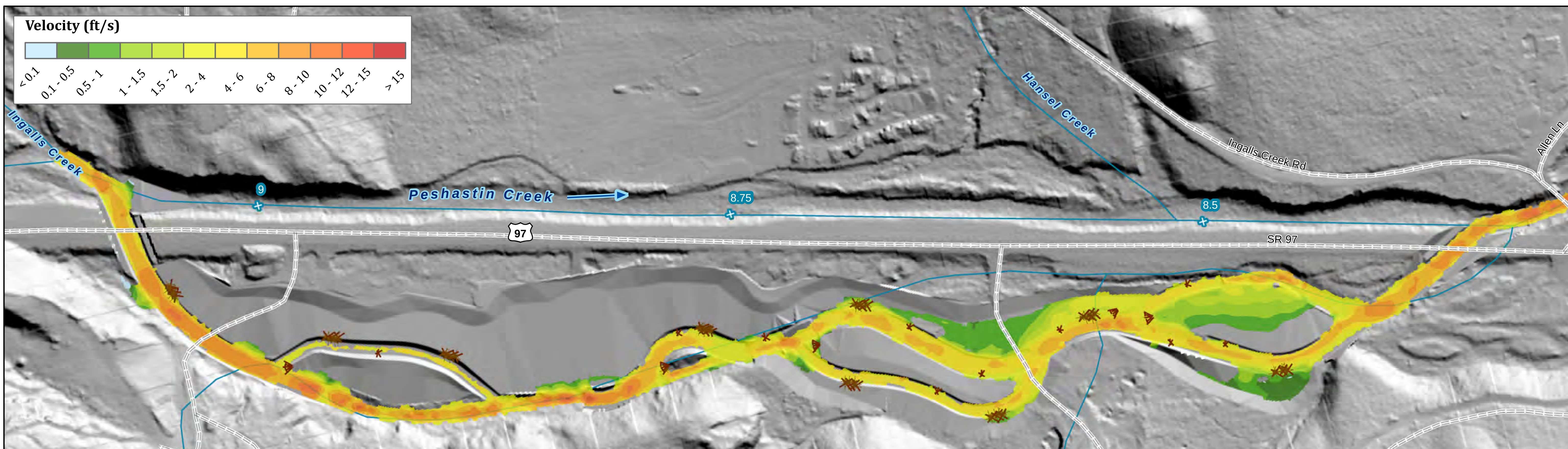
Project: Peshastin Creek RM 8.8
Project No: 0

Analyst: D.Devier, M. Hrachovec, P.E.
Latest Revision: 10/23/2015
Inflation to 2018 $ Included in Bid Items: 9%

Item #	Item Description	Quantity	Unit	Unit Price ($)	Amount ($)
1	Mobilization/ Demobilization (10% Maximum)	1	LS	$1,361,000	$1,361,000
2	Erosion/ Water Pollution Control Measures	1	LS	$93,000	$93,000
3	Stream Bypass	1	LS	$20,000	$20,000
4	Traffic Control & Bypass	1	LS	$497,000	$497,000
5	Removal of Structures and Obstructions	1	LS	$146,869	$146,869
6	Upstream Bridge [150 ft]	1	EA	$2,404,000	$2,404,000
7	Downstream Bridge [195 ft]	1	EA	$3,109,000	$3,109,000
8	Clearing and Grubbing	1	LS	$31,800	$31,800
9	Common Excavation	162,336	CY	$10	$2,581,142
10	Structural Excavation	3,799	CY	$35	$132,976
11	Channel Excavation	64,577	CY	$15	$1,540,154
12	Wood Structure [Type 1]	5	EA	$17,633	$88,166
13	Wood Structure [Type 2]	9	EA	$13,420	$120,776
14	Wood Structure [Type 3]	10	EA	$6,249	$62,487
15	Partial Channel Plug	1	LS	$376,487	$376,487
16	Wood Chips	1,866	CY	$45	$133,540
17	Revegetation [Riparian]	6	ac	$16,000	$152,430
18	Revegetation [Floodplain]	7	ac	$16,000	$168,782
19	Revegetation [Upland]	12	ac	$16,000	$311,868
20	Revegetation [Hydroseed - Dry Seedmix]	19	ac	$2,683	$240,415
21	Revegetation [Hydroseed - Wet Seedmix]	6	ac	$5,320	$50,683
	Constrution Sub-Total				$13,622,575
	Taxes (as % of Construction Sub-Total + Inflation)	8.2%			$1,117,051
	Total Estimated Construction Cost (rounded)				**$14,740,000**

APPENDIX C
HYDRAULIC MODEL OUTPUT GRAPHICS





David French, NSD Date: 10/22/2015 Path: N:\Projects\CCNRD\Peshastin Creek RM 8.8 Design\GIS\maps\mxd\Hydraulics\PC_2yr_Depth_Velocity.mxd

Peshastin Creek RM 8.8 Design

Proposed Condition Hydraulics - 2 yr Flow (900 cfs)

Hydronia RiverFlow-2D Plus GPU Hydraulic Model output for simulated proposed conditions.

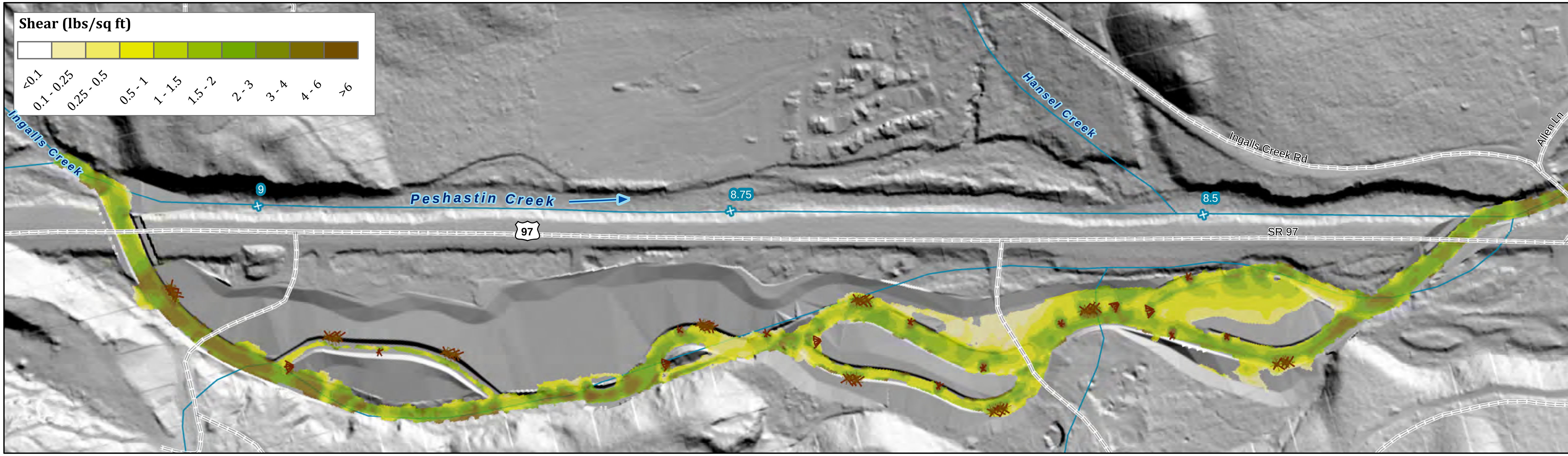
15 River Mile
Streams
Roads

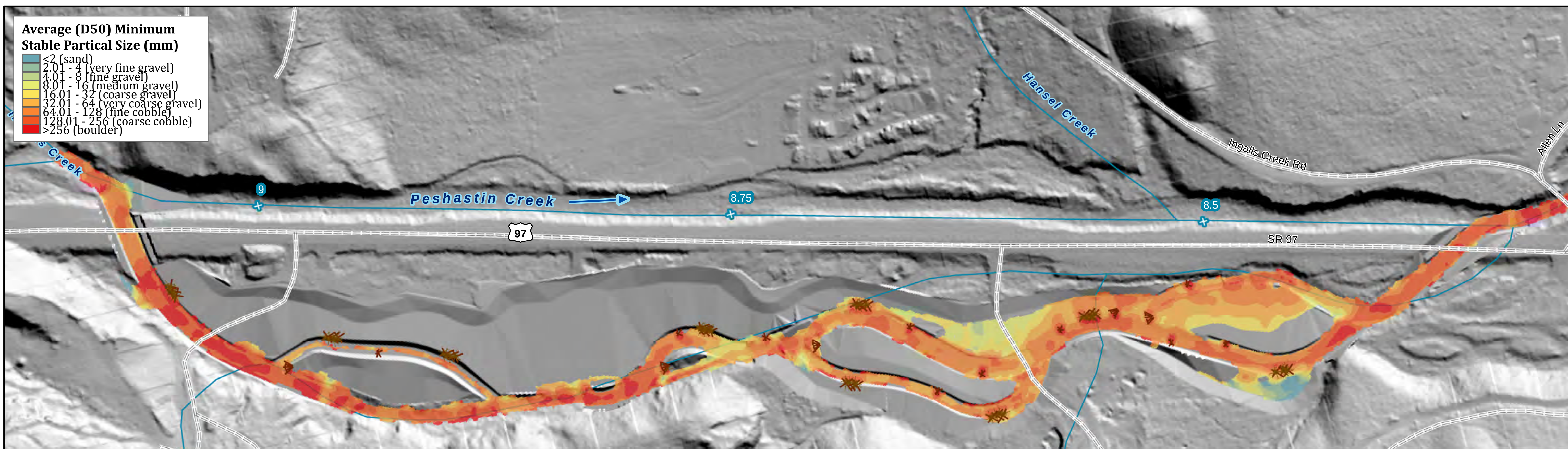
Type I ELJ
Type 2 ELJ
Type 3 ELJ

0 500 1,000 Feet

- Lambert conformal conic projection, NAD 1983 State Plane Coordinate System (WA North Zone)
- Topography: 2006 LIDAR DEM composite with C3D design surface (Puget Sound LIDAR Consortium, NSD).
- Streams and Roads: Chelan County DNR

Natural Systems Design





David French, NSD Date: 10/22/2015 Path: N:\Projects\CCNRD\Peshastin Creek RM 8.8 Design\GIS\maps\mxd\Hydraulics\PC_2yr_Shear_BedMobility.mxd

Peshastin Creek RM 8.8 Design

Proposed Condition Hydraulics - 2 yr Flow (900 cfs)

Hydronia RiverFlow-2D Plus GPU Hydraulic Model output for simulated proposed conditions.

15 River Mile

Streams

Roads

Type I ELJ

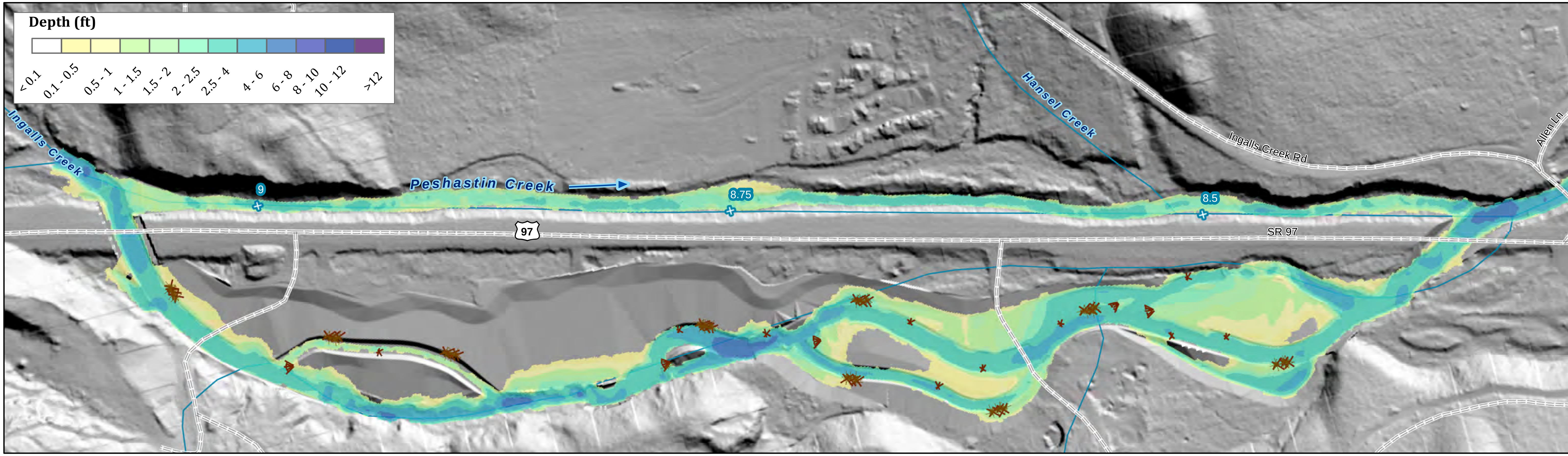
Type 2 ELJ

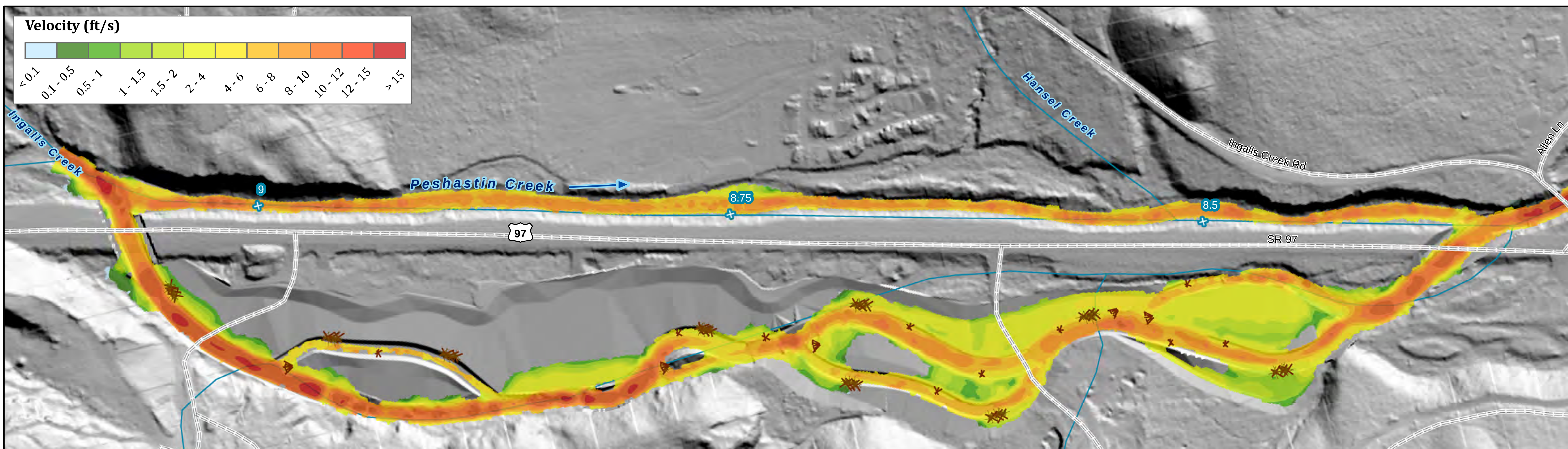
Type 3 ELJ

0 500 1,000 Feet

- Lambert conformal conic projection, NAD 1983 State Plane Coordinate System (WA North Zone)
- Topography: 2006 LIDAR DEM composite with C3D design surface (Puget Sound LIDAR Consortium, NSD).
- Streams and Roads: Chelan County DNR

Natural Systems Design





Peshastin Creek RM 8.8 Design

Proposed Condition Hydraulics - 100 yr Flow (3310 cfs)

Hydronia RiverFlow-2D Plus GPU Hydraulic Model output for simulated proposed conditions.

15 River Mile
Streams
Roads

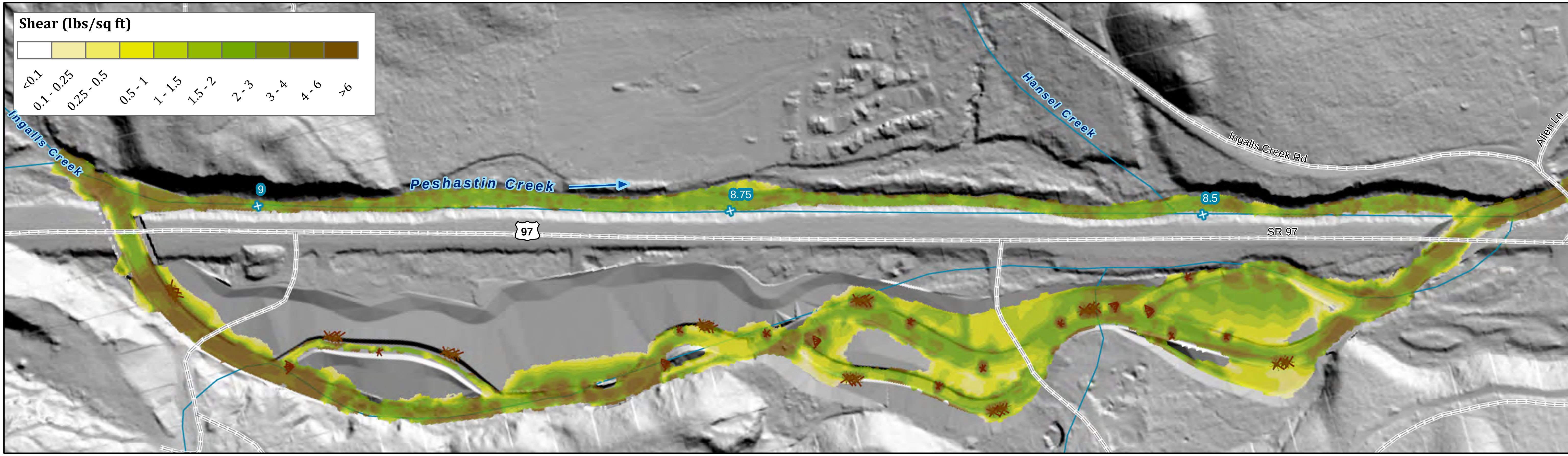
Type I ELJ
Type 2 ELJ
Type 3 ELJ

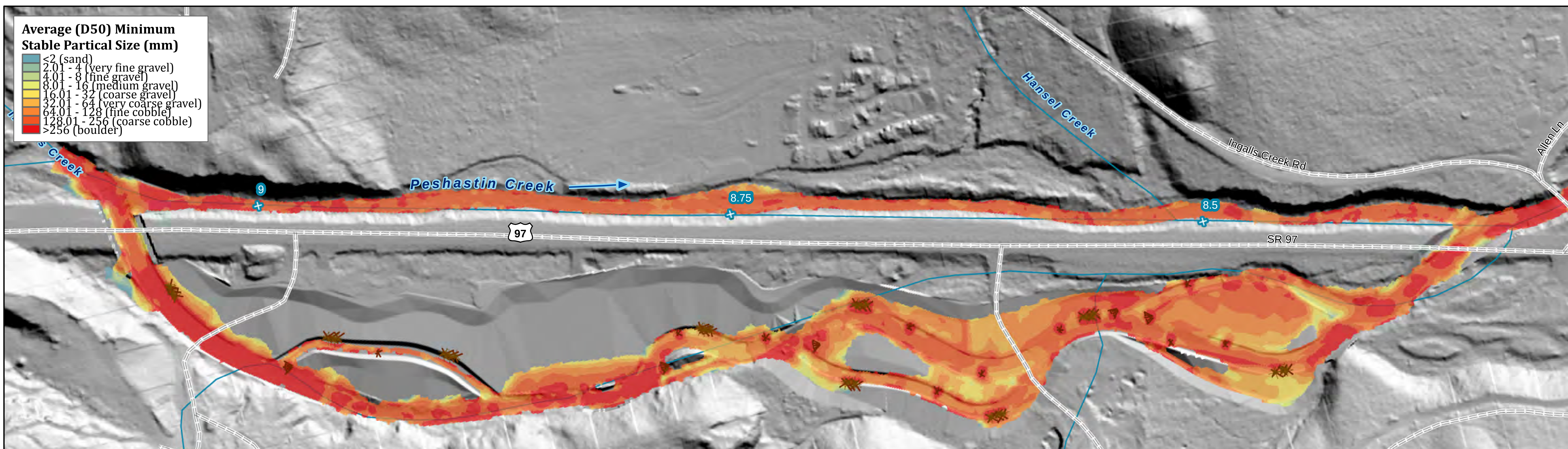
0 500 1,000 Feet

- Lambert conformal conic projection, NAD 1983 State Plane Coordinate System (WA North Zone)
- Topography: 2006 LIDAR DEM composite with C3D design surface (Puget Sound LIDAR Consortium, NSD).
- Streams and Roads: Chelan County DNR

Natural Systems Design

David French, NSD Date: 10/22/2015 Path: N:\Projects\CCNRD\Peshastin Creek RM 8.8 Design\GIS\maps\mxd\Hydraulics\PC_100yr_Depth_Velocity.mxd





David French, NSD Date: 10/22/2015 Path: N:\Projects\CCNRD\Peshastin Creek RM 8.8 Design\GIS\maps\mxd\Hydraulics\PC_100yr_Shear_BedMobility.mxd

Peshastin Creek RM 8.8 Design

Proposed Condition Hydraulics - 100 yr Flow (3310 cfs)

Hydronia RiverFlow-2D Plus GPU Hydraulic Model output for simulated proposed conditions.

15 River Mile
Streams
Roads
Type I ELJ
Type 2 ELJ
Type 3 ELJ

0 500 1,000 Feet

- Lambert conformal conic projection, NAD 1983 State Plane Coordinate System (WA North Zone)
- Topography: 2006 LIDAR DEM composite with C3D design surface (Puget Sound LIDAR Consortium, NSD).
- Streams and Roads: Chelan County DNR

Natural Systems Design