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TECHNICAL MEMORANDUM

Date: May 12, 2026

Project: Lewis County Wildwood MP 10.14 Scour Mitigation
To: Doug Sarkkinen, PE | Otak

From: Mike Zarecor, PE | Osborn Consulting
Monika Kaneshige, EIT | Osborn Consulting

cc:
Subject: Wildwood Hydraulic and Hydrology Report

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INTRODUCTION

Lewis County (County) is implementing a scour mitigation project at the Wildwood Road Bridge (MP 10.14) crossing of the South Fork of the Chehalis River. The goal of the project is to raise the existing structure's National Bridge Inspection (NBI) Code 113 Rating 3 – Scour Critical, up to 7 – Design Countermeasures Installed. Osborn Consulting, Inc. (Osborn) performed hydrologic, hydraulic, and scour analyses for the Wildwood Road Bridge crossing as part of this project. Project location and vicinity are shown below in Figure 1.

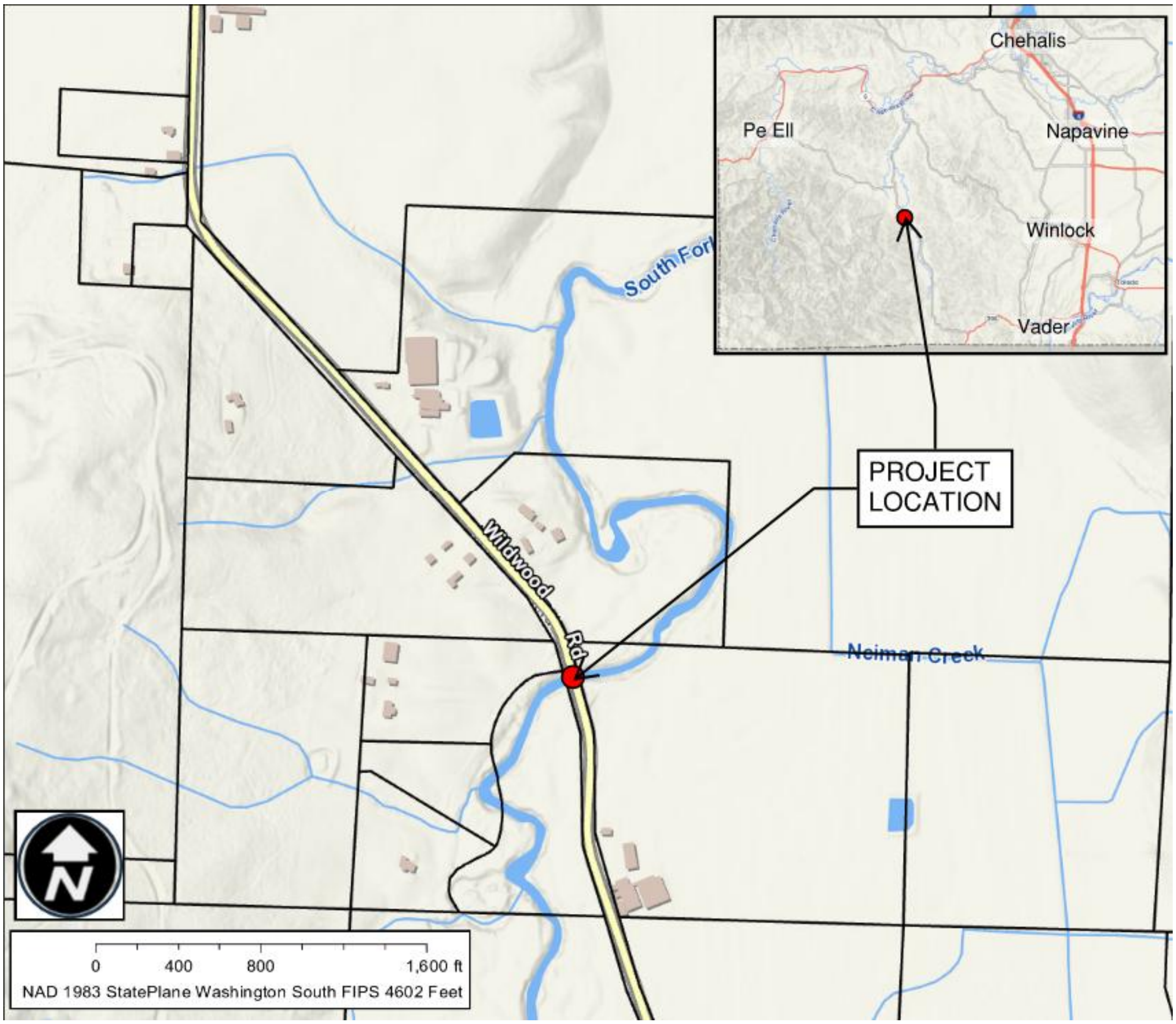

Figure 1: Project Vicinity Map (Lewis County GIS Web Map)

SECTION 1 HYDROLOGIC ANALYSIS

A hydrologic analysis of the South Fork of the Chehalis River at the project location was conducted to inform subsequent hydraulic modeling efforts. The methods for the analysis include regression equations from the United States Geological Survey (USGS) StreamStats application (USGS 2019), and use of the USGS Flood Q Ratio Tool. The report generated by StreamStats, including the regression equation flows, is provided in Appendix A. The Flood Q Ratio Tool uses gage data, statistical analysis, and regional regression equations to provide weighted estimates of flood discharges at the project location. The Flood Q Ratio Tool was used on three stream-flow gages in the vicinity of the project. Gages #12020800, #12020900, and #12021000, were analyzed and scaled using the tool. Inputs to the tool include the drainage areas of the gaged location (27.0, 45.2, and 48.1 square miles, respectively) and the drainage area of the project location (43.0 square miles) as well as the mean annual precipitation of the project basin (68.1 inches). The project drainage area and mean annual precipitation values are from the StreamStats report. The basin size for Gage #12020800 is out of the applicable range for which the drainage area adjustment is valid and therefore was not considered further. The drainage areas for Gages #12020900 and #12021000 were within the applicable range for which the drainage area adjustment is valid. Gage #12021000 was used instead of #12020900 as there is a longer period of record and the flows generated by the Flood Q Ratio Tool were more consistent with the flows from the StreamStats report. Gage #12021000 (South Fork Chehalis River at Boistfort, WA) flow estimates were used for hydraulic modeling. See Appendix B for the Flood Q Ratio Tool results. Estimated flood discharges for the South Fork Chehalis River at the Wildwood Bridge crossing are listed in Table 1.

Table 1. Peak Flows for the South Fork Chehalis River at the Wildwood Road Bridge Crossing

Gage # Analysis Tool	Flow Frequency Return Period					
	2-Year (cfs)	10-Year (cfs)	25-Year (cfs)	50-Year (cfs)	100-Year (cfs)	500-Year (cfs)
#12021000 Flood Q Ratio Tool	2,590	3,860	4,490	4,960	5,440	6,560

Notes:
cfs = cubic feet per second

SECTION 2 HYDRAULIC ANALYSIS

Hydraulic modeling was conducted using the United States Bureau of Reclamation's SRH-2D Version 3.3.1 computer program, a two-dimensional hydraulic and sediment transport numerical model (USBR, 2020). Pre- and post- processing for this model was included using the Surface-water Modeling System (SMS) version 13.4.2 (Aquaveo, 2025). Results from the hydraulic modeling were used in coordination with the FHWA Hydraulic Toolbox software version 5.4, specifically the Bridge Scour Analysis calculator (FHWA 2024a). Scour calculations are discussed in Section 3.

The existing condition and proposed condition scenarios were analyzed using SRH-2D simulations for each flow frequency. Model configuration including mesh qualities, roughness coefficients, and boundary conditions are discussed in the subsequent section.

2.1 Model Setup

Channel geometry data in the existing model was developed from topographic survey provided by Otak, which extended 300 feet upstream and 300 feet downstream of the Wildwood Road bridge. Supplemental topographic information sourced from the SWWA Foothills 2017 dataset on the Washington LiDAR Portal (USGS 2017) was merged with the survey to provide adequate model extents for larger flood simulations. The existing conditions mesh extends from approximately 300 feet upstream to approximately 300 feet downstream of the crossing. The channel bed, banks, and thalweg were modeled using patch-type (quadrilateral) elements to capture the more singular-directional flow. Areas outside of the channel were modeled using paving-type (triangular) elements. The existing bridge abutments and piers were modeled as holes in the mesh. There are two groups of seven cylindrical piers: one group on either side of the channel. The spacing between piers in a grouping is 3.2 feet, and the piers have a width of 1.1 feet. The spacing between piers is less than five times the width of an individual pier, therefore the two groups of seven piers were each modeled as two round-nosed piers (FHWA 2012). The existing model mesh is shown in Figure 2.

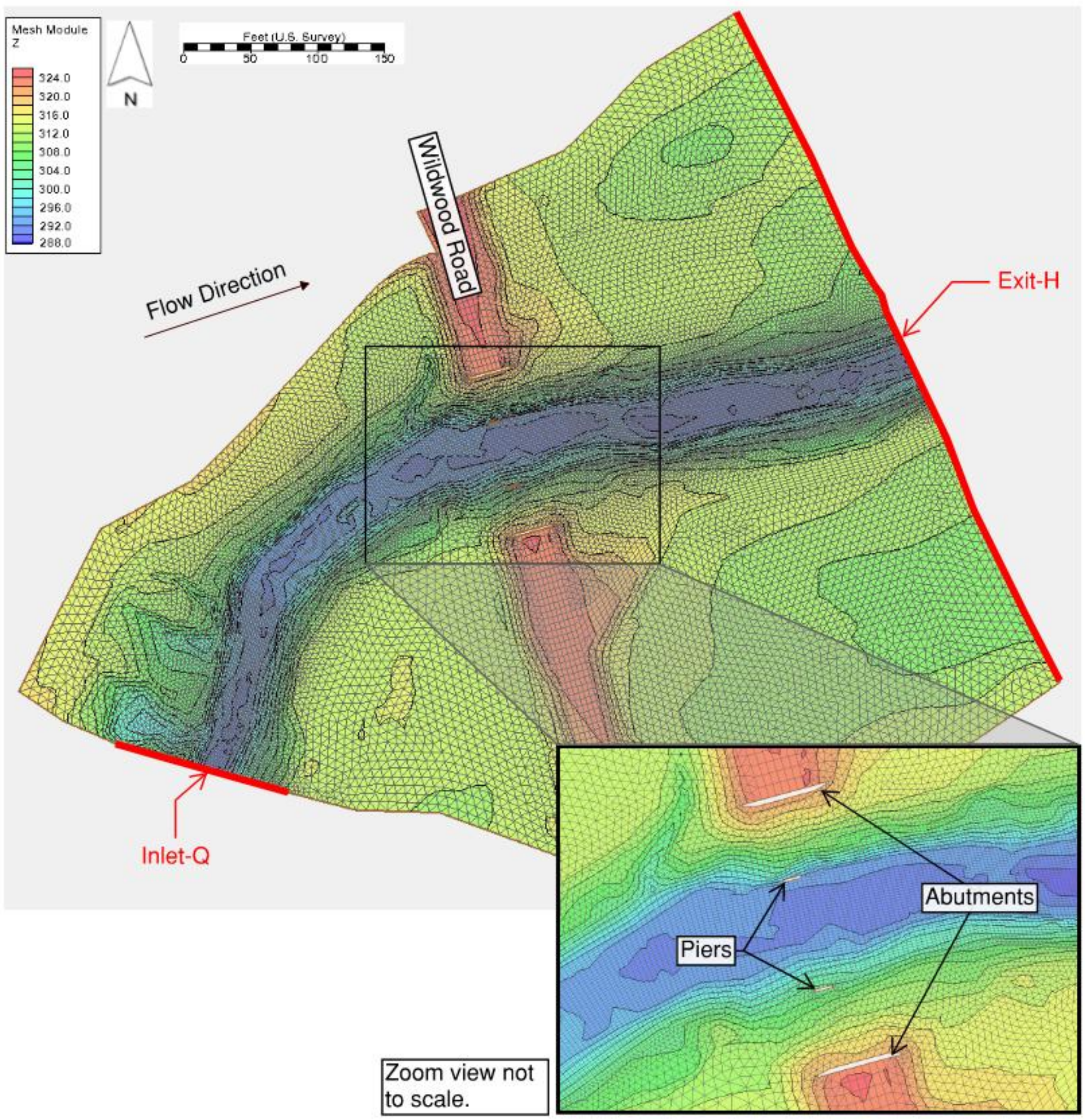

Figure 2: Existing conditions mesh and boundary conditions

Most properties of the proposed condition model were kept the same as existing condition, including mesh domain, element types, and existing abutments and piers represented as voids in the mesh. Differences are reflected in the proposed channel geometry, which was graded in Civil 3D. Proposed grading extends from about 75 feet upstream to 115 feet downstream from the center of the bridge. Mesh areas affected by the proposed grading were adjusted so that patch-type elements were in line with the proposed channel. The proposed model mesh is shown in Figure 3.

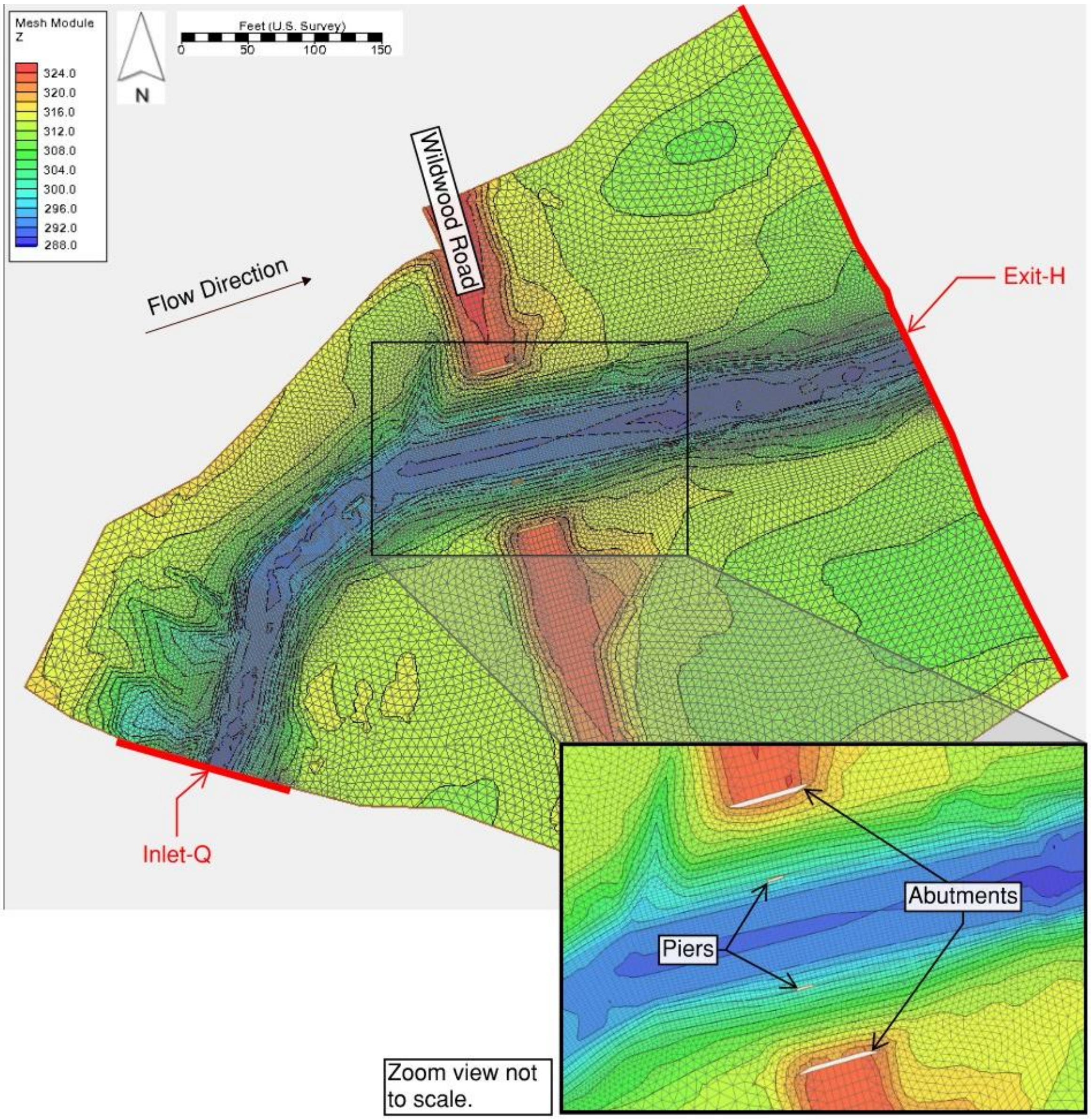

Figure 3: Proposed conditions mesh and boundary conditions

Boundary conditions were placed within survey limits. Inflow boundary conditions used the Inlet-Q (subcritical flow) type with a constant discharge and conveyance distribution at the inlet. Discharge values varied by design flow event. The 2-year, 10-year, 25-year, 50-year, 100-year, and 500-year flow events were simulated (see Table 1 for flood discharge values). Outflow boundary conditions used the Exit-H (subcritical outflow) type with an exit water surface elevation generated from a normal depth rating curve. The rating curve was populated using the following inputs: Manning's n = 0.045, slope = 0.00178 feet/foot, and flows ranging from 0 to 6,600 cfs. Boundary arc locations are shown in Figure 2 and Figure 3.

Hydraulic roughness within each model simulation is defined by Manning' n values. Material coverages, which define the spatial distribution of roughness values, were delineated for the existing-conditions model. The channel roughness coefficient was evaluated using the quasi-quantitative method (Arcement and Schneider 1989) in the Stream Channel Flow Resistance Coefficient Computation Tool (NSAEC 2018). Other material coverages including vegetated overbank, roadway, and agricultural land, were assigned Manning's n roughness coefficients estimated from Chow's *Open-Channel Hydraulics* (Chow 1959). For proposed conditions, the existing channel roughness is maintained, except in areas on the overbanks where riprap will be exposed. Manning's n values are listed in Table 2.

Table 2. Roughness Coefficients

Material	Manning's n
Existing Channel	0.45
Vegetated Overbank	0.08
Roadway	0.016
Agricultural Land	0.035
Riprap	0.033

2.2 Model Results

Hydraulic results for maximum channel depth, average channel velocity, and average channel shear stress were analyzed at representative cross section locations. Results were analyzed at seven cross section locations: three downstream (DS), one spanning the bridge, and three upstream (US). Maximum depth at DS 2+36 increased by approximately 1.4 feet due to changes to the streambed elevation in the proposed condition. This increase in depth does not indicate a water surface rise, see Section 2.3 for no-rise analysis. Cross section locations overlayed on the 100-year velocity dataset are shown below for existing and proposed conditions on Figure 4 and Figure 5, respectively. Main channel existing and proposed condition results are summarized in Table 3 and Table 4.

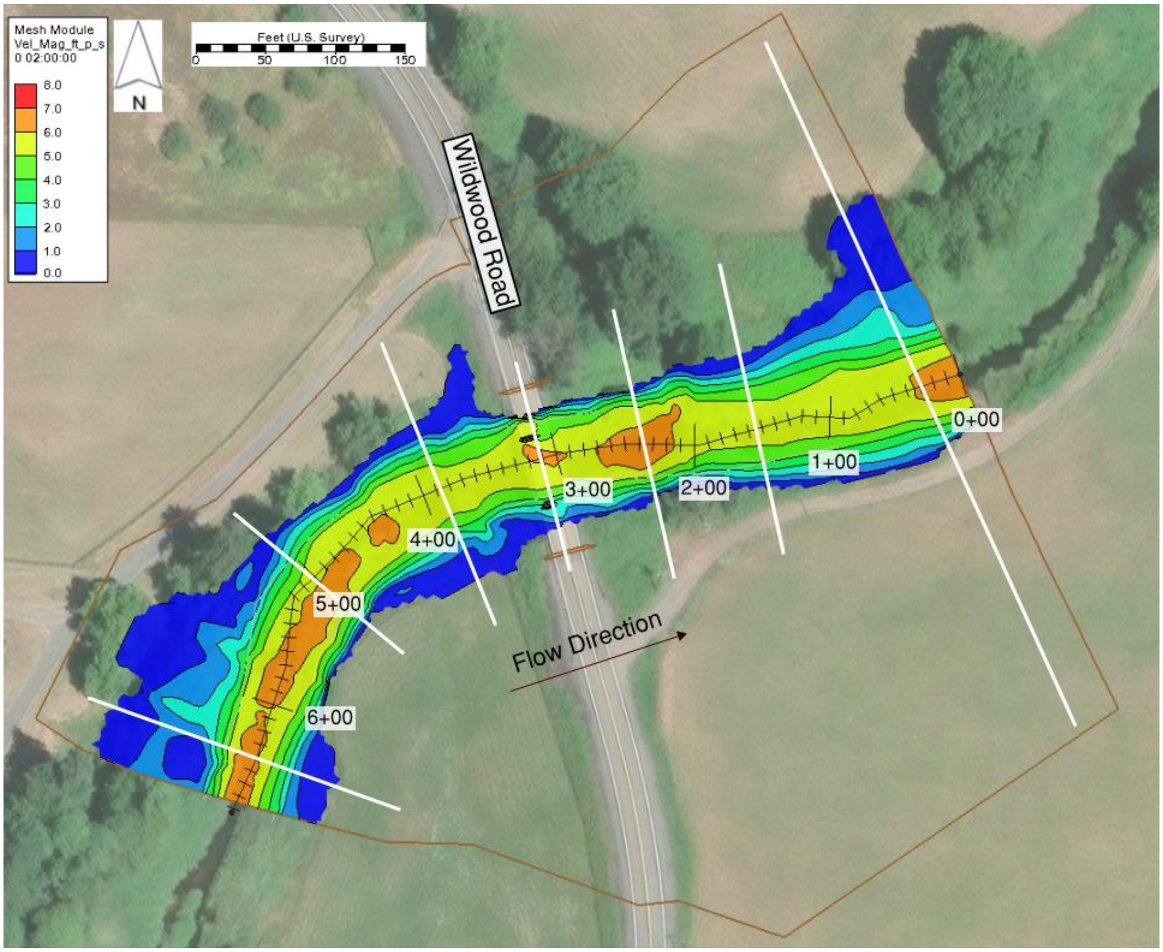

Figure 4: Existing conditions 100-year velocity dataset with locations of cross sections

Table 3. Existing Conditions Hydraulic Model Results

Hydraulic Parameter	Cross Section STA	2-Year	100-Year	500-Year
Max Depth (ft)	DS 0+29	14.9	21.0	21.9
	DS 1+53	15.6	21.6	22.5
	DS 2+36	14.1	20.0	21.0
	Structure 3+15	15.1	21.1	22.1
	US 3+86	15.0	21.1	22.1
	US 5+01	14.3	20.4	21.5
	US 6+40	15.6	21.9	23.0
Average Velocity (ft/s)	DS 0+29	5.2	5.9	6.4
	DS 1+53	3.6	4.9	5.6
	DS 2+36	4.7	5.9	6.7
	Structure 3+15	4.0	5.3	6.0
	US 3+86	4.1	5.1	5.7
	US 5+01	4.4	5.6	6.2
	US 6+40	4.3	5.1	5.6

Hydraulic Parameter	Cross Section STA	2-Year	100-Year	500-Year
Average Shear (lb/SF)	DS 0+29	0.7	0.8	0.9
	DS 1+53	0.4	0.5	0.7
	DS 2+36	0.6	0.8	1.0
	Structure 3+15	0.5	0.7	0.9
	US 3+86	0.4	0.6	0.7
	US 5+01	0.5	0.7	0.9
	US 6+40	0.6	0.6	0.7

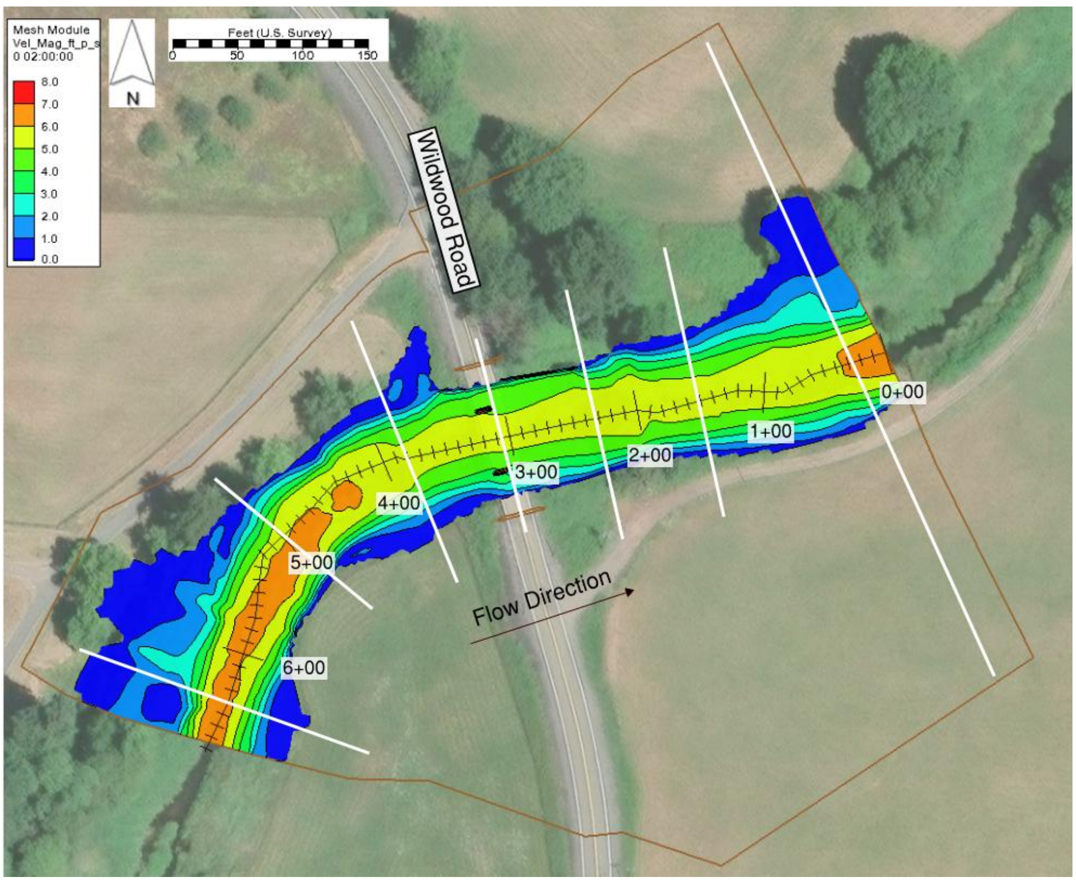

Figure 5: Proposed conditions 100-year velocity dataset with locations of cross sections

Table 4. Proposed Conditions Hydraulic Model Results

Hydraulic Parameter	Cross Section STA	2-Year	100-Year	500-Year
Max Depth (ft)	DS 0+29	14.9	21.0	21.9
	DS 1+53	15.5	21.5	22.4
	DS 2+36	15.4	21.4	22.4

Hydraulic Parameter	Cross Section STA	2-Year	100-Year	500-Year
	Structure 3+13	14.5	20.5	21.5
	US 3+85	14.8	20.9	21.9
	US 5+01	14.3	20.3	21.4
	US 6+40	15.6	21.8	22.9
Average Velocity (ft/s)	DS 0+29	5.2	5.9	6.4
	DS 1+53	3.7	4.9	5.6
	DS 2+36	3.8	5.0	5.6
	Structure 3+13	3.4	4.4	5.0
	US 3+85	3.8	4.9	5.5
	US 5+01	4.4	5.6	6.2
	US 6+40	4.3	5.2	5.7
Average Shear (lb/SF)	DS 0+29	0.7	0.8	0.9
	DS 1+53	0.4	0.5	0.7
	DS 2+36	0.4	0.6	0.8
	Structure 3+13	0.4	0.5	0.7
	US 3+85	0.4	0.6	0.7
	US 5+01	0.5	0.7	0.9
	US 6+40	0.6	0.6	0.8

2.3 100-Year Water Surface Elevation Comparison

This project is within FEMA Zone A Special Flood Hazard Area. Otak performed a 1D no-rise analysis of the project reach (see Appendix C). Results show that there is not an increase in the 100-year water surface elevation anywhere within the modeled project reach. Results are provided in Table 5.

Table 5. 1D No-Rise: 100-Year Average WSE Comparison

Cross Section STA	Existing WSE	Proposed WSE	WSE Difference[1]
US 6+15	312.2	312.0	-0.2
US 5+62	312.1	311.9	-0.2
US 5+00	312.0	311.9	-0.1
US 4+36	311.9	311.7	-0.2
US 3+65	311.8	311.7	-0.1
US 3+33	311.9	311.6	-0.3
DS 2+64	311.4	311.4	0.0
DS 2+39	311.4	311.4	0.0
DS 1+73	311.4	311.4	0.0
DS 1+03	311.2	311.2	0.0
DS 0+18	310.8	310.8	0.0

1. Difference is Proposed WSE minus Existing WSE.

SECTION 3 SCOUR ANALYSIS

3.1 Scour Results

Hydraulic model results were exported from the bridge scour coverage in SMS to the Hydraulic Toolbox Bridge Scour Calculator (FWHA 2024a). Placement of the bridge scour coverage arcs are shown in Figure 6. Contraction, pier, and abutment scour were evaluated for proposed conditions. All modeled flood events were evaluated to identify which flow produced the greatest amount of scour. Long-term degradation potential was evaluated separately.

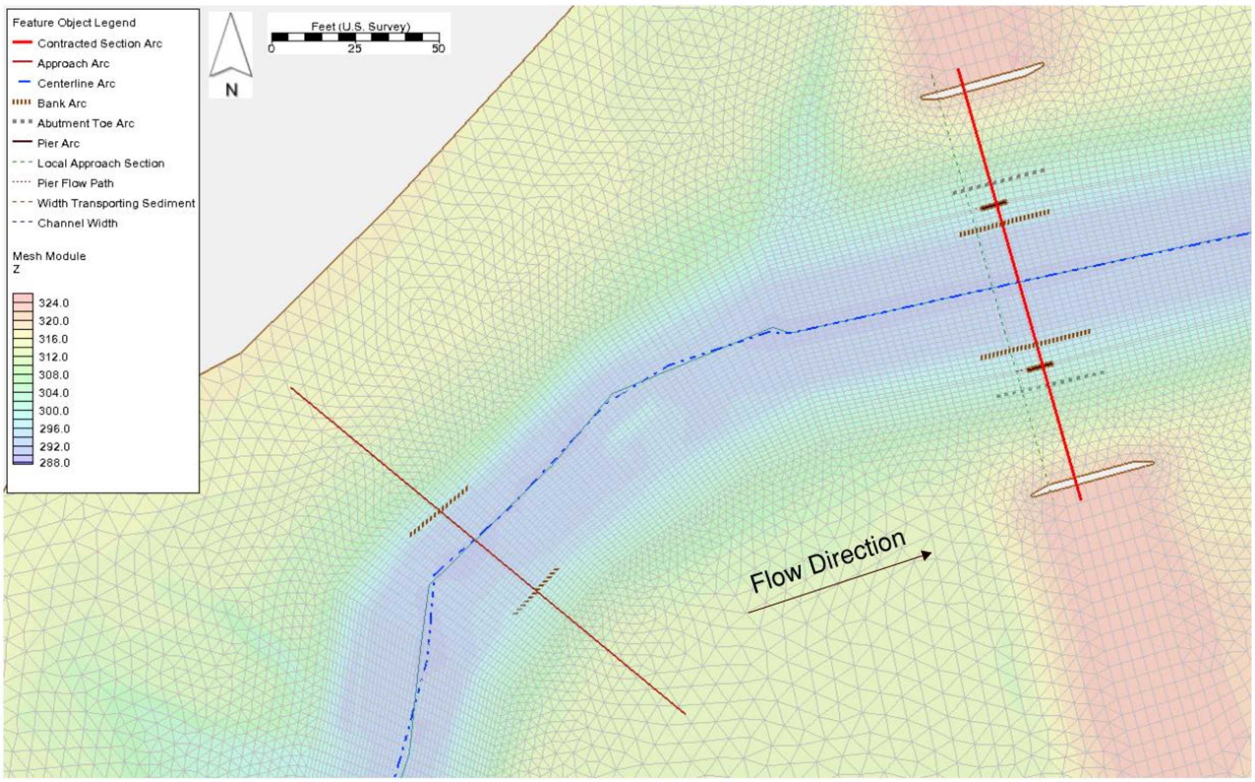

Figure 6: Bridge scour coverage arcs

There is no expected contraction scour for all flood events. Maximum abutment scour depths are expected to occur at the 500-year flow event with a value of 0.7 feet. Maximum pier scour is expected at the 500-year flow event with a scour depth of 5.2 feet.

Table 6. Scour Summary

Flood Frequency	Scour Type			
	Contraction (feet)	Pier #1 (feet)	Pier #2 (feet)	Abutment (1) (feet)
500-Year	0.0	**5.2(2)**	4.8	**0.7**
100-Year	0.0	4.9	4.7	0.0
50-Year	0.0	4.8	4.6	0.0
25-Year	0.0	4.7	4.6	0.0

Flood Frequency	Scour Type			
	Contraction (feet)	Pier #1 (feet)	Pier #2 (feet)	Abutment [1] (feet)
10-Year	0.0	5.0	4.5	0.0
2-Year	0.0	4.6	3.6	0.0

1. Abutment scour depths are the same for left and right abutment.
2. Bold values indicate maximum scour depth for each type of scour.

Long-term degradation potential is low because the South Fork Chehalis River has a flat slope with a large sediment supply. The cross section drawn on the original bridge plans from 1954 shows the thalweg to be approximately 34 feet below the bridge deck (see Appendix D). A cross section from the existing conditions mesh shows the thalweg approximately 33 feet below the bridge deck (see Figure 7). This 1-foot difference in thalweg elevation is likely due to short-term bed adjustments and shows no indication of long-term degradation occurring at this site since the existing bridge was built. Additionally, cross section data from the years 1993, 1996, 2017, and 2020 shows minor adjustments and no significant change in channel shape and elevation (see Figure 8).

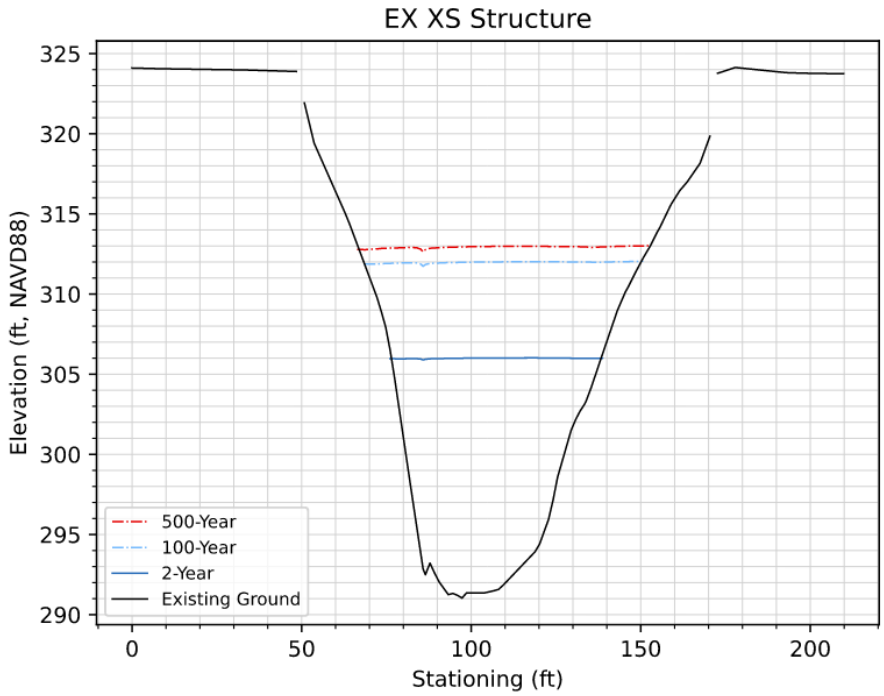

Figure 7: Existing (EX) cross section (XS) spanning the existing bridge with 2-year, 100-year, and 500-year water surface elevations

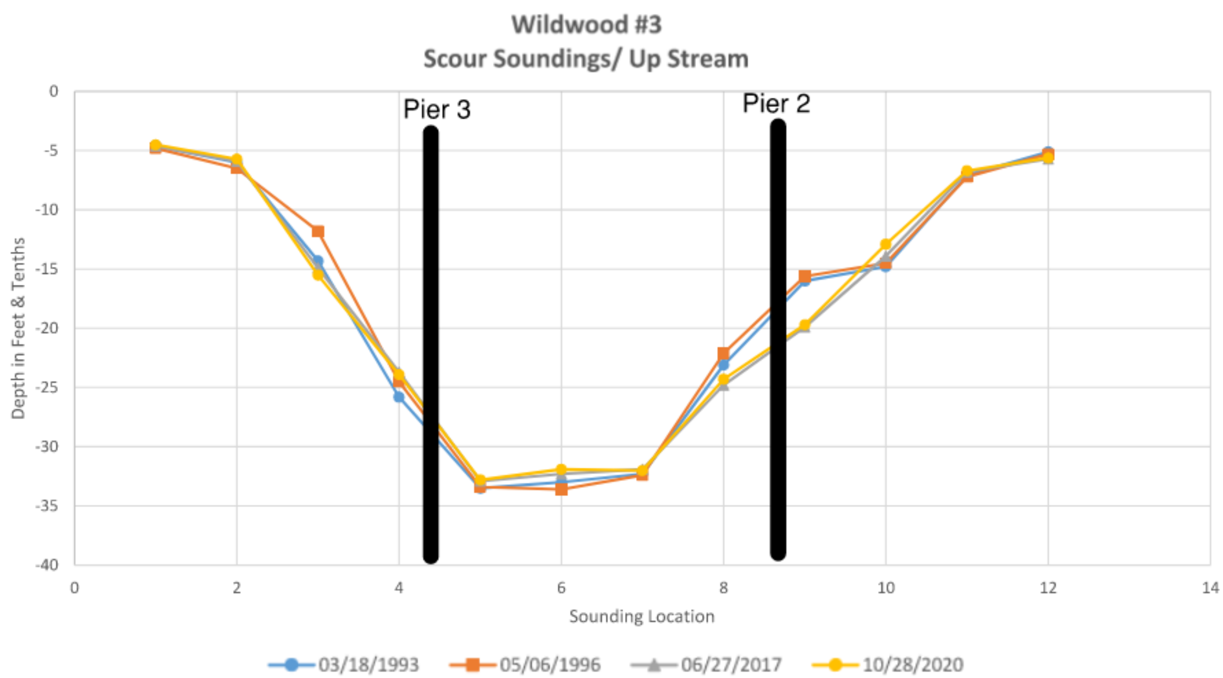

Figure 8: Historical Cross Section Data

3.2 Scour Countermeasure Design

Scour countermeasures were designed using the hydraulic and scour results described above in Section 2 and Section 3. Proposed designs are detailed in this section and plans are included in Appendix E.

3.2.1 Material Sizing

The scour countermeasure rock class was calculated using the Federal Highway Administration's (FHWA) HEC-23: Bridge Scour and Stream Instability Countermeasures Experience, Selection, and Design Guidance Volume 2 (HEC 23 V2), Equation 4.1 (FHWA 2009). The inputs and results of this calculation are provided in Appendix F. A conservative factor of safety of 2.0 was used in the calculations. Based on these calculations the D_{30} and D_{50} of the proposed rock material must be greater than 1.0 and 1.2 feet, respectively, and therefore will be sized per the Washington State Department of Transportation (WSDOT) Standard Specification 9-13.4(2) Rock for Erosion and Scour Protection Class B (WSDOT 2025).

Pier scour material sizing was evaluated separately using equations 11.1 and 11.3 from HEC 23 V2, and the results are presented in Appendix G. The results indicate Rock for Erosion and Scour Protection Class A could be used for pier protection, however, since the piers are located within the revetment Rock for Erosion and Scour Protection Class B will be utilized everywhere within the countermeasure footprint.

3.2.2 Layout

Layout of the revetment and aprons was performed using the FHWA Hydraulic Considerations of Abutments on Deep Foundations and Bridge Embankment Protection Tech Brief (TechBrief) (FHWA 2023) as well as recommendations from HEC 23 V2 Design Guidelines 4 & 11 (FHWA 2009). Figure 9, Figure 10, Figure 11, and Figure 12 illustrate the suggested countermeasure extents from the three guidelines. Proposed plan and section views are shown in Appendix E.

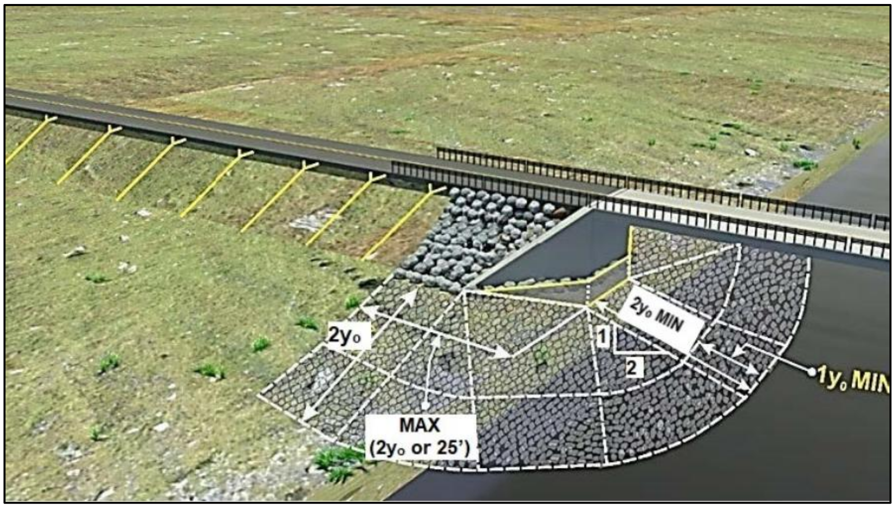

Figure 9: Countermeasure extents (y_o = main channel flow depth through the bridge) (TechBrief)

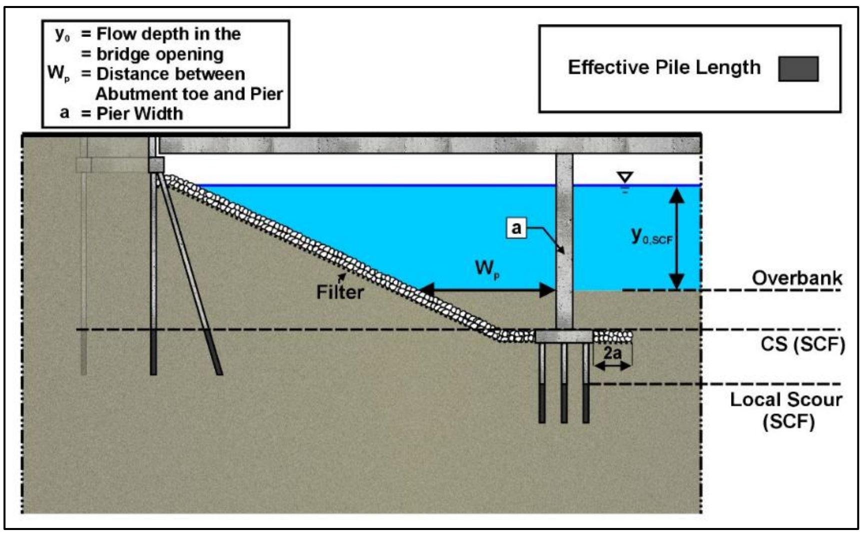

Figure 10: Countermeasure for scour condition B and a closely located pier (TechBrief)

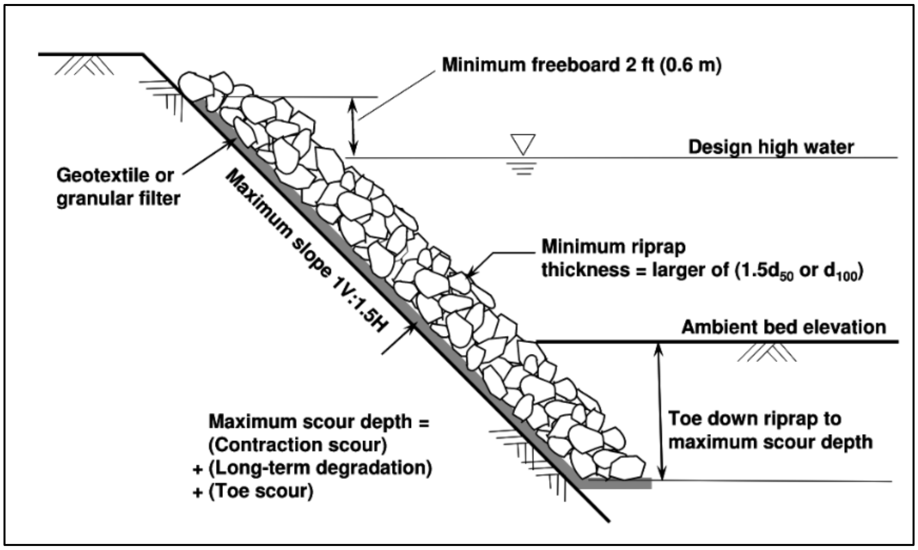

Figure 11: Riprap revetment with buried toe (HEC 23 V2 Design Guideline 4)

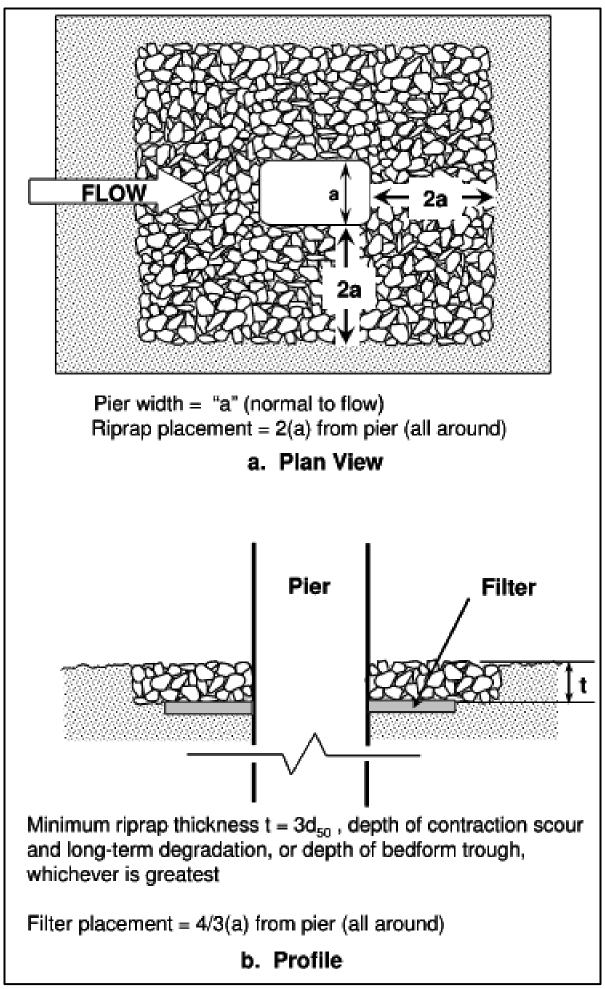

Figure 12: Riprap layout diagram for pier scour protection (HEC 23 V2 Design Guideline 11)

The design incorporates elements from several of the recommended scour countermeasure treatments shown above, while accommodating project requirements, site constraints, constructability, and cost considerations.

1. 1.5H:1V slopes were used for the revetment design, as the proposed rock for erosion and scour protection material can sustain that slope.

2. The top of the countermeasure provides 2 feet of freeboard over the 500-year water surface elevation.

3. The proposed revetment and apron do not extend out from the abutment parallel to the roadway at the countermeasure design depth. The cross sections shown in Figure 6 indicate that over the last 30 years there has not been channel migration at the crossing. Furthermore, review of Google Earth Aerial Imagery indicates there has been limited to no change in channel alignment since 1990 within 500 feet of the bridge structure. Lateral migration of streams generally occurs at bends and progresses from upstream to downstream. The scour countermeasure and bridge structure will prevent lateral migration downstream of the structure.

   Upstream of the structure, the banks are vegetated and appear stable. The nearest river bend that could progress towards the roadway embankment on the right side of the channel is approximately 600 feet upstream which is sufficiently far upstream to ensure the structure should not be impacted within its design life. On the left side of the structure, the bank is on the outside of a slight bend with a radius of curvature of approximately 180 feet. This is approximately 3 times the bankfull width, indicating the curve is a slight curve, with minimal additional erosive potential. Additionally, LWM will be installed at the toe of the bank to improve bank stability. To be conservative, the rock thickness on the upstream left bank was increased from 3 feet to 6 feet

4. The toe of the revetment and the apron was extended further below the channel grade than required to provide for placement of streambed material above the countermeasure. Placing streambed material above the countermeasure is beneficial from a habitat and project permitting perspective and will not negatively impact the effectiveness of the countermeasure.

5. Design Guideline 11 recommends that rock pier protection be installed at the surface to facilitate inspection. In this case since the piers are located near the abutments, the proposed pier protection would be installed as shown in the TechBrief.

6. HEC-23 guidance for pier protection requires Class A rock with a thickness of 3 feet. The guidance for revetments requires Class B rock with a thickness of 3 feet. The proposed protection measures were sized per the revetment guidance, which equals the thickness required for pier protection, but with a larger rock size.

SECTION 4 STREAM BYPASS SIZING

The conceptual stream diversion plan in Appendix E includes a gravity bypass pipe. Maximum mean daily flows for the USGS Gage #12021000 during the date range from July 15th to September 30th were used to estimate expected flow during construction. The average flow was approximately 31 cfs, and a factor of safety of 2 was applied due to the age of the stream gage data and uncertainty around determining the base flow. The maximum flow in the summer gage data was 118 cfs, but to be conservative, 5 percent of the 2-year flood event was used as the maximum summer flow instead. The summer base flow of 62 cfs, and maximum summer flow of 130 cfs were used to size the diversion pipe(s).

HY-8 (FWHA 2024b) was used to determine a suitable diversion pipe size for the average flow of 62cfs. A single 3.5-foot diameter high-density polyethylene (HDPE) pipe would be sufficient to convey this flow with an upstream cofferdam height of approximately 5.0 feet. To convey the maximum daily peak flow of 130 cfs, two 3.5-foot diameter HDPE pipes in parallel would be needed with an upstream cofferdam height of approximately 6.0 feet. See key HY-8 inputs, resulting headwater depths, and resulting cofferdam heights summarized in Table 7.

Table 7. Stream Bypass Sizing

Bypass Pipe(s) (quantity, size)	Discharge (cfs)	Headwater Depth (ft)	Cofferdam Height Upstream (ft)[1]	Tailwater Depth (ft)	Cofferdam Height Downstream (ft)[1]
One, 3.5-ft diameter	62.0	4.0	5.0	1.9	3.0
Two, 3.5-ft diameter (in parallel)	130.0	4.2	6.0	2.8	4.0

1 Cofferdam height is the difference between headwater or tailwater elevation and thalweg elevation, rounded up, plus 1-foot.

SECTION 5 CONCLUSION

The hydrologic and hydraulic analyses of the project site were used to develop a scour countermeasure design which is expected to provide protection to the piers and abutments of the existing Wildwood Road Bridge. Installing this countermeasure would reach the project goal of raising the NCI Code rating for this bridge to a 7 - Design Countermeasures Installed.

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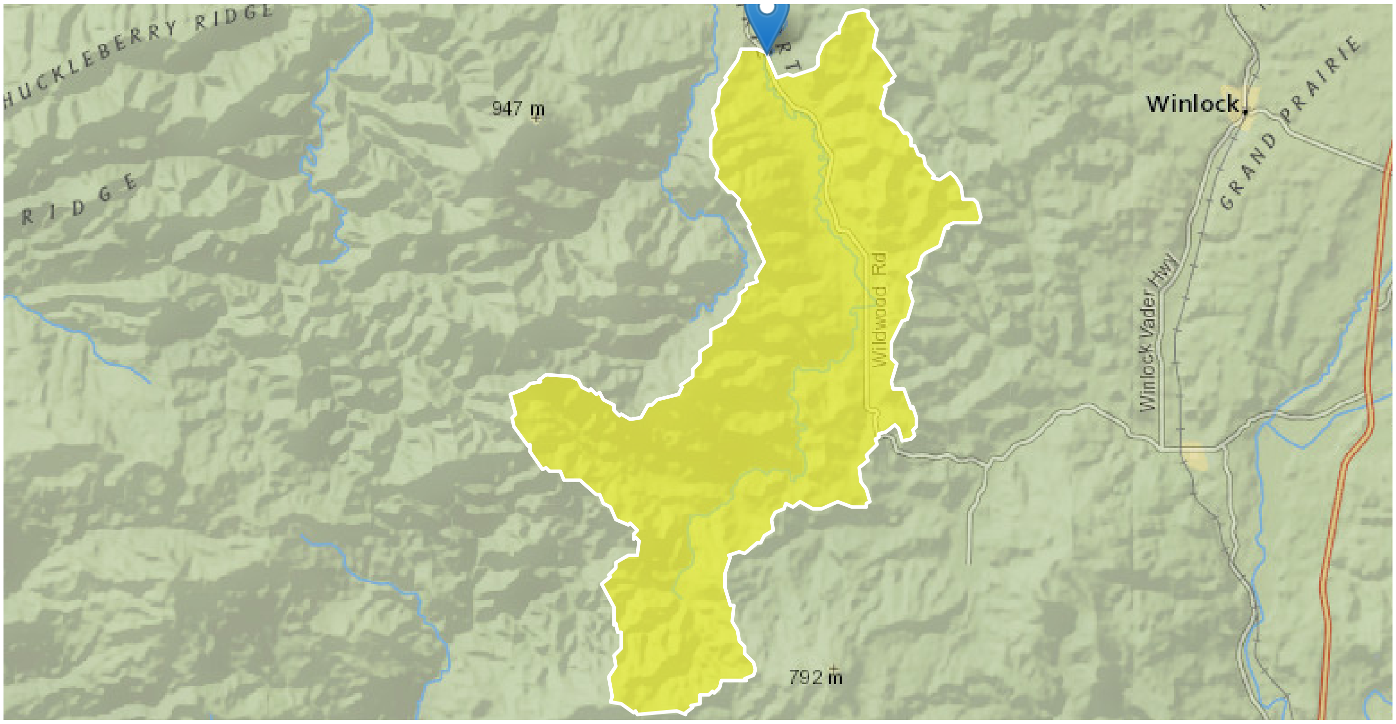
Attachments: **Appendix A: StreamStats Report**
Appendix B: Flood Q Ratio Tool
Appendix C: No-Rise Analysis
Appendix D: Original Bridge Plans (1954)
Appendix E: Proposed Plans
Appendix F: Revetment Rock Sizing Calculations
Appendix G: Pier Rock Sizing Calculations

Appendix A: StreamStats Report

Appendix A: StreamStats Report

StreamStats Report

Region ID: WA
Workspace ID: WA20240610164449556000
Clicked Point (Latitude, Longitude): 46.50588, -123.12153
Time: 2024-06-10 09:45:24 -0700



Collapse All

Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
DRNAREA	Area that drains to a point on a stream	42.95	square miles
PRECPRIS10	Basin average mean annual precipitation for 1981 to 2010 from PRISM	68.1	inches

Peak-Flow Statistics

Peak-Flow Statistics Parameters [Peak Region 4 2016 5118]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	42.95	square miles	0.18	2230
PRECPRIS10	Mean Annual Precip PRISM 1981 2010	68.1	inches	11.9	187

Peak-Flow Statistics Flow Report [Peak Region 4 2016 5118]

PIL: Lower 90% Prediction Interval, PIU: Upper 90% Prediction Interval, ASEp: Average Standard Error of Prediction, SE: Standard Error, PC: Percent Correct (other -- see report)

Statistic	Value	Unit	PIL	PIU	ASEp
50-percent AEP flood	1480	ft^3/s	328	6670	52.5
20-percent AEP flood	2360	ft^3/s	537	10400	50.6
10-percent AEP flood	3060	ft^3/s	684	13700	50.5
4-percent AEP flood	3960	ft^3/s	834	18800	51.7
2-percent AEP flood	4690	ft^3/s	937	23500	52.9
1-percent AEP flood	5460	ft^3/s	1040	28700	54.2
0.5-percent AEP flood	6160	ft^3/s	1110	34100	55.5
0.2-percent AEP flood	7330	ft^3/s	1220	44000	58

Peak-Flow Statistics Citations

Mastin, M.C., Konrad, C.P., Veilleux, A.G., and Tecca, A.E.,2016, Magnitude, frequency, and trends of floods at gaged and ungaged sites in Washington, based on data through water year 2014 (ver 1.1, October 2016): U.S. Geological Survey Scientific Investigations Report 2016–5118, 70 p. (http://dx.doi.org/10.3133/sir20165118)

Application Version: 4.20.1

StreamStats Services Version: 1.2.22

NSS Services Version: 2.2.1

Appendix B: Flood Q Ratio Tool

Appendix B: Flood Q Ratio Tool

Gage #12021000

Flood Q Ratio Tool. Estimates of flood discharge for an ungaged sites in Washington State using the Drainage-Area Ratio Method

Station Index= 24

A_u, contributing drainage area of ungaged site; A_g, contributing drainage area of the streamflow gaging site; $Q_{(u)g}$, gage-based estimate of flood discharge in cubic feet per second at ungaged site; $Q_{(u)wtd}$, weighted estimate of flood discharge in cubic feet per second for the ungaged site and indicated streamflow characteristic; $Q_{(u)reg}$, regression estimate of flood discharge in cubic feet per second for ungaged site; Q(g)wtd, weighted estimate of flood discharge for streamgaging station]

Instructions for estimating streamflow characteristics at an ungaged site using the Drainage-Area Ratio Method

Steps	Instructions
1	Select a streamflow-gaging station from the list box below which is on the same stream as the ungaged site.
2	Determine contributing drainage area for ungaged site (A_u, in square miles) and enter value in the green cell (F12), where $0.5A_g \le A_u \le 1.5A_g$. If the drainage area is outside the appropriate range, the cell will turn red. An initial estimate of the flood discharges will be computed in column G, rows 23 to 30.
3	The estimates will be improved by computing weighted estimates using the regional regression estimates. To do this, enter the Mean Annual Precipitation in the green box (column I, row x). If the site is in regression region 1 or 2, enter the percent canopy coverage for the ungaged basin in the green box (column I, row x). If either of these values are outside the acceptible range, the cell will turn red.
4	The final answer, the weighted estimates of flood discharge ($Q_{(u)wtd}$), will be listed in column G, rows 37-44.

12009500 BEAR BRANCH NEAR NASELLE, WA
12010000 NASELLE RIVER NEAR NASELLE, WA
12010500 SALMON CREEK NEAR NASELLE, WA
12010600 LANE CREEK NEAR NASELLE, WA
12010700 SOUTH FORK NASELLE RIVER NEAR NASELLE, WA
12010800 SOUTH NEMAH RIVER NEAR NASELLE, WA
12011000 NORTH NEMAH RIVER NEAR SOUTH BEND, WA
12011100 NORTH NEMAH RIVER TRIBUTARY NEAR SOUTH BEND, WA
12011200 WILLIAMS CREEK NEAR SOUTH BEND, WA
12011500 WILLAPA RIVER AT LEBAM, WA
12012000 FORK CREEK NEAR LEBAM, WA
12012200 GREEN CREEK NEAR LEBAM, WA
12013500 WILLAPA RIVER NEAR WILLAPA, WA
12014500 SOUTH FORK WILLAPA RIVER NEAR RAYMOND, WA
12015100 CLEARWATER CREEK NEAR RAYMOND, WA
12015500 NORTH RIVER NEAR BROOKLYN, WA
12016700 JOE CREEK NEAR COSMOPOLIS, WA
12017000 NORTH RIVER NEAR RAYMOND, WA
12019600 WATER MILL CREEK NEAR PE ELL, WA
12020000 CHEHALIS RIVER NEAR DOTY, WA
12020500 ELK CREEK NEAR DOTY, WA
12020800 SOUTH FORK CHEHALIS RIVER NEAR WILDWOOD, WA
12020900 SOUTH FORK CHEHALIS RIVER NEAR BOISTFORT, WA
12021000 SOUTH FORK CHEHALIS RIVER AT BOISTFORT, WA

Estimates of streamflow characteristics based on Drainage-Area Ratio method

Contributing drainage areas of the streamflow-gaging station (A_g) and ungaged site (A_u), located on the same stream				Range of drainage areas for which drainage area adjustment is valid
Drainage area of selected index site, A_g	=	48.1	square miles	--
Drainage area of ungaged location, A_u	=	42.95	square miles	24.1 - 72.2

	Station Number	Number of Years of Record
Selected Streamflow-gaging Station:	12021000	21

Regression Region: 4

Initial estimate of Flood Discharges at ungaged site, Q_u (eq. 10)

AEP		$Q_{(g)wtd}$	$Q_{(u)g}$, ft³/s
0.5	=	3,210.0	2,893.7
0.2	=	4,020.0	3,623.1
0.1	=	4,520.0	4,072.8
0.04	=	5,140.0	4,629.8
0.02	=	5,590.0	5,034.0
0.01	=	6,030.0	5,429.6
0.005	=	6,470.0	5,824.5
0.002	=	7,050.0	6,344.5

$2(|A_g-A_u|)/A_g=$ 0.215250364

Regression Region: 4

Weighted estimate of Flood Discharge at ungaged site, using regression estimate, $Q_{(u)wtd}$ (eq. 11)

AEP		$Q_{(u)reg}$	*$Q_{(u)wtd}$
0.5	=	1,481.7	2590
0.2	=	2,363.2	3350
0.1	=	3,061.3	3860
0.04	=	3,963.9	4490
0.02	=	4,689.8	4960
0.01	=	5,462.1	5440
0.005	=	6,157.2	5900
0.002	=	7,325.8	6560

*rounded to 3 significant figures

Used in hydraulic analysis

Basin Characteristics for Regional Regression Estimate, $Q_{(u)reg}$

		Applicable Range
Enter Mean Annual Precipitation of ungaged basin=	68.1	11.94 - 186.6
If ungaged location is in regression region 1 or 2, enter percent canopy coverage=	0.8	not applicable

Gage #12020900

Not Used

Flood Q Ratio Tool. Estimates of flood discharge for an ungaged sites in Washington State using the Drainage-Area Ratio Method

Station Index= 23

A_u, contributing drainage area of ungaged site; A_g, contributing drainage area of the streamflow gaging site; $Q_{(u)g}$, gage-based estimate of flood discharge in cubic feet per second at ungaged site; $Q_{(u)wtd}$, weighted estimate of flood discharge in cubic feet per second for the ungaged site and indicated streamflow characteristic; $Q_{(u)reg}$, regression estimate of flood discharge in cubic feet per second for ungaged site; Q(g)wtd, weighted estimate of flood discharge for streamgaging station]

Instructions for estimating streamflow characteristics at an ungaged site using the Drainage-Area Ratio Method

Steps	Instructions
1	Select a streamflow-gaging station from the list box below which is on the same stream as the ungaged site.
2	Determine contributing drainage area for ungaged site (A_u, in square miles) and enter value in the green cell (F12), where $0.5A_g \leq A_u \leq 1.5A_g$. If the drainage area is outside the appropriate range, the cell will turn red. An initial estimate of the flood discharges will be computed in column G, rows 23 to 30.
3	The estimates will be improved by computing weighted estimates using the regional regression estimates. To do this, enter the Mean Annual Precipitation in the green box (column I, row x). If the site is in regression region 1 or 2, enter the percent canopy coverage for the ungaged basin in the green box (column I, row x). If either of these values are outside the acceptible range, the cell will turn red.
4	The final answer, the weighted estimates of flood discharge ($Q_{(u)wtd}$), will be listed in column G, rows 37-44.

12009500 BEAR BRANCH NEAR NASELLE, WA
12010000 NASELLE RIVER NEAR NASELLE, WA
12010500 SALMON CREEK NEAR NASELLE, WA
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12010700 SOUTH FORK NASELLE RIVER NEAR NASELLE, WA
12010800 SOUTH NEMAH RIVER NEAR NASELLE, WA
12011000 NORTH NEMAH RIVER NEAR SOUTH BEND, WA
12011100 NORTH NEMAH RIVER TRIBUTARY NEAR SOUTH BEND, WA
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12011500 WILLAPA RIVER AT LEBAM, WA
12012000 FORK CREEK NEAR LEBAM, WA
12012200 GREEN CREEK NEAR LEBAM, WA
12013500 WILLAPA RIVER NEAR WILLAPA, WA
12014500 SOUTH FORK WILLAPA RIVER NEAR RAYMOND, WA
12015100 CLEARWATER CREEK NEAR RAYMOND, WA
12015500 NORTH RIVER NEAR BROOKLYN, WA
12016700 JOE CREEK NEAR COSMOPOLIS, WA
12017000 NORTH RIVER NEAR RAYMOND, WA
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12020800 SOUTH FORK CHEHALIS RIVER NEAR WILDWOOD, WA
12020900 SOUTH FORK CHEHALIS RIVER NEAR BOISTFORT, WA
12021000 SOUTH FORK CHEHALIS RIVER AT BOISTFORT, WA

Estimates of streamflow characteristics based on Drainage-Area Ratio method

Contributing drainage areas of the streamflow-gaging station (A_g) and ungaged site (A_u), located on the same stream				Range of drainage areas for which drainage area adjustment is valid
Drainage area of selected index site, A_g	=	45.2	square miles	--
Drainage area of ungaged location, A_u	=	42.95	square miles	22.6 - 67.9

	Station Number	Number of Years of Record
Selected Streamflow-gaging Station:	12020900	15

Regression Region: 4

Initial estimate of Flood Discharges at ungaged site, Q_u (eq. 10)

AEP		$Q_{(g)wtd}$	$Q_{(u)g}$, ft³/s
0.5	=	2,800.0	2,670.6
0.2	=	4,070.0	3,881.5
0.1	=	4,950.0	4,720.2
0.04	=	6,110.0	5,825.5
0.02	=	7,000.0	6,673.3
0.01	=	7,920.0	7,550.0
0.005	=	8,860.0	8,445.2
0.002	=	10,200.0	9,721.0

$2(|A_g-A_u|)/A_g=$ 0.101237843

Regression Region: 4

Weighted estimate of Flood Discharge at ungaged site, using regression estimate, $Q_{(u)wtd}$ (eq. 11)

AEP		$Q_{(u)reg}$	$*Q_{(u)wtd}$
0.5	=	1,481.7	2550
0.2	=	2,363.2	3730
0.1	=	3,061.3	4550
0.04	=	3,963.9	5640
0.02	=	4,689.8	6470
0.01	=	5,462.1	7340
0.005	=	6,157.2	8210
0.002	=	7,325.8	9480

Basin Characteristics for Regional Regression Estimate, $Q_{(u)reg}$

		Applicable Range
Enter Mean Annual Precipitation of ungaged basin=	68.1	11.94 - 186.6
If ungaged location is in regression region 1 or 2, enter percent canopy coverage=	0.8	not applicable

*rounded to 3 significant figures

Gage #12020800

Not Used

Flood Q Ratio Tool. Estimates of flood discharge for an ungaged sites in Washington State using the Drainage-Area Ratio Method

Station Index= 22

A_u, contributing drainage area of ungaged site; A_g, contributing drainage area of the streamflow gaging site; $Q_{(u)g}$, gage-based estimate of flood discharge in cubic feet per second at ungaged site; $Q_{(u)wtd}$, weighted estimate of flood discharge in cubic feet per second for the ungaged site and indicated streamflow characteristic; $Q_{(u)reg}$, regression estimate of flood discharge in cubic feet per second for ungaged site; Q(g)wtd, weighted estimate of flood discharge for streamgaging station]

Instructions for estimating streamflow characteristics at an ungaged site using the Drainage-Area Ratio Method

Steps	Instructions
1	Select a streamflow-gaging station from the list box below which is on the same stream as the ungaged site.
2	Determine contributing drainage area for ungaged site (A_u, in square miles) and enter value in the green cell (F12), where $0.5A_g \leq A_u \leq 1.5A_g$. If the drainage area is outside the appropriate range, the cell will turn red. An initial estimate of the flood discharges will be computed in column G, rows 23 to 30.
3	The estimates will be improved by computing weighted estimates using the regional regression estimates. To do this, enter the Mean Annual Precipitation in the green box (column I, row x). If the site is in regression region 1 or 2, enter the percent canopy coverage for the ungaged basin in the green box (column I, row x). If either of these values are outside the acceptible range, the cell will turn red.
4	The final answer, the weighted estimates of flood discharge ($Q_{(u)wtd}$), will be listed in column G, rows 37-44.

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12020900 SOUTH FORK CHEHALIS RIVER NEAR BOISTFORT, WA
12021000 SOUTH FORK CHEHALIS RIVER AT BOISTFORT, WA

Estimates of streamflow characteristics based on Drainage-Area Ratio method

Contributing drainage areas of the streamflow-gaging station (A_g) and ungaged site (A_u), located on the same stream				Range of drainage areas for which drainage area adjustment is valid
Drainage area of selected index site, A_g	=	27.0	square miles	--
Drainage area of ungaged location, A_u	=	42.95	square miles	13.5 - 40.4

	Station Number	Number of Years of Record
Selected Streamflow-gaging Station:	12020800	16

Regression Region: 4

Initial estimate of Flood Discharges at ungaged site, Q_u (eq. 10)

AEP		$Q_{(g)wtd}$	$Q_{(u)g}$, ft³/s
0.5	=	3,180.0	4,862.0
0.2	=	5,110.0	7,820.2
0.1	=	6,560.0	10,048.6
0.04	=	8,570.0	13,145.8
0.02	=	10,200.0	15,660.7
0.01	=	11,900.0	18,279.4
0.005	=	13,600.0	20,910.2
0.002	=	16,100.0	24,788.6

$2(|A_g - A_u|)/A_g =$ 1.187384045

Regression Region: 4

Weighted estimate of Flood Discharge at ungaged site, using regression estimate, $Q_{(u)wtd}$ (eq. 11)

AEP		$Q_{(u)reg}$	*$Q_{(u)wtd}$
0.5	=	1,481.7	848
0.2	=	2,363.2	1340
0.1	=	3,061.3	1750
0.04	=	3,963.9	2240
0.02	=	4,689.8	2630
0.01	=	5,462.1	3060
0.005	=	6,157.2	3390
0.002	=	7,325.8	4050

Basin Characteristics for Regional Regression Estimate, $Q_{(u)reg}$

		Applicable Range
Enter Mean Annual Precipitation of ungaged basin=	68.1	11.94 - 186.6
If ungaged location is in regression region 1 or 2, enter percent canopy coverage=	0.8	not applicable

*rounded to 3 significant figures

Appendix C: No-Rise Analysis

From: Nick Cook <Nick.Cook@otak.com>
Sent: Thursday, March 5, 2026 1:24 PM
To: Mike Zarecor <mikez@osbornconsulting.com>; Doug Sarkkinen <doug.sarkkinen@otak.com>
Cc: Isaac Fournier <isaacf@osbornconsulting.com>
Subject: RE: Senn and Wildwood Scour Repair

see data
below:

HEC-RAS River: Wildwood Reach: Reach 1 Profile: 100-yr

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Frou
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach 1	615	100-yr	EC	5440.00	291.67	312.17		312.60	0.001031	5.59	1244.95	149.75	
Reach 1	615	100-yr	PC	5440.00	291.67	312.03		312.47	0.001071	5.66	1223.75	148.39	
Reach 1	562	100-yr	EC	5440.00	292.16	312.05		312.53	0.001222	5.85	1158.60	122.81	
Reach 1	562	100-yr	PC	5440.00	292.16	311.91		312.40	0.001271	5.93	1140.70	122.56	
Reach 1	500	100-yr	EC	5440.00	291.55	312.00		312.45	0.001072	5.48	1064.99	96.09	
Reach 1	500	100-yr	PC	5440.00	291.55	311.85		312.32	0.001109	5.54	1051.05	95.15	
Reach 1	436	100-yr	EC	5440.00	291.80	311.85		312.37	0.001236	5.86	990.71	88.13	
Reach 1	436	100-yr	PC	5440.00	291.80	311.70		312.24	0.001278	5.92	977.66	86.53	
Reach 1	365	100-yr	EC	5440.00	290.96	311.84		312.27	0.000943	5.48	1182.71	112.96	
Reach 1	365	100-yr	PC	5440.00	291.04	311.67		312.14	0.000987	5.71	1149.98	110.18	
Reach 1	333	100-yr	EC	5440.00	291.94	311.89	300.55	312.21	0.000694	4.60	1239.80	103.47	
Reach 1	333	100-yr	PC	5440.00	291.50	311.58	301.43	312.10	0.000981	6.05	1114.64	95.69	
Reach 1	300			Bridge									
Reach 1	264	100-yr	EC	5440.00	291.25	311.40		312.01	0.001264	6.37	969.26	82.98	
Reach 1	264	100-yr	PC	5440.00	291.90	311.39		311.96	0.001385	6.12	948.91	83.21	
Reach 1	239	100-yr	EC	5440.00	291.11	311.35		311.97	0.001977	6.37	911.93	83.60	
Reach 1	239	100-yr	PC	5440.00	291.10	311.35		311.93	0.001216	6.23	992.29	85.58	
Reach 1	173	100-yr	EC	5440.00	289.23	311.36		311.79	0.000906	5.28	1091.88	85.75	
Reach 1	173	100-yr	PC	5440.00	289.23	311.36		311.79	0.000907	5.28	1091.68	85.79	
Reach 1	103	100-yr	EC	5440.00	290.50	311.22		311.71	0.001126	5.77	1079.98	105.92	
Reach 1	103	100-yr	PC	5440.00	290.50	311.22		311.71	0.001126	5.77	1079.98	105.92	
Reach 1	18	100-yr	EC	5440.00	291.02	310.83	302.91	311.57	0.001782	7.08	943.87	137.12	
Reach 1	18	100-yr	PC	5440.00	291.02	310.83	302.91	311.57	0.001782	7.08	943.87	137.12	

Nicholas Cook, PhD, PE | Water Resources

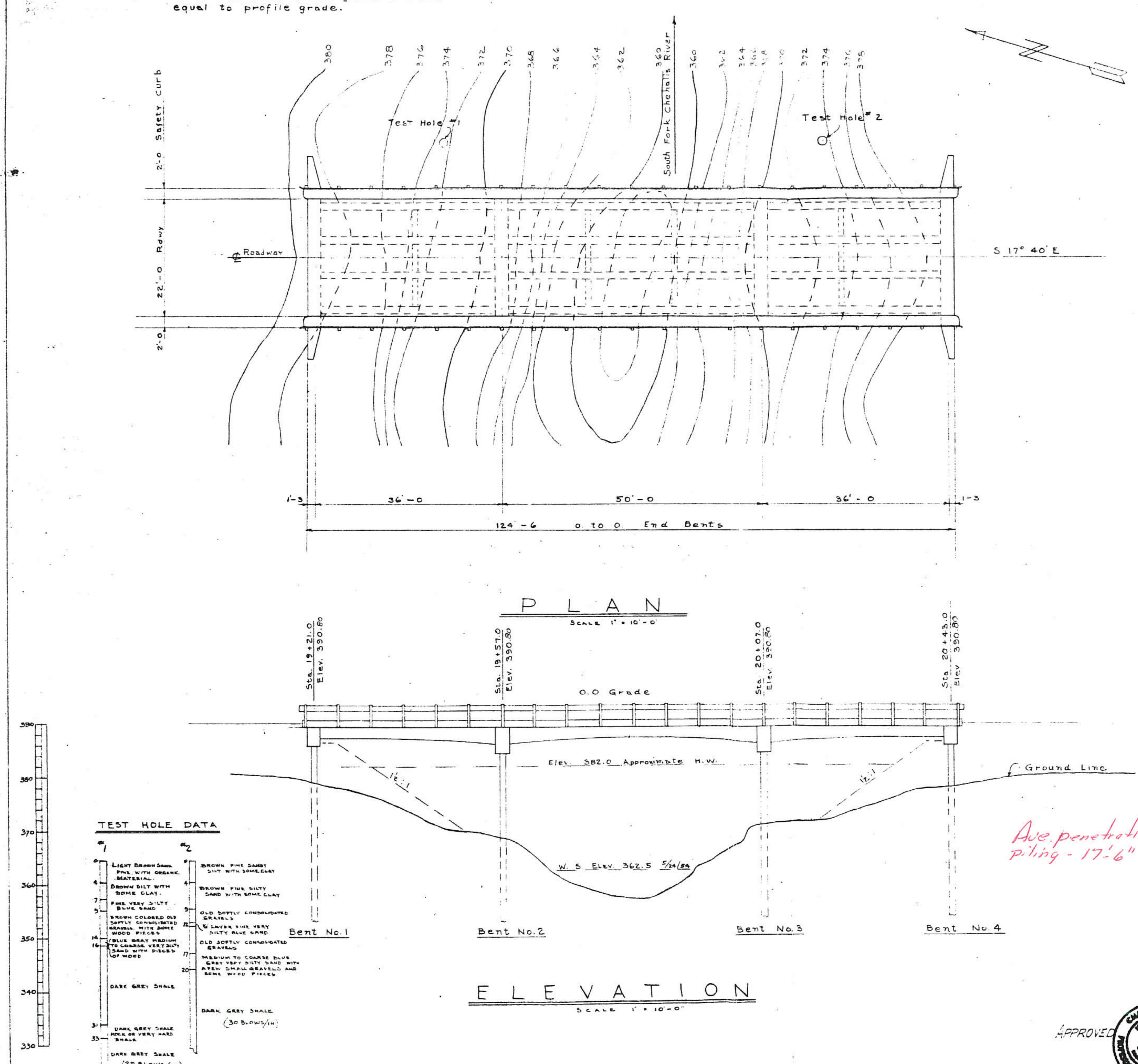
808 SW Third Ave., Suite 800 | Portland, OR 97204
Direct: 503.415.2362 | | Cell: 828.291.8004 Main: 503.287.6825
www.otak.com

Appendix D: Original Bridge Plans (1954)

Appendix C: Original Bridge Plans (1954)

FED. ROAD DIV. No.	STATE	FED. AID PROJ. No.	FISCAL YEAR
8	WASH.	S-0338(3)	

NOTE:
Elevations shown are finish grade and are equal to profile grade.



GENERAL NOTES

All material and workmanship shall be in accor... with the requirements of the Standard Specificat... for Road and Bridge Construction of the State of Washington Dated April 1948

All concrete shall be class "A" mix.

Precast concrete piles shall be driven to a depth suff... to develop a minimum load bearing capacity of thirty (30) tons per pile.

All bolts, nuts, shims and washers shall be galvanized accordance with A.S.T.M. Designation A-153, clas...

Reinforcing steel shall be of intermediate grade with deformations in accordance with A-305-50T designa...

Falsework shall not be released in any span until all con... except rail posts, has been in place the require... length of time and has developed sufficient stren... in accordance with the standard specifications.

Falsework shall be carefully released to prevent impa... or undue stresses in the structure.

SEQUENCE OF POURING

1. Caps, girders, end walls and cross beams to fil... of roadway slab in one continuous pour - Class...
2. Roadway slab in one continuous pour — Class "A"
3. Safety Curbs — Class "A" mix.

APPROXIMATE QUANTITIES

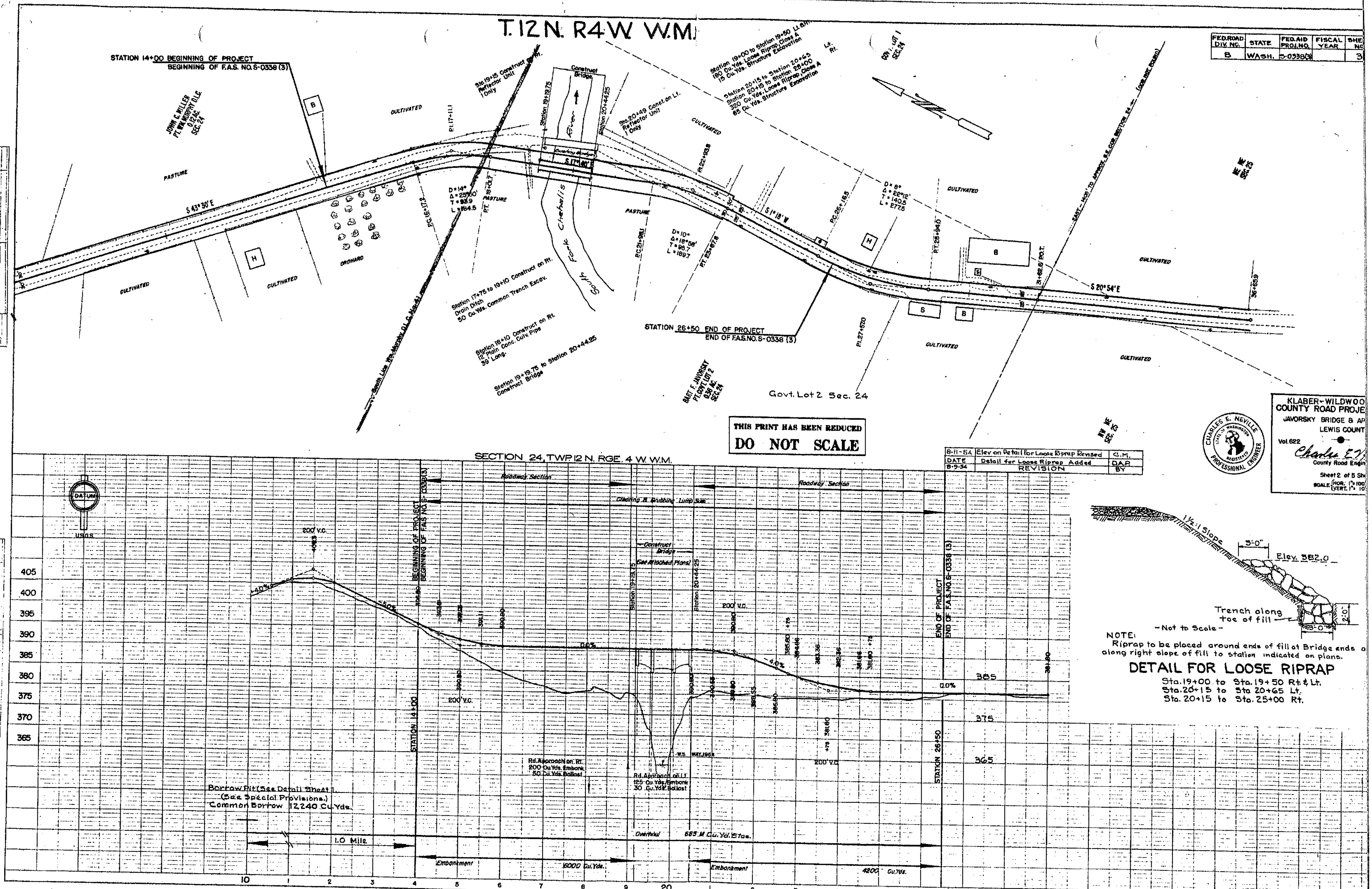
Mechanical Tamper	4	Days
Concrete Class "A"	187.0	Cu. Yds
Steel Reinforcing Bars	38,700.0	Lbs
Steel Bridge Rail	255.5	Lin. Ft
Furnishing Precast Concrete Piling	700	Lin. Ft
Driving Precast Concrete Piles	20	Only
Furnishing & Driving Precast Conc. Test Piles	2	Only

H15-S12-44 LOADING

THIS PRINT HAS BEEN REDU...
DO NOT SCAL...

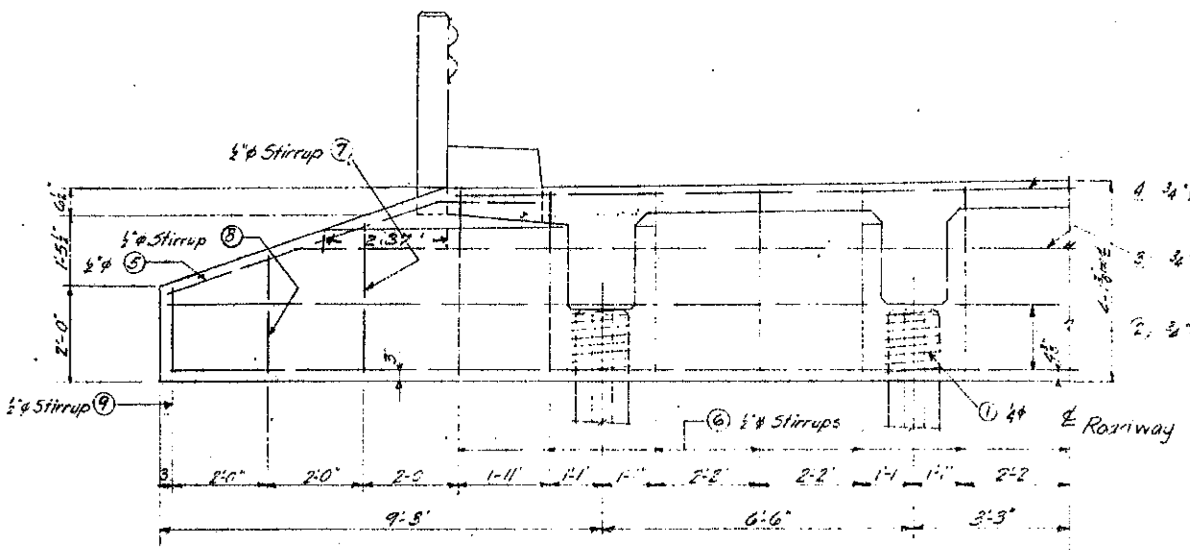
JAVORSKY BRID...
SOUTH FORK CHEHALIS...
PLAN & ELEVAT...
FOR: LEWIS COUNTY
CHEHALIS WAS...
HORACE J. WHITACRE & AS...
Professional Engineers
CIVIL & STRUCTURAL
2907 "A" STREET TACOMA 4 WASHI...
Drawn: SLF Chkd. HFS
Scale: As Noted 212-1 Shee...
Date: 7/12/54

APPROVED Charles E. Neville
LEWIS COUNTY ROAD ENGINEER



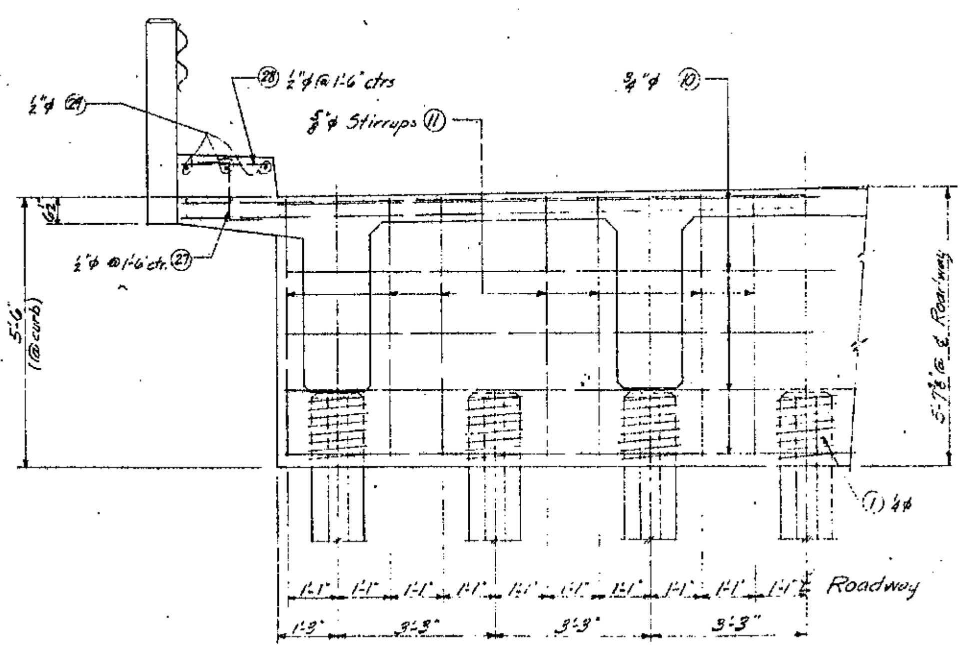
T.12N. R4W. W.M.
FED. ROAD DIV. NO. | STATE | FED. AID PROJ. NO. | FISCAL YEAR | SHEET NO.
8 | WASH. | S-0338(3)
STATION 14+00 BEGINNING OF PROJECT
BEGINNING OF F.A.S. NO. S-0338 (3)
JOHN C. MILLER PT. WM. MURPHY D.L.C. 0.12 AC. SEC. 24
PASTURE
CULTIVATED
ORCHARD
S 43°30' E
Sta. 19+15 Construct on Rt. Reflector Unit 1 Only
Construct Bridge
River
Station 19+19.75
Station 20+44.25
Sta. 20+49 Const. on Lt. Reflector Unit 1 Only
Station 19+00 to Station 19+50 Lt. & Rt. 180 Cu. Yds. Loose Riprap, Class A 15 Cu. Yds. Structure Excavation
Station 20+15 to Station 20+65 Lt. Station 20+15 to Station 25+00 Rt. 320 Cu. Yds. Loose Riprap, Class A 65 Cu. Yds. Structure Excavation
COR. LOT 1 SEC. 24
D = 14° Δ = 25°50' T = 93.9 L = 184.5
D = 10° Δ = 18°58' T = 95.7 L = 189.7
D = 8° Δ = 22°12' T = 140.5 L = 277.5
South Fork Chehalis River
S 1°18' W
S 20°54' E
Station 17+75 to 19+10 Construct on Rt. Drain Ditch 50 Cu. Yds. Common Trench Excav.
Station 18+10 Construct on Rt. 12" Plain Conc. Culv. Pipe 39' Long.
Station 19+19.75 to Station 20+44.25 Construct Bridge
STATION 26+50 END OF PROJECT
END OF F.A.S. NO. S-0338 (3)
BART F. JAVORSKY PT. GOVT. LOT 2 0.36 AC. SEC. 24
Govt. Lot 2 Sec. 24
THIS PRINT HAS BEEN REDUCED
DO NOT SCALE
NE NE SEC. 25
NW NE SEC. 25
KLABER-WILDWOOD COUNTY ROAD PROJECT
JAVORSKY BRIDGE & APPROACHES
LEWIS COUNTY
CHARLES E. NEVILLE STATE OF WASHINGTON REGISTERED PROFESSIONAL ENGINEER
County Road Engineer
Sheet 2 of 5 Sheets
8-11-54 | Elev. on Detail for Loose Riprap Revised | G.M.
8-9-54 | Detail for Loose Riprap Added | D.A.P.
DATE | REVISION | BY
SECTION 24, TWP. 12 N. RGE. 4 W. W.M.
DATUM U.S.G.S.
Roadway Section
Clearing & Grubbing Lump Sum
200' V.C.
BEGINNING OF PROJECT BEGINNING OF F.A.S. NO. S-0338 (3)
STATION 14+00
Construct Bridge (See Attached Plans)
END OF PROJECT END OF F.A.S. NO. S-0338 (3)
STATION 26+50
0.0%
Rd. Approach on Rt. 200 Cu. Yds. Embank. 50 Cu. Yds. Ballast
Rd. Approach on Lt. 125 Cu. Yds. Embank. 30 Cu. Yds. Ballast
Borrow Pit (See Detail Sheet 1) (See Special Provisions) Common Borrow 12,240 Cu. Yds.
1.0 Mile
Overhaul 685 M Cu. Yd. Stas.
Embankment 16000 Cu. Yds.
Embankment 4200 Cu. Yds.
1½:1 Slope
3'-0"
Elev. 382.0
Trench along toe of fill
- Not to Scale -
NOTE: Riprap to be placed around ends of fill at Bridge ends and along right slope of fill to station indicated on plans.
DETAIL FOR LOOSE RIPRAP
Sta. 19+00 to Sta. 19+50 Rt. & Lt.
Sta. 20+15 to Sta. 20+65 Lt.
Sta. 20+15 to Sta. 25+00 Rt.

FED. ROAD DIV. No.	STATE	FED. AID PROJ. No.	FISCAL YEAR
8	WASH.	S-0358(5)	



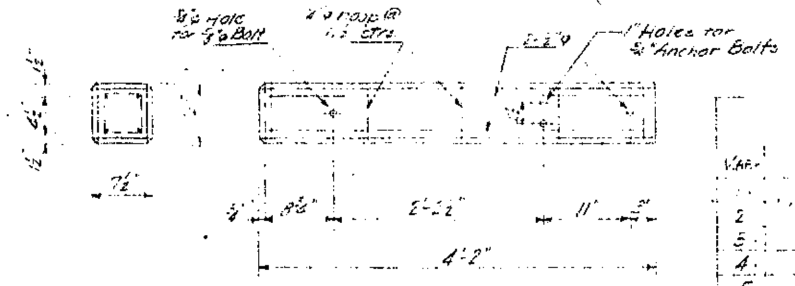
HALF ELEVATION BENTS 1 & 4

Scale ½" = 1'-0"



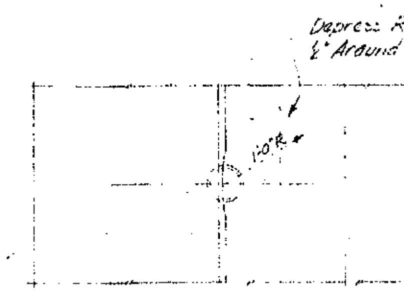
HALF ELEVATION BENTS 2 & 3

Scale ½" = 1'-0"

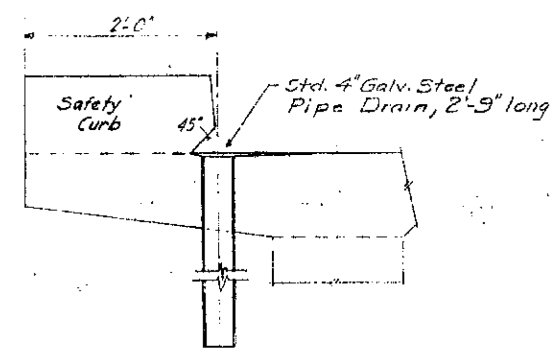


POST DETAIL

Scale 1" = 1'-0"
(Steel not included in Bar List)
42 - REQUIRED

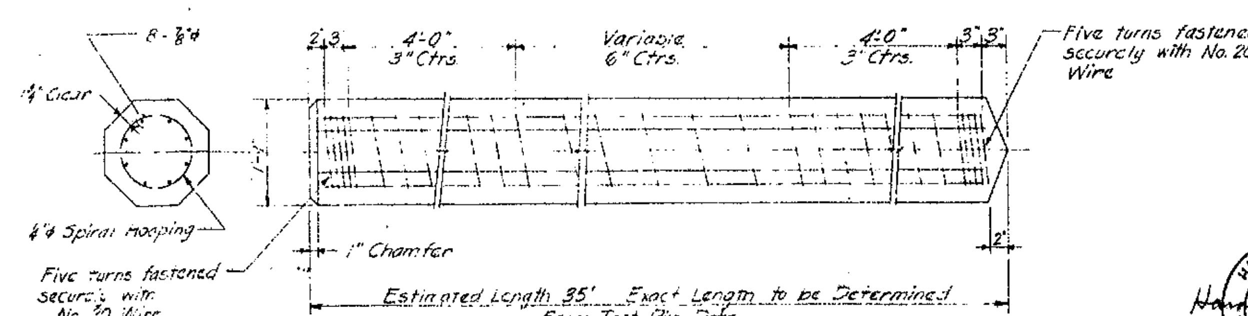


PLAN



DRAIN DETAIL

Scale 1" = 1'-0"
6 - REQUIRED



PRECAST CONCRETE PILE

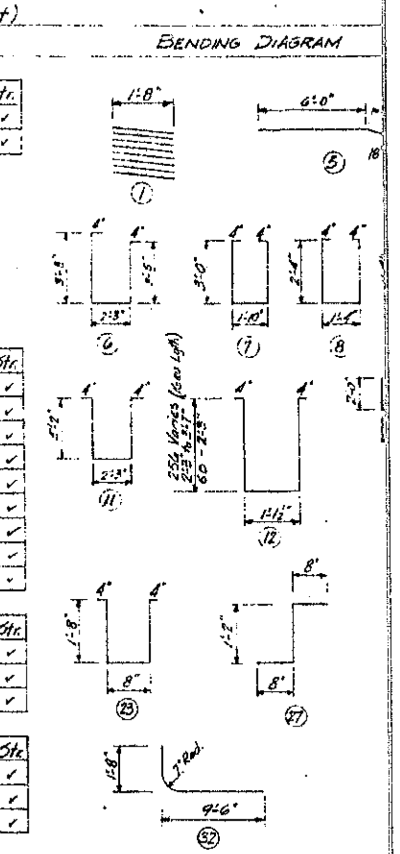
Scale 1" = 1'-0"
(Steel not included in Bar List)
20 REQUIRED

BAR LIST

(All Dimensions out to out)

MARK	LOCATION	NO	SIZE	LENGTH	
1	Pile Head Hoops	22	¼"φ	26'-2"	
2	End Beam Longits.	8	¾"φ	37'-8"	Str.
3	✓ ✓ ✓	4	✓	33'-4"	✓
4	✓ ✓ ✓	4	✓	25'-8"	✓
5	✓ ✓ ✓	8	½"φ	8'-0"	
6	End Beam Stirrups	26	½"φ	10'-0"	
7	✓ ✓ ✓	4	✓	8'-6"	
8	✓ ✓ ✓	4	✓	6'-8"	
9	✓ ✓ ✓	4	✓	4'-11"	
10	Int. Beam Longits.	20	¾"φ	25'-8"	
11	Int. Beam Stirrups	28	⅝"φ	13'-3"	
12	Girder Stirrups	308	½"φ	Varies	
13	Girder Longits. (Top)	16	1⅛"φ	50'-0"	Str.
14	✓ ✓ ✓	16	✓	15'-0"	✓
15	✓ ✓ ✓	16	✓	36'-0"	✓
16	✓ ✓ ✓	16	✓	16'-0"	✓
17	Girder Longits. (Bott)	16	✓	38'-0"	✓
18	✓ ✓ ✓	8	✓	52'-0"	✓
19	✓ ✓ ✓	16	1⅛"φ	26'-0"	✓
20	✓ ✓ ✓	16	✓	14'-0"	✓
21	✓ ✓ ✓	8	✓	32'-0"	✓
22	✓ ✓ ✓	8	✓	20'-0"	✓
23	Intermediate Crossbeams Stirrups	60	½"φ	4'-8"	
24	✓ ✓ Longits.	16	⅝"φ	20'-6"	Str.
25	Deck Slab (Transv.)	368	⅝"φ	25'-8"	✓
26	✓ ✓ (Longit.	64	⅝"φ	42'-6"	✓
		24	✓	43'-3"	✓
27	Safety Curb	182	½"φ	2'-6"	
28	✓ ✓	190	✓	1'-7"	Str.
29	✓ ✓	48	✓	12'-2"	✓
30	✓ ✓	8	✓	9'-6"	✓
31	✓ ✓	6	✓	6'-0"	✓
32	✓ ✓	4	✓	10'-11"	
33	Girder Longits. (Interm.)	32	¾"φ	32'-0"	Str.

BENDING DIAGRAM

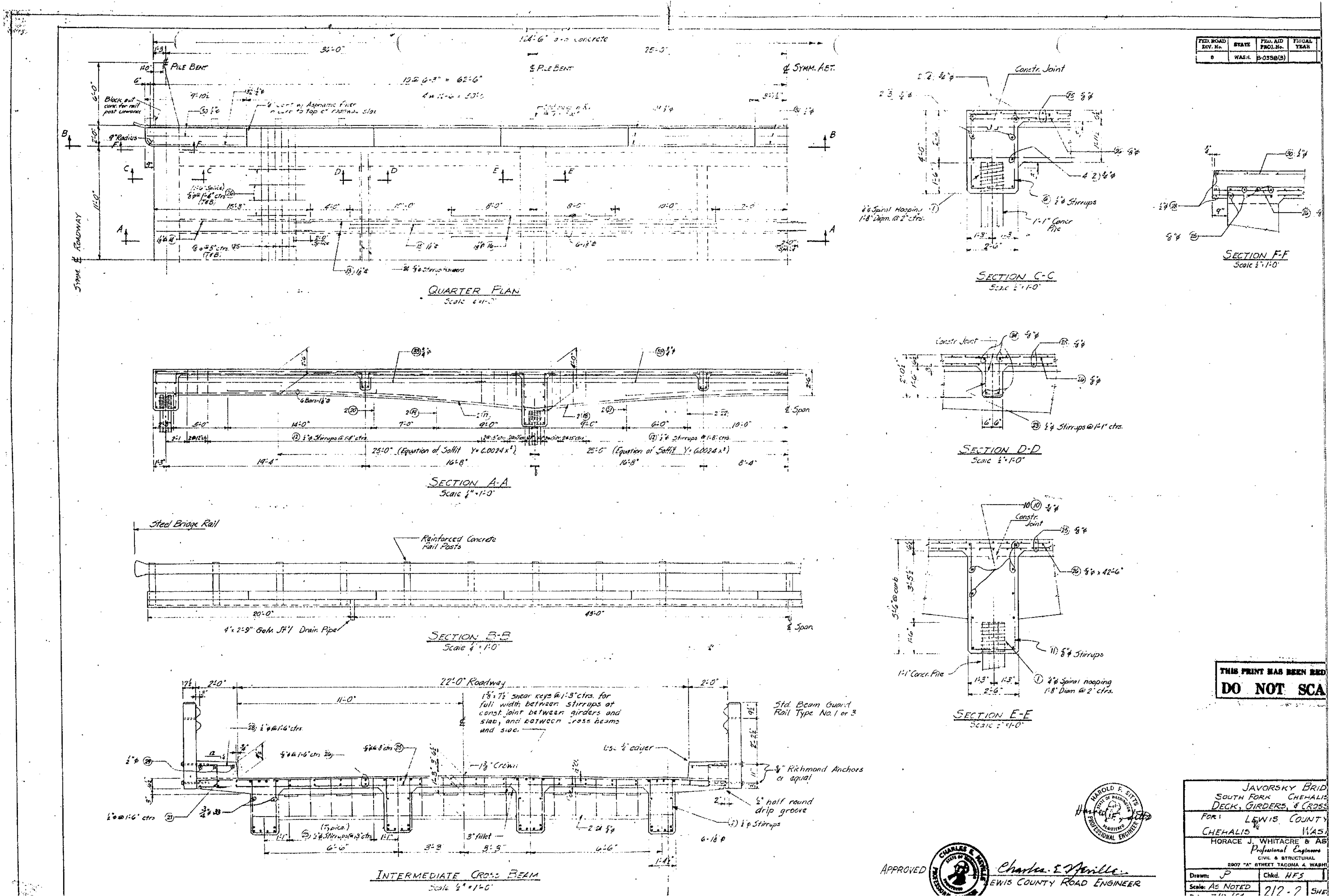


THIS PRINT HAS BEEN REDUCED
DO NOT SCALE

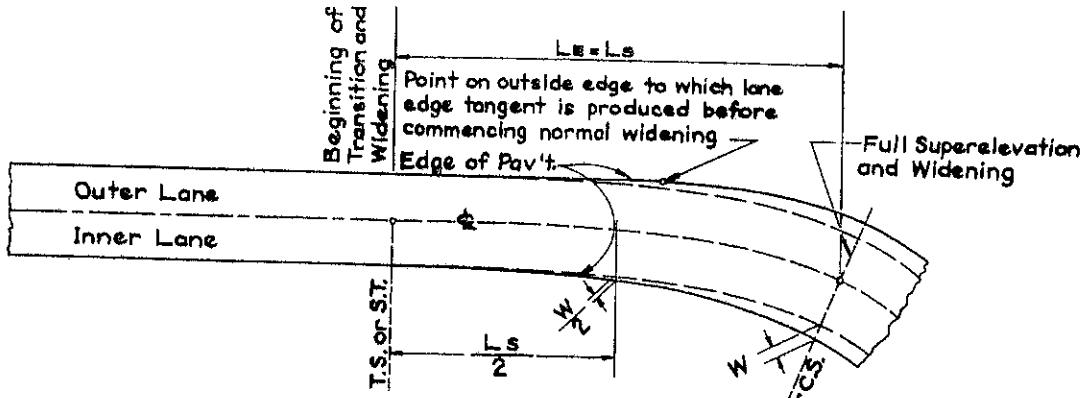
HAROLD F. SITTS — STATE OF WASHINGTON — REGISTERED PROFESSIONAL ENGINEER

APPROVED: Charles E. [illegible]
LEWIS COUNTY ROAD ENGINEER

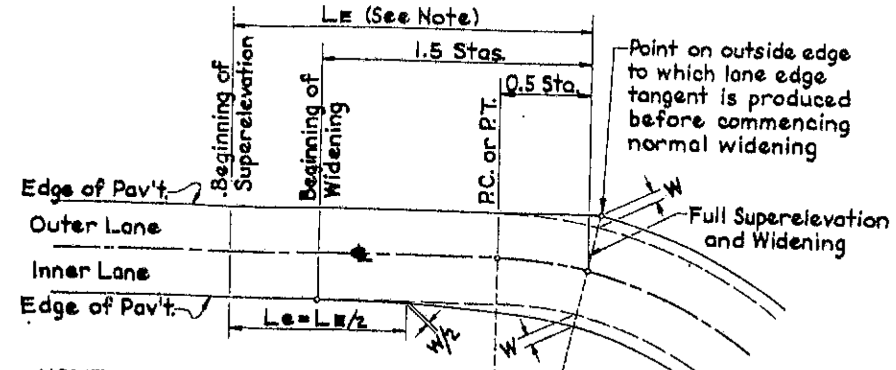
JAVORSKY BRIDGE
SOUTH FORK CHEHALIS
BENTS, BAR LIST & MISC.
FOR: LEWIS COUNTY
CHEHALIS · WASH.
HORACE J. WHITACRE & ASS.
Professional Engineers
CIVIL & STRUCTURAL
2907 "A" STREET TACOMA 4, WASHIN.
Drawn: JP — Chkd. HFS
Scale: AS NOTED — 212-3 — SHEET
Date: 7/12/54



FED. ROAD DIV. No. 8 | STATE WASH. | FED. AID PROJ. No. B-0338(3) | FISCAL YEAR
QUARTER PLAN
SECTION C-C
Scale ½"=1'-0"
SECTION F-F
Scale ½"=1'-0"
SECTION A-A
Scale ¼"=1'-0"
SECTION D-D
Scale ½"=1'-0"
Steel Bridge Rail
Reinforced Concrete Rail Posts
4"x 2'-9" Galv. St'l Drain Pipe
SECTION B-B
Scale ¼"=1'-0"
SECTION E-E
22'-0" Roadway
1⅞"x 7½" shear keys @ 1'-3" ctrs. for full width between stirrups at const. joint between girders and slab, and between cross beams and slab.
Std. Beam Guard Rail Type No. 1 or 3
¾" Richmond Anchors or equal
½" half round drip groove
INTERMEDIATE CROSS BEAM
Scale ½"=1'-0"
THIS PRINT HAS BEEN RED
DO NOT SCA
APPROVED
LEWIS COUNTY ROAD ENGINEER
JAVORSKY BRID
SOUTH FORK CHEHALIS
DECK, GIRDERS, & CROSS
FOR: LEWIS COUNTY
CHEHALIS WASH
HORACE J. WHITACRE & AS
Professional Engineers
CIVIL & STRUCTURAL
2007 "A" STREET TACOMA 4, WASH
Drawn: P
Chkd. HFS
Scale: AS NOTED
212-2



PLAN OF SPIRALED CURVE
SHOWING WIDENING

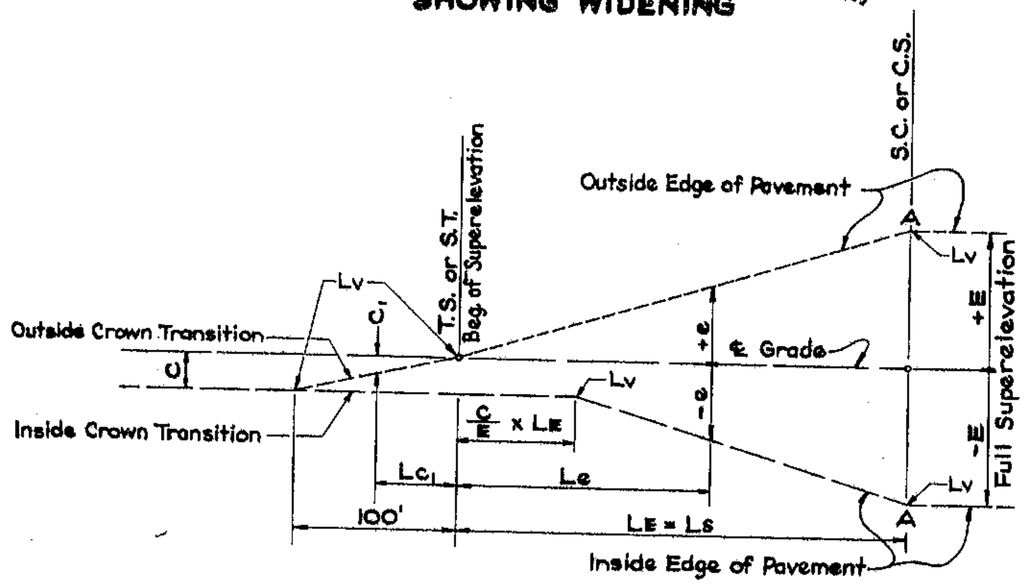


NOTE:
Where tangent distance between curves is less than 5 Stas. Le = 1.5 Stas.
Where tangent distance between curves is 5 Stas. or more Le = 3.0 Stas.

PLAN OF CIRCULAR CURVE (NOT SPIRALED)
SHOWING WIDENING
(SUPERELEVATION TRANSITION IS SIMILAR TO METHOD SHOWN FOR SPIRALED CURVES)

LEGEND:
- D Degree of Circular Curve.
- E Rate of full superelevation in feet per foot of roadway width.
- e Rate of superelevation at any intermediate point in feet per foot.
- L_{c_1} Distance in stations from T.S. or S.T. to intermediate point in crown transition.
- L_E Length of transition from zero superelevation to full superelevation in stations.
- L_e Length of transition in stations from beginning to any intermediate superelevation rate.
- L_s Length of Spiral Curve in stations.
- L_v Length of a curve in stations for eliminating sharp break in straight line transition when required.
- C Rate of full crown in feet per foot of lane width.
- C_1 Rate of crown on upper side at any intermediate point in transition in feet per foot of lane width.
- b Width of single lane, in feet.
- R Radius of Circular Curve in feet.
- V Velocity in miles per hour.
- W Widening required for one lane, in feet.

ADDITIONAL FOR WIDENING EQUATION (W)
- G Maximum width of vehicular body in feet (8 feet used)
- Z Maximum length of vehicular wheel base in feet (25 feet used)
- K Variable factor applied to maximum speed for determination of normal speed (approx. 0.75)

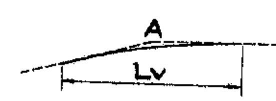


PROFILE SHOWING METHOD OF ATTAINING
SUPERELEVATION TRANSITION
WHEN GRADE IS CARRIED ON ℄
(FOR SPIRALED CURVE)

For transition through spiral $L_v = \frac{(V-30)(D)}{200}$

Note: Computed value Lv for approximation only. Use a convenient curve length of approximately equivalent value.

For transition to Circular Curve
150' Transition Lv = 0.40 Sta.
300' Transition Lv = 0.80 Sta.



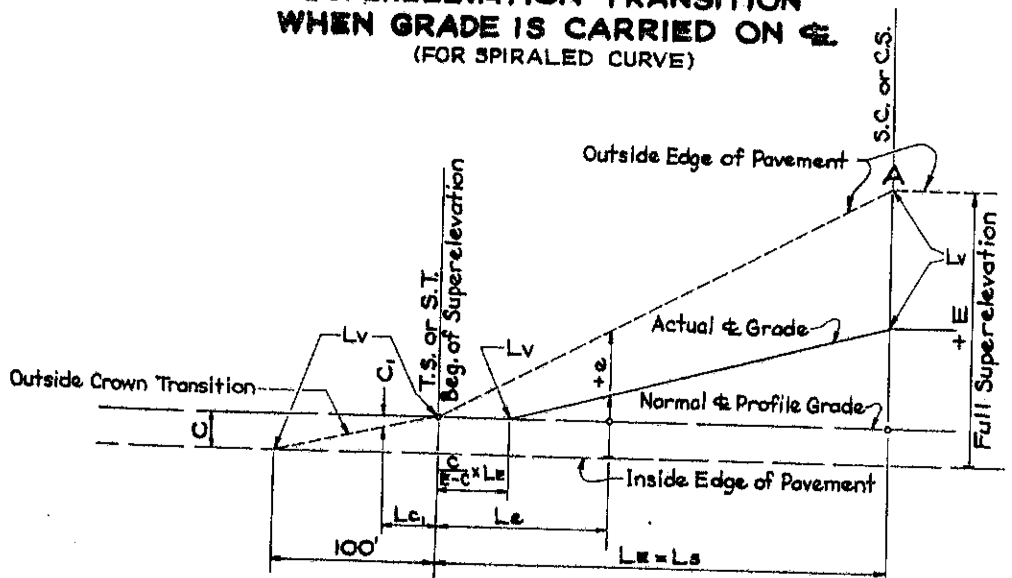
CURVE FOR EASING BREAK IN STRAIGHT LINE TRANSITION
(See "Notes" below)

EQUATIONS:

$E = 0.02D$ (Max. = 0.10' per ft.)

$$W = 3 + G - b + R - \sqrt{R^2 - Z^2} + \frac{KV}{\sqrt{R}}$$

WIDENING (W) FOR EACH LANE														
Lane Width (b)	DEGREE OF CURVE (D)													
	1°	2°	3°	4°	5°	6°	7°	8°	9°	10°	11°	12°	13°	14°
11'	0.7	1.1	1.3	1.5	1.6	1.8	1.8	1.9	2.0	2.0	2.0	2.0	2.1	2.3
12'	–	–	–	0.5	0.6	0.8	0.8	0.9	1.0	1.0	1.0	1.0	1.1	1.3



PROFILE SHOWING METHOD OF ATTAINING
SUPERELEVATION TRANSITION WHEN GRADE
IS CARRIED AT INSIDE EDGE OF PAVEMENT
(FOR SPIRALED CURVE)

NOTES:

Transition to full superelevation shall be carried at a uniform rate of change from level section to full superelevation.

The roadway crown shall be eliminated uniformly through a length of 100 feet except as noted for the inside crown.

Value of Lv based on parabolic curve as used for vertical curves.

Since the factors of gradient, superelevation and crown may produce a condition that would not assure positive drainage along the ditch or gutter lines, each transition should be thoroughly checked for this condition.

Widening for each lane shall be proportioned through the length, LE, except that no widening shall be applied on the outside of the outer lane tangent.

Ordinarily, the break at beginning or end of the straight line transition can be adjusted by eye in the field, and a curve of length, Lv, need be resorted to only in the case of structures or high type pavement.

STANDARD
SUPERELEVATION AND WIDENING
STATE OF WASHINGTON
DEPARTMENT OF HIGHWAYS
OLYMPIA, WASHINGTON

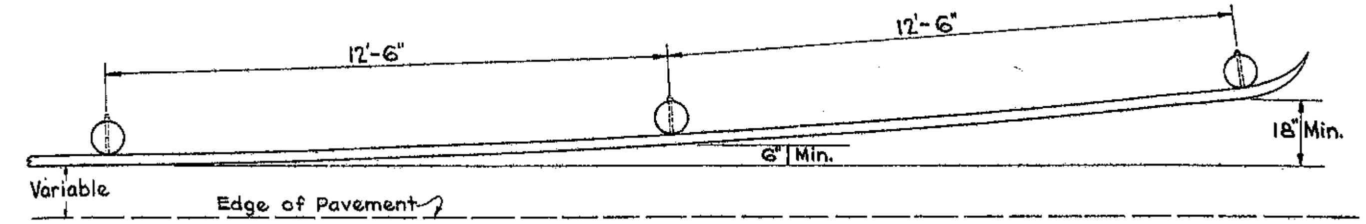
APPROVED: DEC. 1, 1950

W. A. Bugge
DIRECTOR OF HIGHWAYS

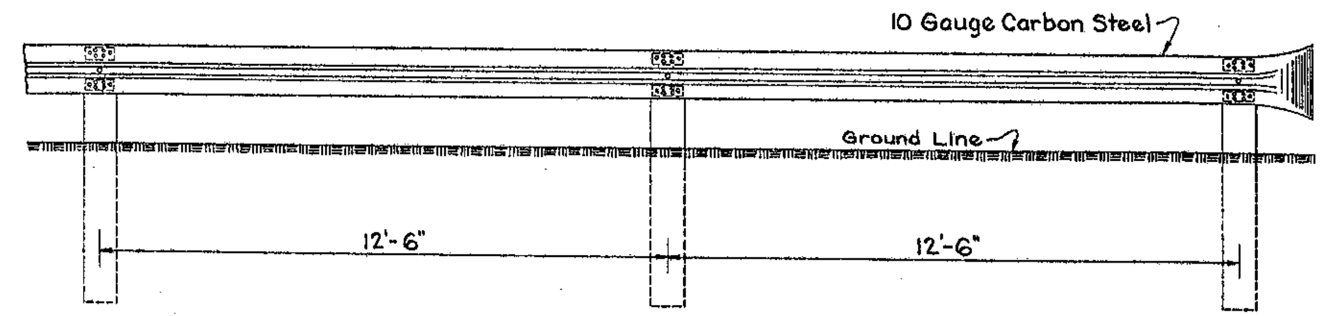
REINFORCED CONCRETE POSTS:
The reinforcement mesh shall contain 13 #2 Longitudinal Wires spaced at 2" O.C.
Guard rail posts shall be marked to indicate the overlap of wire on guard rail side.

ALTERNATE REINFORCEMENT:
Use American Steel and Wire Co. Standard No. 216-28 with 2 additional circumferential No. 8 wires spaced equally between the 16" spacings of the mesh. Weld to longitudinal wires.

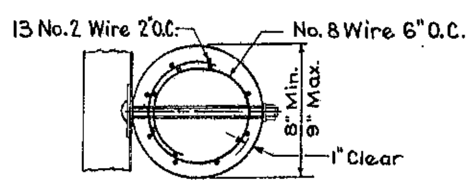
TIMBER POSTS:
Timber Posts shall conform to the requirements of Section 70-2.02 A of the Standard Specifications.
They shall be given a creosote preservative treatment, using the empty cell process in accordance with Section 55 of the Standard Specifications.



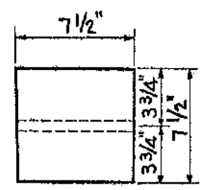
PLAN



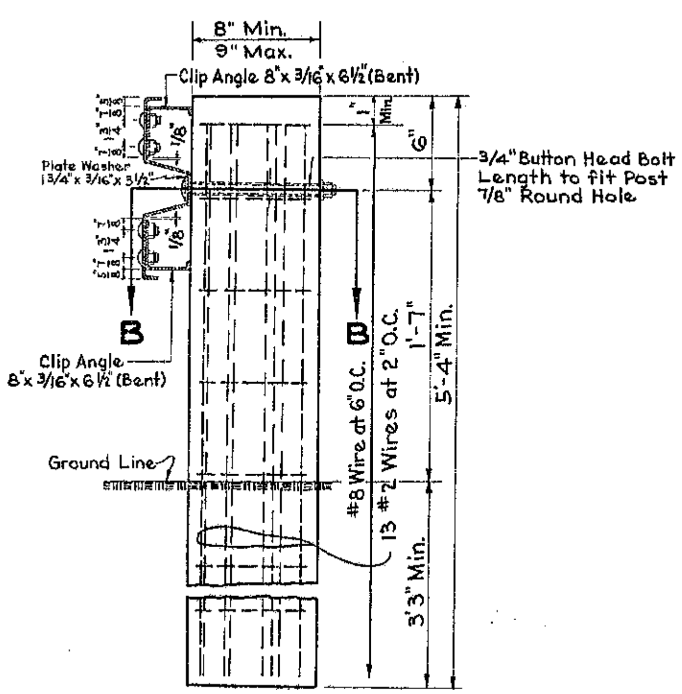
ELEVATION



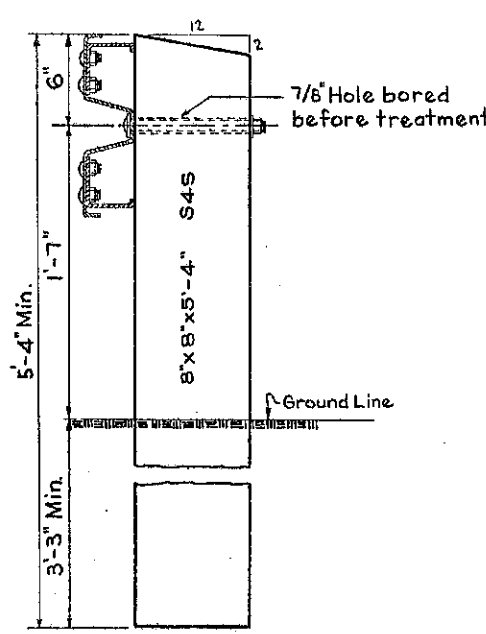
SECTION B-B



PLAN



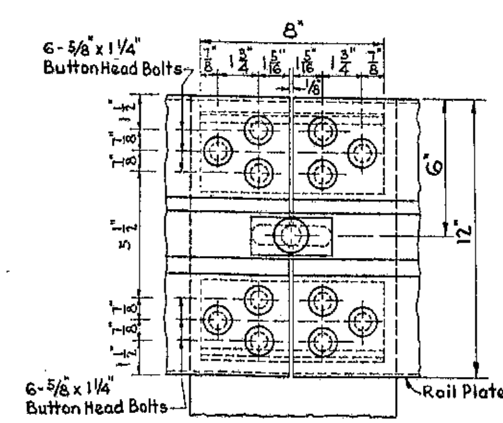
ROUND REINFORCED CONCRETE POST



CREOSOTE TREATED TIMBER POST

(Rail Dimensions shown on Concrete Post)

RAIL PLATES AND PARTS
Rail Plates shall be No. 10 (U.S. Standard) .30% Carbon Steel, Hot Rolled - 70,000 Lbs. Breaking strength at joints.



DETAIL OF SPLICE

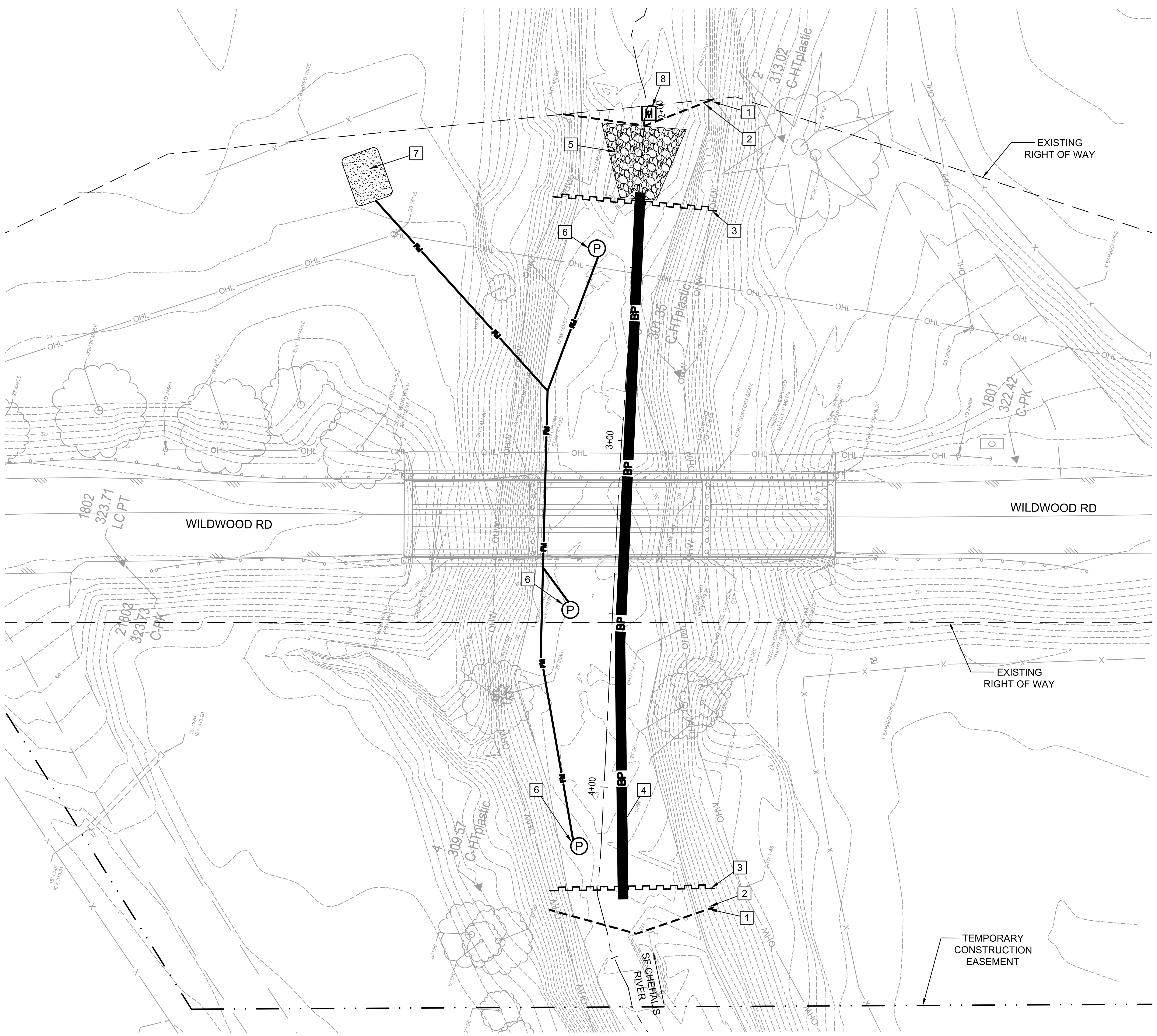
NOTES:
The Contractor shall have the option of furnishing 8" Round Reinforced Concrete Post, 9" Round Reinforced Concrete Post or 8"x8" Creosote Treated Timber Post, however the same type of post shall be used throughout any one particular project.
Rail shall be painted with White Guard Rail Paint.
Painting of Posts is not required.
See Section 72 of the 1948 Standard Specifications for further requirements.

PAYMENT:
"Standard Beam Guard Rail in Place", per Lin. Ft.

STANDARD
BEAM GUARD RAIL
TYPE NO. 3
WASHINGTON STATE HIGHWAY COMMISSION
DEPARTMENT OF HIGHWAYS
OLYMPIA, WASHINGTON
APPROVED: JULY 9, 1953

DIRECTOR OF HIGHWAYS

Appendix E: Proposed Plans



GENERAL NOTE:

1. ALL MATERIAL AND WORK SHALL BE IN ACCCORDANCE WITH THE REQUIREMENTS OF THE WASHINGTON STATE DEPARTMENT OF TRANSPORTATION, "STANDARD SPECIFICATIONS FOR ROAD, BRIDGE, AND MUNICIPAL CONSTRUCTION" 2026 EDITION AND SPECIAL PROVISIONS.

TEMPORARY STREAM DIVERSION NOTES:

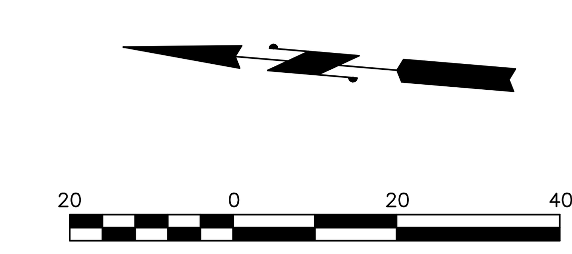
1. THE TEMPORARY STREAM DIVERSION SHOWN IS CONCEPTUAL. SEE SPECIAL PROVISIONS.
2. CONTRACTOR SHALL SUBMIT THE TEMPORARY STREAM DIVERSION PLAN TO THE ENGINEER FOR REVIEW AND APPROVAL WITHIN 7 DAYS OF NOTICE TO PROCEED.
3. THE TEMPORARY STREAM DIVERSION SHALL BE INSPECTED DAILY BY THE CONTRACTOR AND MAINTAINED TO ENSURE CONTINUED PROPER FUNCTIONING.
4. THE STREAM DIVERSION SYSTEM SHALL BE CAPABLE OF CONVEYING THE FLOW SPECIFIED IN THE CONTRACT DOCUMENTS.
5. FISH EXCLUSION AND FISH REMOVAL SHALL BE PERFORMED BY THE CONTRACTOR, BEFORE IN-WATER WORK IN ACCORDANCE WITH THE WASHINGTON DEPARTMENT OF FISH AND WILDLIFE HPA.
6. IF GRADING OR FILL IS REQUIRED TO INSTALL THE TEMPORARY STREAM DIVERSION, TEMPORARY PUMPS MAY BE REQUIRED TO DEWATER THE WORK AREA.

TEMPORARY STREAM DIVERSION KEY NOTES:

1. INSTALL FISH SCREEN.
2. CAPTURE AND REMOVE ALL FISH BETWEEN THE FISH SCREENS IN ACCORDANCE WITH THE HPA. FISH CAPTURE SHALL BE PERFORMED UNDER THE SUPERVISION OF AN EXPERIENCED FISHERY BIOLOGIST.
3. INSTALL COFFERDAM. SEE DETAIL 1 ON SHEET 6. UPSTREAM COFFERDAM LOCATED AT APPROXIMATELY STA 4+30 AND DOWNSTREAM COFFERDAM LOCATED AT APPROXIMATELY STA 2+32.
4. INSTALL TEMPORARY STREAM DIVERSION PIPE. ADJUST LOCATION OF DIVERSION PIPE AS NEEDED TO PERFORM WORK.
5. INSTALL OUTLET PROTECTION TO PREVENT EROSION AT TEMPORARY DIVERSION OUTFALL. OUTLET PROTECTION SHALL BE REMOVED WHEN CONSTRUCTION IS COMPLETE. SEE DETAIL 1 ON SHEET 6.
6. INSTALL DEWATERING PUMP(S) AND PIPES AS NEEDED DURING CONSTRUCTION. ADJUST LOCATION OF DEWATERING PUMPS AND PIPES AS NEEDED TO PERFORM WORK.
7. INSTALL FILTER BAG FOR SEDIMENT REMOVAL FROM ANY DEWATERING ACTIVITIES THAT MAY BE NECESSARY DURING CONSTRUCTION. SEE DETAIL 2 ON SHEET 6.
8. TURBIDITY MONITORING STATION. SEE SPECIAL PROVISIONS FOR TURBIDITY MONITORING REQUIREMENTS.

LEGEND

- COFFERDAM
- FISH SCREEN
- BP — CONCEPTUAL 42-IN SMOOTH BORE HDPE GRAVITY BYPASS PIPE FOR THE TEMPORARY STREAM DIVERSION
- FORCE MAIN
- P — PUMP
- M — MONITORING POINT
- TEMPORARY QUARRY SPALLS
- FILTER BAG



Lewis County Department of Public Works	57 W. MAIN ST. CHEHALIS WA 98532 PHONE # (360) 740-1123 FAX # (360) 740-2719	DESIGNED BY : MNZ DRAWN BY : JAR CHECKED BY : LCR DATE : 05/14/2026

NO.	DATE	REVISION	BY	APP.

WILDWOOD MP 10.14 BRIDGE SCOUR REPAIR

99% CONSTRUCTION PLANS
COUNTY ROAD PROJECT NO: 2159S
TEMPORARY STREAM DIVERSION PLAN

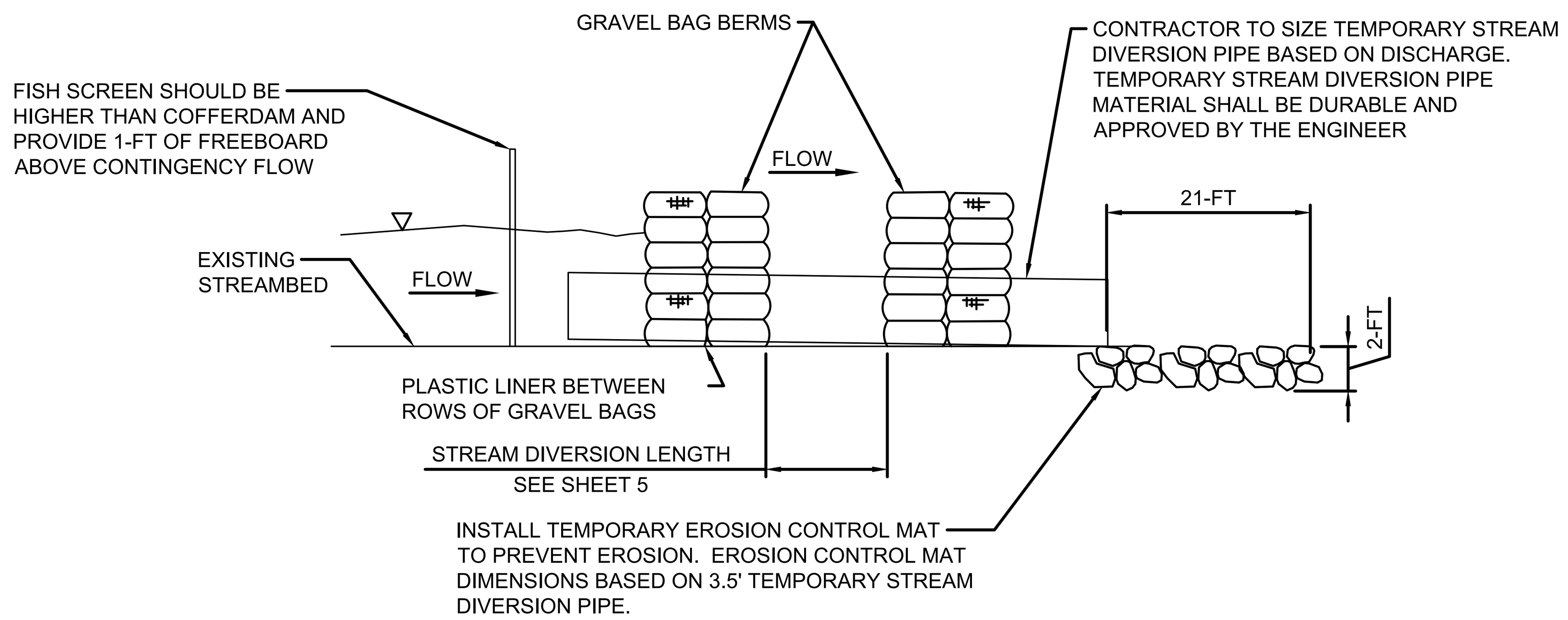
SHEET 5 OF 15

CALL 48 HOURS BEFORE YOU DIG
1-800-424-5555
"It's the Law"
Utilities Underground Location Center

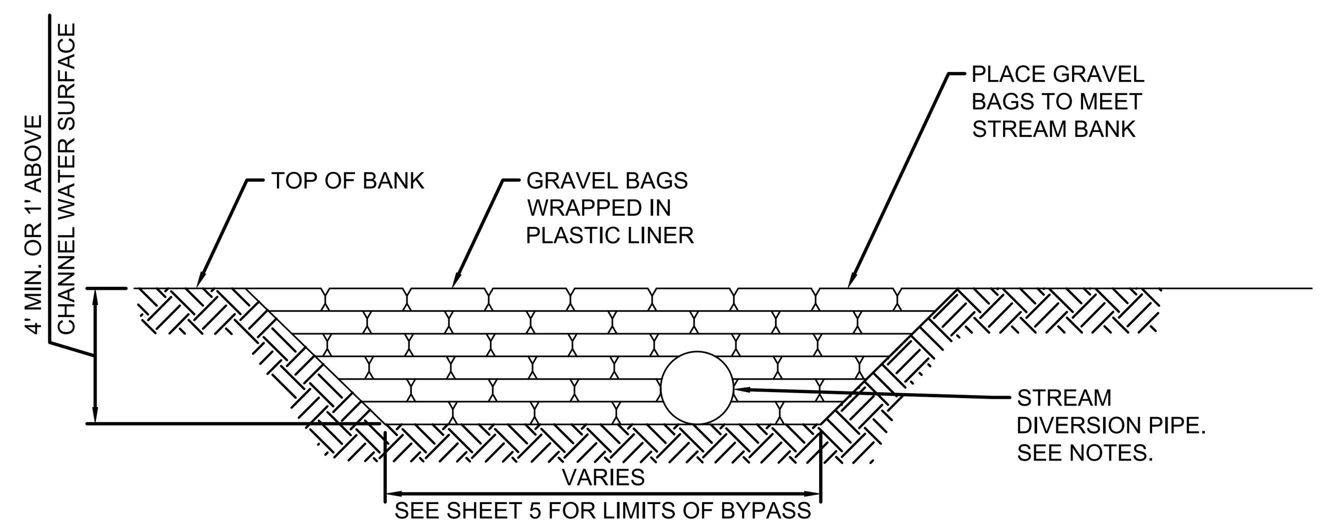
Osborn Consulting

GENERAL NOTE:

1. THE TEMPORARY STREAM DIVERSION DETAILS SHOWN ARE CONCEPTUAL. SEE SPECIAL PROVISIONS.



SIDE VIEW



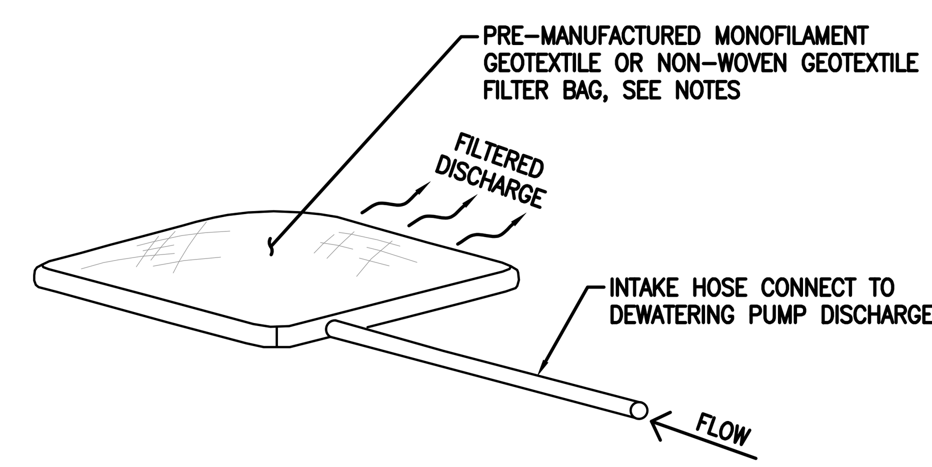
FRONT VIEW

NOTES:

1. COFFERDAM SHALL BE CONSTRUCTED BY THE CONTRACTOR WITH ROUNDED PEA GRAVEL BAGS, OR OTHER MEANS PRE-APPROVED BY THE ENGINEER. GRAVEL BAGS SHALL BE CONSTRUCTED OF WOVEN SYNTHETIC FIBER. NO ANGULAR OR CRUSHED MATERIALS MAY BE USED. GRAVEL BAGS SHALL BE WASTEHAULED AFTER REMOVAL OF TEMPORARY STREAM DIVERSION.
2. THE HEIGHT AND WIDTH OF THE COFFERDAM SHALL BE DETERMINED BY THE CONTRACTOR BASED ON THE WATER SURFACE ELEVATION AND CHANNEL SHAPE AT THE TIME OF CONSTRUCTION. THE COFFERDAMS SHALL BE REVIEWED AND APPROVED BY THE ENGINEER. THE AVERAGE MAXIMUM DAILY FLOW AND MAXIMUM DAILY FLOW DURING THE IN-STREAM WORK WINDOW FROM USGS GAGE #12021000 IS 62 CFS (BASE FLOW) AND 130 CFS (CONTINGENCY FLOW), RESPECTIVELY.
3. REMOVE LOOSE COBBLES AND BOULDERS FROM THE STREAMBED PRIOR TO INSTALLING COFFERDAM.
4. EXTEND BOTH ENDS OF THE COFFERDAM UP THE BANKS OF THE CHANNEL AS NEEDED TO PREVENT THE STREAM FROM END-RUNNING THE COFFERDAM.
5. COFFERDAM SHALL BE MAINTAINED BY THE CONTRACTOR AND IMPROVED AS NECESSARY AND DIRECTED BY THE ENGINEER.
6. CONTRACTOR SHALL HAVE ON SITE, EMERGENCY DIVERSION PIPE AND APPURTENANCES IN THE EVENT OF HIGH FLOWS. SEE THE CONTRACT PROVISIONS AND HPA FOR ADDITIONAL INFORMATION ON TEMPORARY STREM DIVERSION.
7. COFFERDAM MATERIALS SHALL BE REMOVED FROM THE SITE AND BECOME PROPERTY OF CONTRACTOR.

1/5 COFFER DAM DETAIL

NOT TO SCALE



NOTES:

1. FILTER BAG SHALL BE MINIMUM 10-FT X 15-FT AND REPLACED AS NEEDED TO ACCOMMODATE ACTUAL SEDIMENT LOAD CONDITIONS (I.E. VOLUME, TYPE OF SEDIMENT, ETC.)
2. DRAIN FILTER BAG TO COUNTY APPROVED RECEIVING AREA. RECEIVING AREA SHALL BE VEGETATED AND UPLAND OF THE OHWM AND TURBIDITY MONITORING STATION.
3. FILTER BAG SYSTEM TO BE INSPECTED DAILY WHEN IN USE TO VERIFY ADEQUATE PERFORMANCE.
4. TURBIDITY MONITORING STATION INSTALLED AND MAINTAINED. SEE SPECIAL PROVISIONS FOR TURBIDITY MONITORING REQUIREMENTS. SHOULD A TURBIDITY EXCEEDENCE OCCUR, THE FILTER BAG SYSTEM IS TO BE INSPECTED IMMEDIATELY AND REPLACED IF ANOTHER SEDIMENT SOURCE IS NOT IDENTIFIED.

2/5 FILTER BAG DETAIL

NOT TO SCALE

Lewis County
Department of Public Works
57 W. MAIN ST.
CHEHALIS WA 98532
PHONE # (360) 740-1123
FAX # (360) 740-2719

DESIGNED BY : MNZ
DRAWN BY : JAR
CHECKED BY : LCR
DATE : 05/14/2026

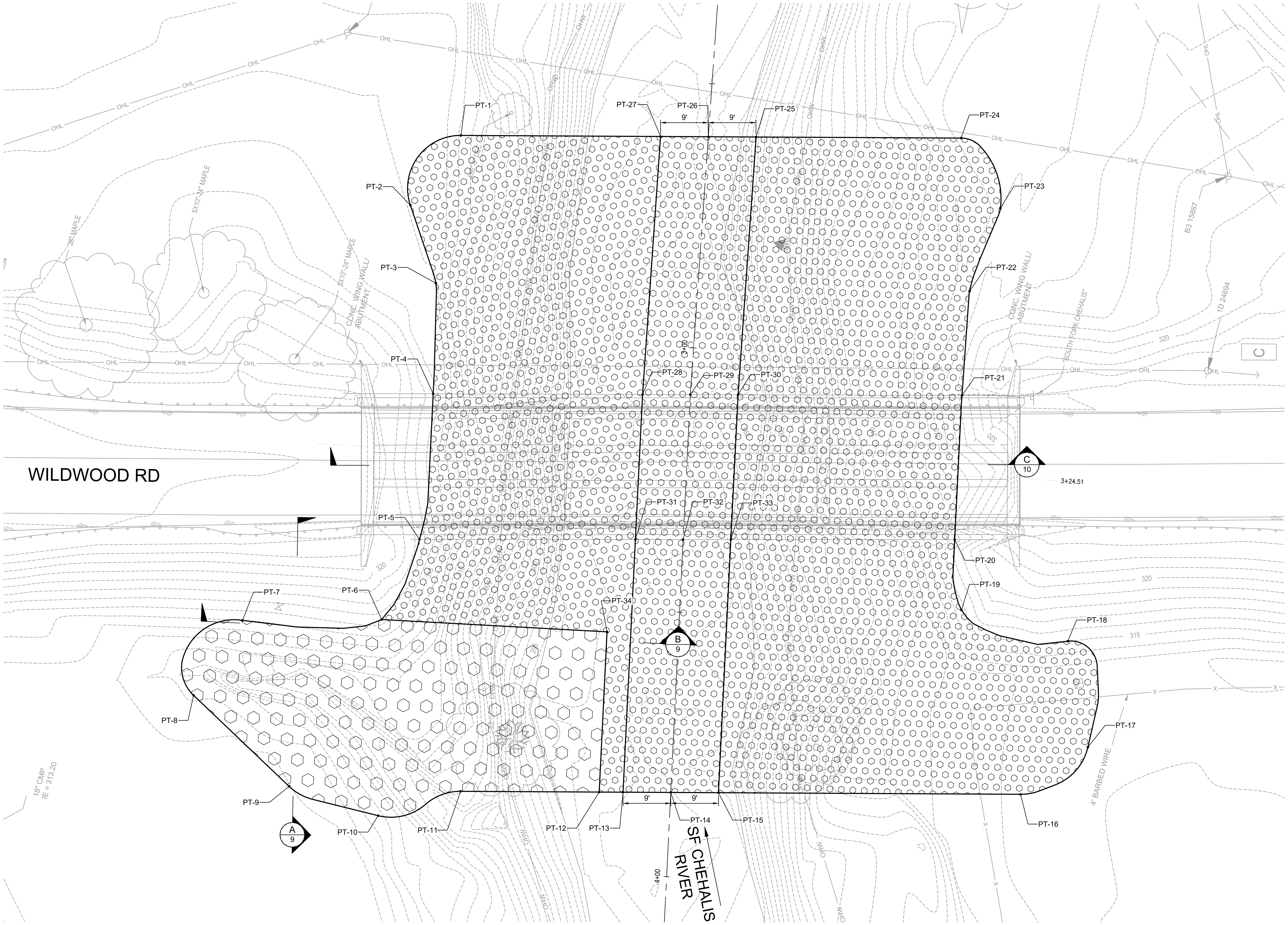
NO.	DATE	REVISION	BY	APP.

WILDWOOD MP 10.14 BRIDGE
SCOUR REPAIR

99% CONSTRUCTION PLANS
COUNTY ROAD PROJECT NO: 2159S

TEMPORARY STREAM DIVERSION DETAILS

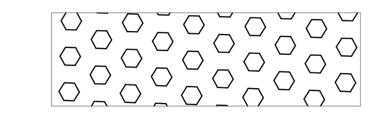
Osborn Consulting

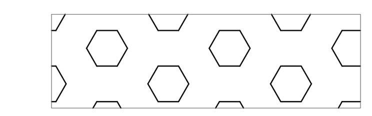


SCOUR COUNTERMEASURE NOTES:

1. SEE SCOUR COUNTERMEASURE LAYOUT TABLE ON THIS SHEET FOR LAYOUT POINTS AND TOP OF COUNTERMEASURE ELEVATIONS.
2. SEE SHEET 8 FOR SCOUR COUNTERMEASURE PROFILE.
3. SEE SHEETS 9 AND 10 FOR SCOUR COUNTERMEASURE SECTIONS.
4. MINIMIZE DISTURBANCE OF THE STREAMBED OUTSIDE OF THE SCOUR COUNTERMEASURE FOOTPRINT TO THE MAXIMUM EXTENT PRACTICABLE. STREAMBED OUTSIDE THE SCOUR COUNTERMEASURE LIMITS THAT IS DISTURBED SHALL BE RETURNED TO EXISTING CONDITIONS.
5. SEE SHEET 11 FOR ALIGNMENT LAYOUT TABLE.

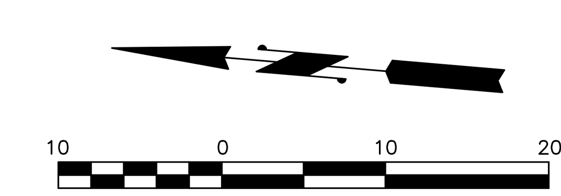
LEGEND


ROCK FOR EROSION AND SCOUR PROTECTION CLASS B, 3-FOOT THICKNESS (APPROXIMATELY 1005 TONS)


ROCK FOR EROSION AND SCOUR PROTECTION CLASS B, 6-FOOT THICKNESS (APPROXIMATELY 400 TONS)

CONTROL POINT TABLE

POINT ID	STA	OFFSET	TOP OF COUNTER MEASURE ELEVATION
PT-1	2+63.0	46.6' R	312.9'
PT-2	2+76.9	55.2' R	315.0'
PT-3	2+91.2	49.4' R	315.0'
PT-4	3+11.1	48.5' R	315.0'
PT-5	3+38.6	49.7' R	315.0'
PT-6	3+54.1	56.1' R	315.0'
PT-7	3+55.6	82.3' R	315.0'
PT-8	3+70.2	90.9' R	311.9'
PT-9	3+86.4	72.0' R	313.1'
PT-10	3+91.2	55.0' R	308.2'
PT-11	3+85.8	39.6' R	300.7'
PT-12	3+84.7	13.5' R	291.4'
PT-13	3+84.5	9.0' R	288.4'
PT-14	3+84.1	0.0' C	288.4'
PT-15	3+83.7	9.0' L	288.4'
PT-16	3+81.2	66.0' L	312.3'
PT-17	3+71.7	78.2' L	312.9'
PT-18	3+51.9	73.5' L	315.0'
PT-19	3+47.0	53.1' L	315.0'
PT-20	3+33.7	51.2' L	315.0'
PT-21	3+05.4	51.2' L	315.0'
PT-22	2+85.7	51.2' L	315.0'
PT-23	2+69.6	56.0' L	315.0'
PT-24	2+57.0	47.6' L	314.1'
PT-25	2+59.5	9.0' L	287.9'
PT-26	2+60.0	0.0' C	287.9'
PT-27	2+60.6	9.0' R	287.9'
PT-28	3+09.3	9.0' R	288.1'
PT-29	3+08.9	0.0' C	288.1'
PT-30	3+08.3	9.0' L	288.1'
PT-31	3+36.7	9.0' R	288.1'
PT-32	3+36.3	0.0' C	288.1'
PT-33	3+35.8	9.0' L	288.1'
PT-34	3+54.4	13.5' R	291.2'



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DRAWN BY : JAR
CHECKED BY : LCR
DATE : 05/14/2026

NO.	DATE	REVISION	BY	APP.

WILDWOOD MP 10.14 BRIDGE SCOUR REPAIR

99% CONSTRUCTION PLANS
COUNTY ROAD PROJECT NO: 2159S

SCOUR COUNTERMEASURE PLAN

Osborn Consulting

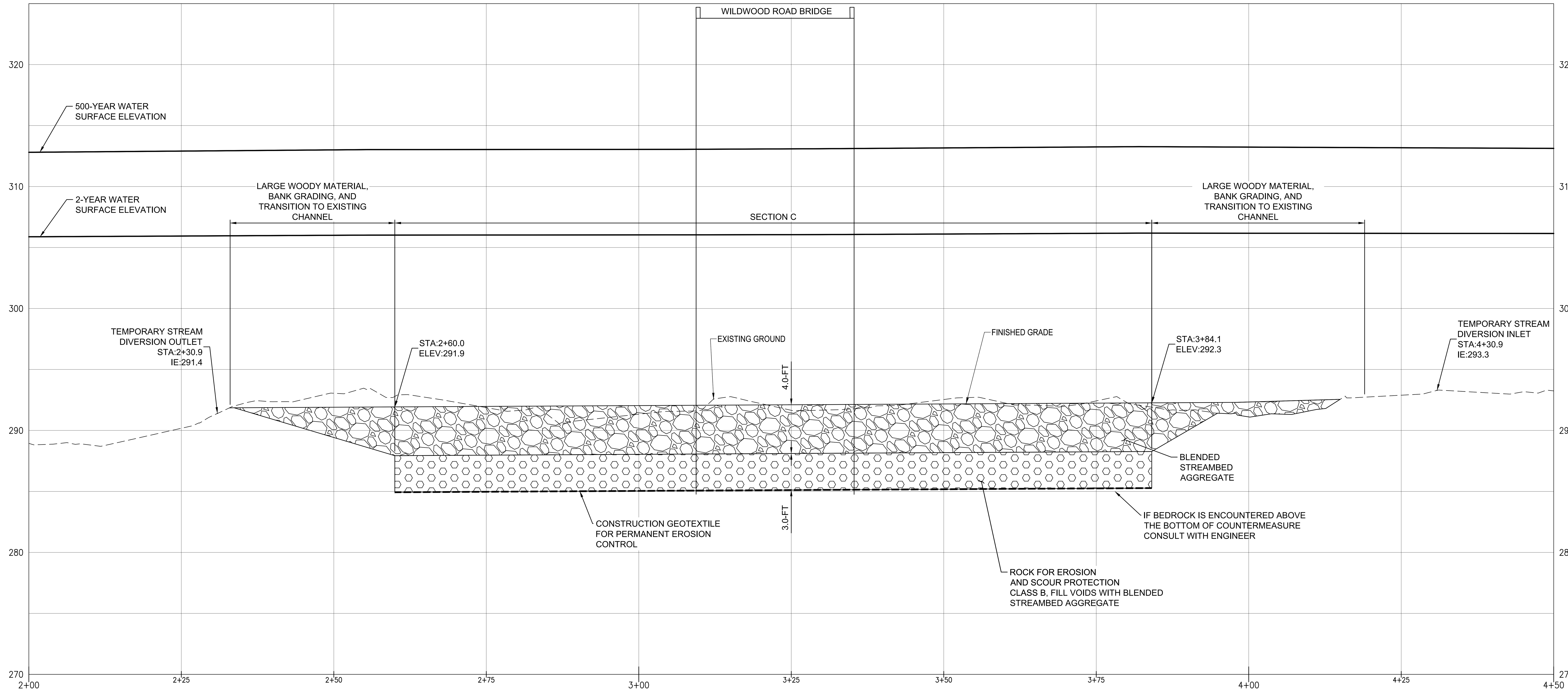
GENERAL NOTES:

1. ALL MATERIAL AND WORK SHALL BE IN ACCCORDANCE WITH THE REQUIREMENTS OF THE WASHINGTON STATE DEPARTMENT OF TRANSPORTATION, "STANDARD SPECIFICATIONS FOR ROAD, BRIDGE, AND MUNICIPAL CONSTRUCTION" 2026 EDITION AND SPECIAL PROVISIONS.
2. SEE SHEETS 9 AND 10 FOR TYPICAL SCOUR COUNTERMEASURE AND STREAM RECONSTRUCTION SECTION.
3. SEE SHEET 12 FOR LARGE WOODY MATERIAL DETAILS.

LEGEND

ROCK FOR EROSION AND SCOUR PROTECTION CLASS B, 3-FOOT THICKNESS

BLENDED STREAMBED AGGREGATE



PROFILE VIEW

H: 1"=10', V: 1"=5'

Lewis County Department of Public Works 57 W. MAIN ST. CHEHALIS WA 98532 PHONE # (360) 740-1123 FAX # (360) 740-2719	DESIGNED BY : MNZ DRAWN BY : JAR CHECKED BY : LCR DATE : 05/14/2026	NO. / DATE / REVISION / BY / APP.	WILDWOOD MP 10.14 BRIDGE SCOUR REPAIR	99% CONSTRUCTION PLANS COUNTY ROAD PROJECT NO: 2159S SCOUR COUNTERMEASURE PROFILE

SHEET 8 OF 15

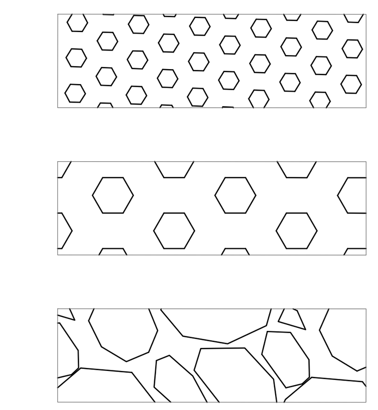
CALL 48 HOURS BEFORE YOU DIG 1-800-424-5555 "It's the Law" Utilities Underground Location Center

Osborn Consulting

GENERAL NOTES:

1. BLENDED STREAMBED AGGREGATE IS 75% STREAMBED SEDIMENT AND 25% 4-INCH COBBLES. SEE STANDARD SPECIFICATION 8-30 "STREAMS, RIVERS, AND WATERBODIES."

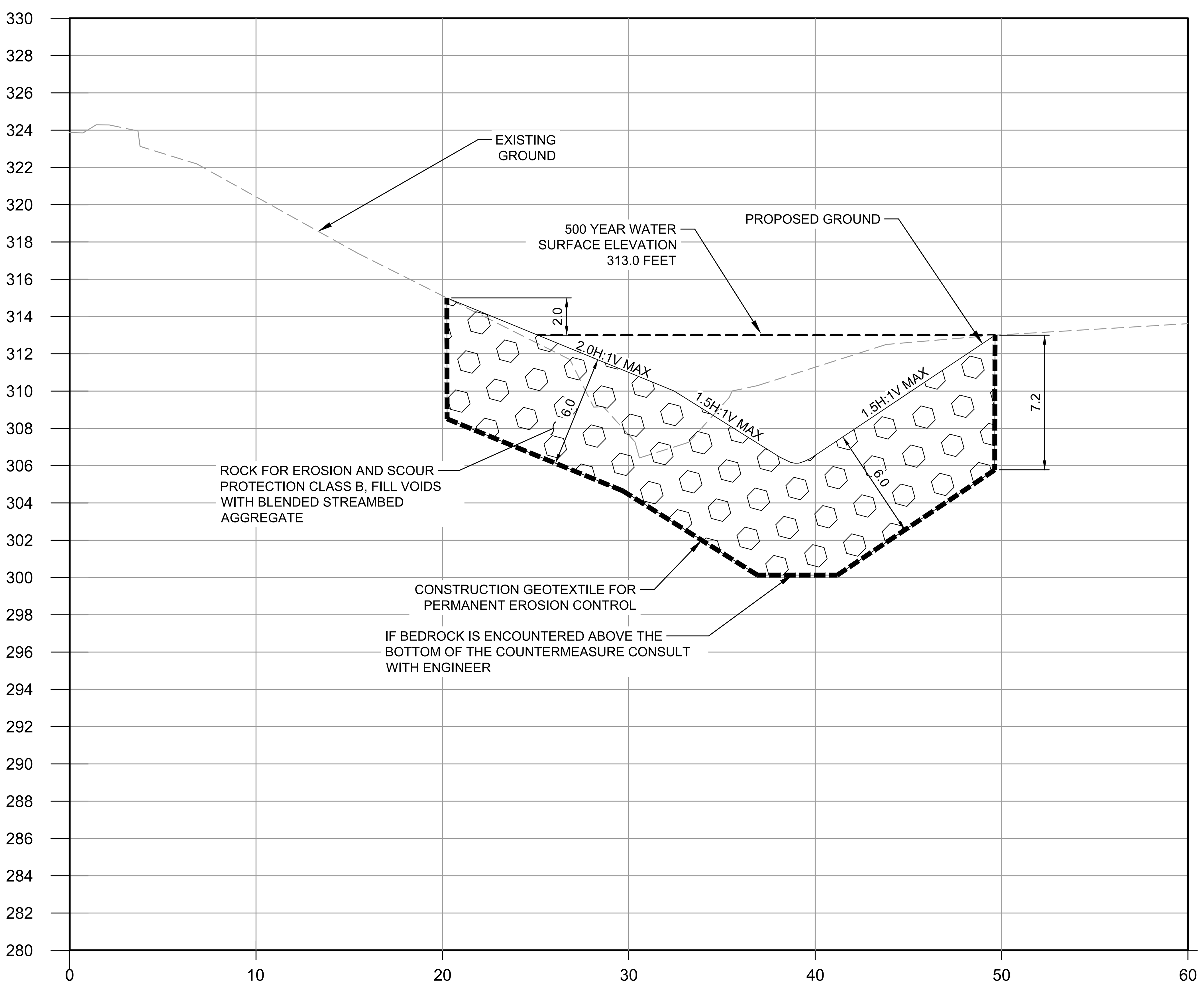
LEGEND



ROCK FOR EROSION AND SCOUR PROTECTION CLASS B, 3-FOOT THICKNESS

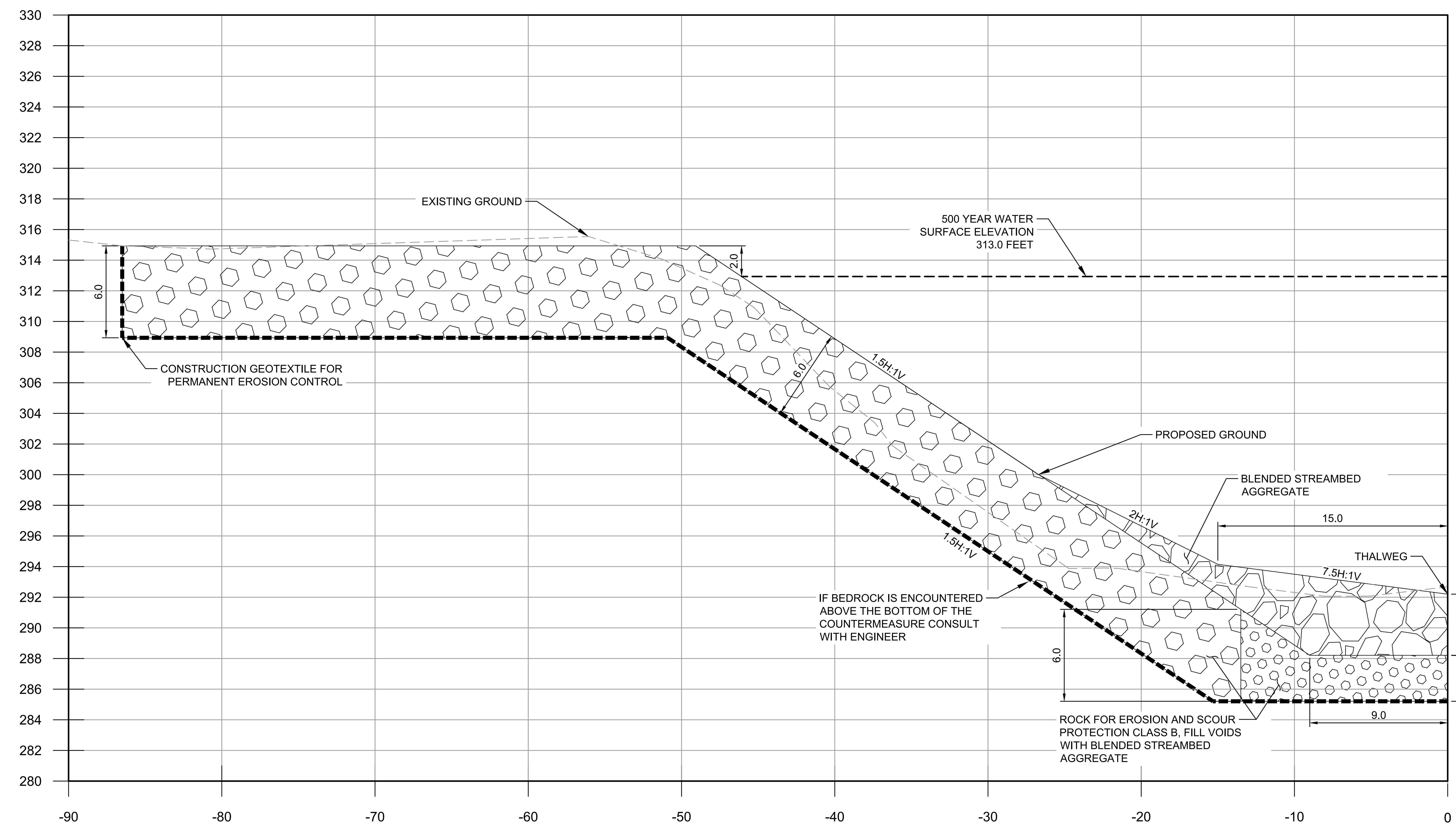
ROCK FOR EROSION AND SCOUR PROTECTION CLASS B, 6-FOOT THICKNESS

BLENDED STREAMBED AGGREGATE



SECTION A - SCOUR COUNTERMEASURE TYPICAL SECTION ALONG BRIDGE APPROACH

SCALE: 1"=5'



SECTION B - SCOUR COUNTERMEASURE TYPICAL SECTION WITH INCREASED RIPRAP THICKNESS

SCALE: 1"=5'

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WILDWOOD MP 10.14 BRIDGE SCOUR REPAIR

99% CONSTRUCTION PLANS
COUNTY ROAD PROJECT NO: 2159S

SCOUR COUNTERMEASURE DETAILS

SHEET 9 OF 15

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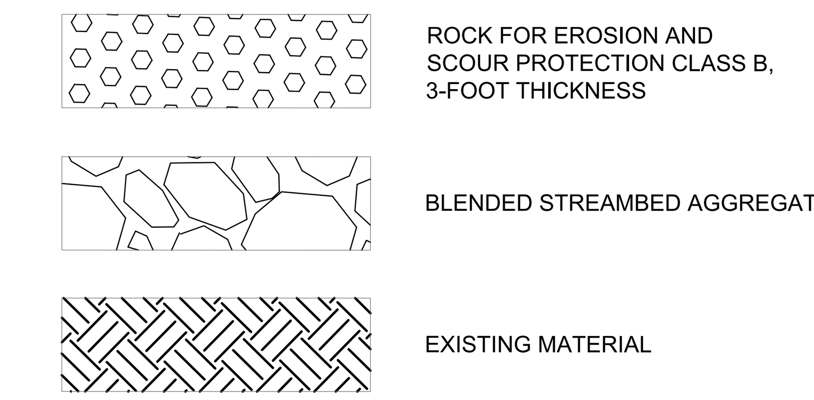
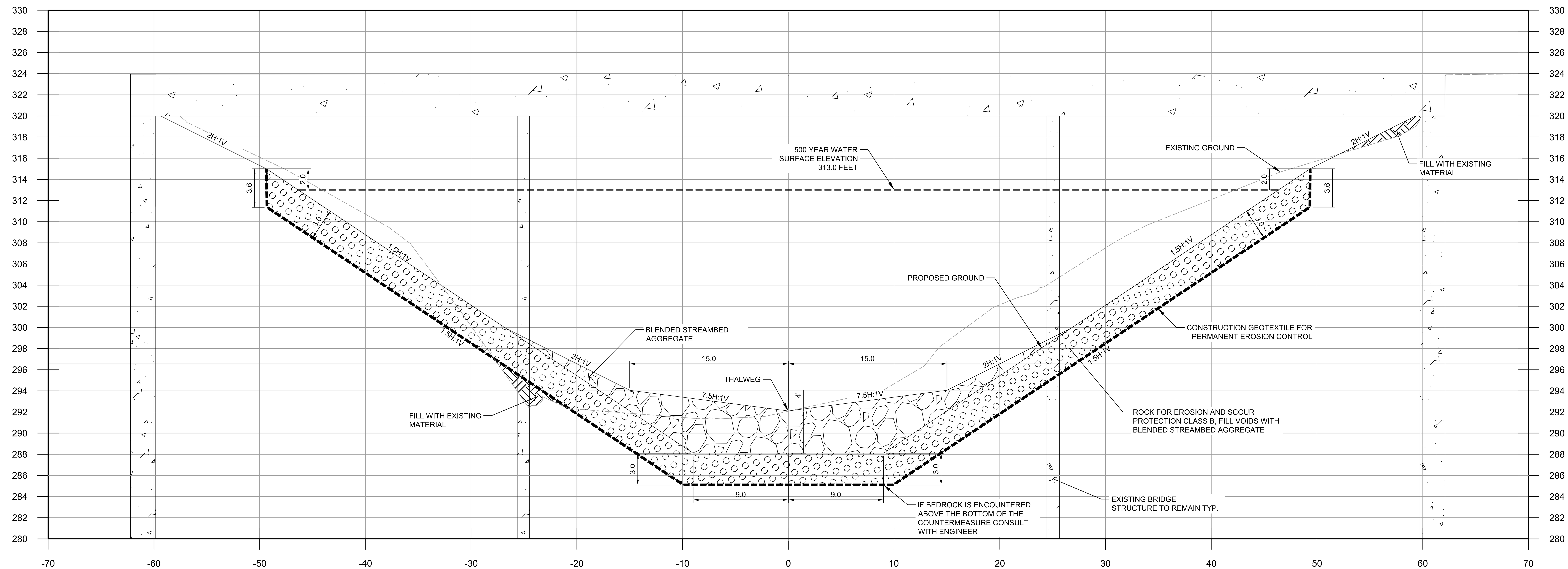
GENERAL NOTES:

1. BLENDED STREAMBED AGGREGATE IS 75% STREAMBED SEDIMENT AND 25% 4-INCH COBBLES. SEE STANDARD SPECIFICATION 8-30 "STREAMS, RIVERS, AND WATERBODIES."

LEGEND





SECTION C - TYPICAL SCOUR COUNTERMEASURE AND STREAM RECONSTRUCTION SECTION
SCALE: 1"=5'

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WILDWOOD MP 10.14 BRIDGE SCOUR REPAIR

99% CONSTRUCTION PLANS
COUNTY ROAD PROJECT NO: 2159S

SCOUR COUNTERMEASURE DETAILS

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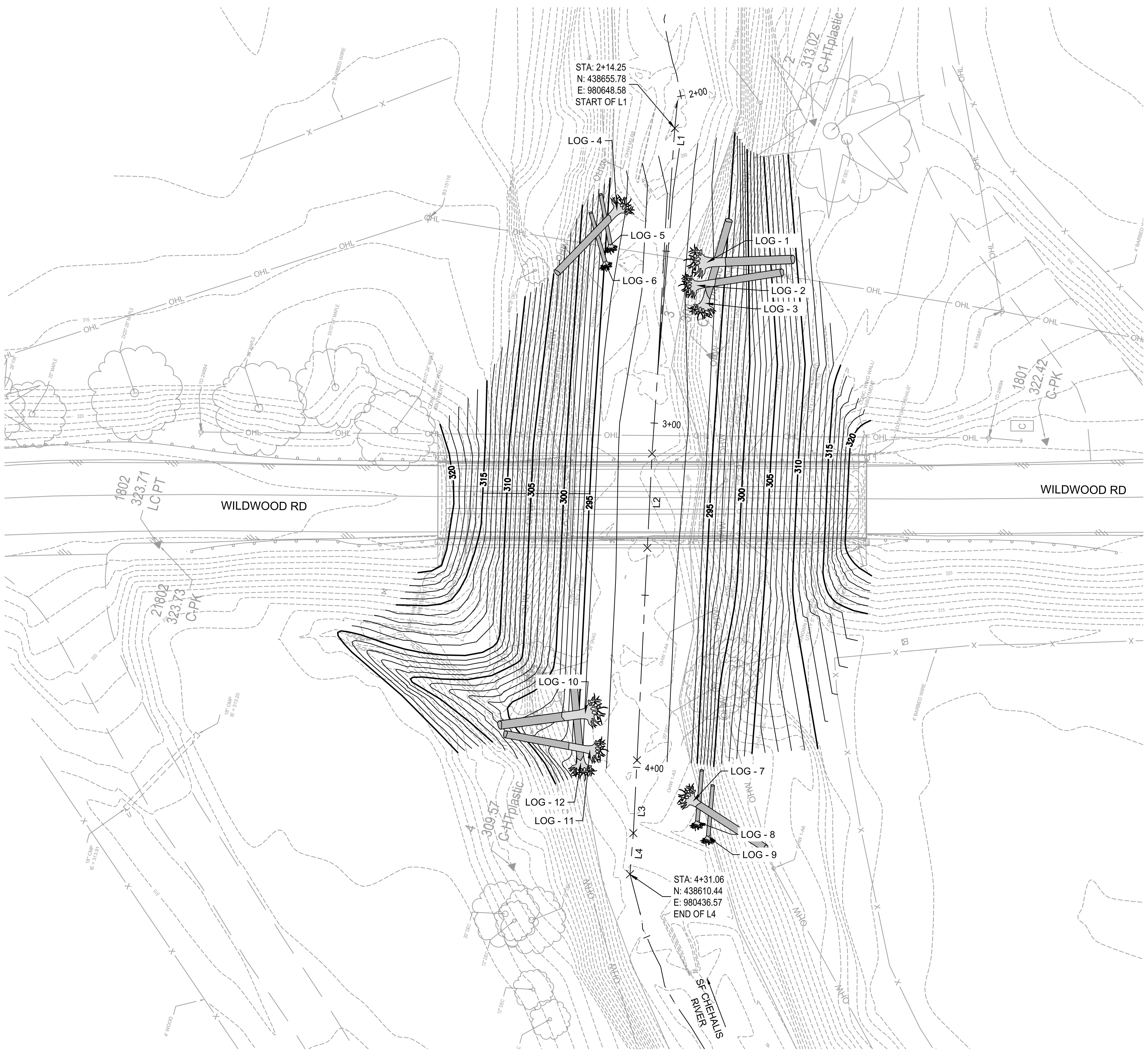
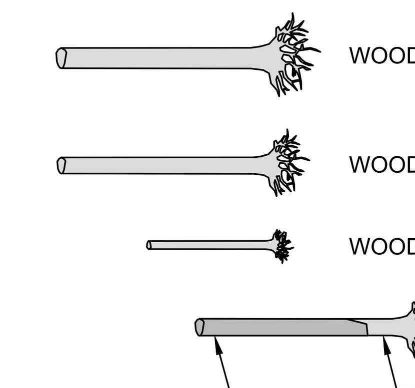


GENERAL NOTE:

1. ALL MATERIAL AND WORK SHALL BE IN ACCORDANCE WITH THE REQUIREMENTS OF THE WASHINGTON STATE DEPARTMENT OF TRANSPORTATION, "STANDARD SPECIFICATIONS FOR ROAD, BRIDGE, AND MUNICIPAL CONSTRUCTION" 2026 EDITION AND SPECIAL PROVISIONS.
2. LOCATIONS AND ORIENTATIONS OF LWM FEATURES ARE APPROXIMATE AND SHALL BE STAKED BY THE CONTRACTOR AND APPROVED BY THE FIELD STREAM DESIGN ENGINEER. FINAL LOCATION AND ORIENTATION OF THESE FEATURES SHALL BE APPROVED BY THE FIELD STREAM DESIGN ENGINEER.
3. SEE SHEET 12 FOR LARGE WOODY MATERIAL DETAILS.
4. SEE SHEET 10 FOR TYPICAL STREAM SECTION.
5. SEE SHEET 8 FOR STREAM PROFILE.

LEGEND



LOG LAYOUT TABLE

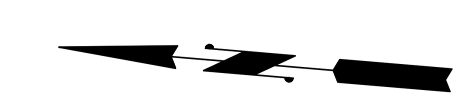
LOG ID	ROOTWAD CROWN STA OFFSET	ROOTWAD CROWN ELEVATION	LOG END STA OFFSET	LOG END ELEVATION	LWM TYPE AND DETAIL
1	2+52.5, 12.0' L	295.8'	2+49.9, 36.3' L	297.5'	LWM TYPE A, SEE DETAIL 1
2	2+59.3, 9.6' L	295.5'	2+53.9, 33.5' L	297.7'	LWM TYPE B, SEE DETAIL 1
3	2+64.3, 12.3' L	293.6'	2+40.3, 17.4' L	292.7'	LWM TYPE B, SEE DETAIL 1
4	2+39.2, 15.1' R	296.3'	2+58.1, 30.8' R	297.6'	LWM TYPE B, SEE DETAIL 2
5	2+49.4, 16.2' R	294.5'	2+35.1, 20.0' R	294.2'	LWM TYPE C, SEE DETAIL 2
6	2+54.5, 17.4' R	294.9'	2+40.6, 22.5' R	294.6'	LWM TYPE C, SEE DETAIL 2
7	4+09.0, 16.9' L	295.5'	4+13.8, 40.9' L	296.8'	LWM TYPE B, SEE DETAIL 2
8	4+14.9, 18.4' L	294.0'	4+00.1, 18.9' L	294.1'	LWM TYPE C, SEE DETAIL 2
9	4+19.1, 21.8' L	295.0'	4+04.3, 22.2' L	294.7'	LWM TYPE C, SEE DETAIL 2
10	3+85.2, 15.7' R	296.4'	3+89.3, 39.7' R	298.1'	LWM TYPE A, SEE DETAIL 1
11	3+95.6, 13.8' R	295.4'	3+92.3, 38.1' R	297.6'	LWM TYPE B, SEE DETAIL 1
12	3+99.5, 16.2' R	294.3'	3+74.9, 19.6' R	293.4'	LWM TYPE B, SEE DETAIL 1

LOG SCHEDULE

LOG TYPE	LOG SIZE	QUANTITY
A	25' LOG WITH ROOTWAD DBH 30"	2
B	25' LOG WITH ROOTWAD DBH 24"	6
C	15' LOG WITH ROOTWAD DBH 12"	4

CENTERLINE LINE DATA

NO.	BEARING	DISTANCE
L1	S78°28'57"W	94.60
L2	S77°20'46"W	27.41
L3	S77°22'10"W	21.16
L4	S79°12'38"W	11.96



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WILDWOOD MP 10.14 BRIDGE
SCOUR REPAIR

99% CONSTRUCTION PLANS
COUNTY ROAD PROJECT NO: 2159S
STREAM RECONSTRUCTION PLAN

SHEET 11 OF 15

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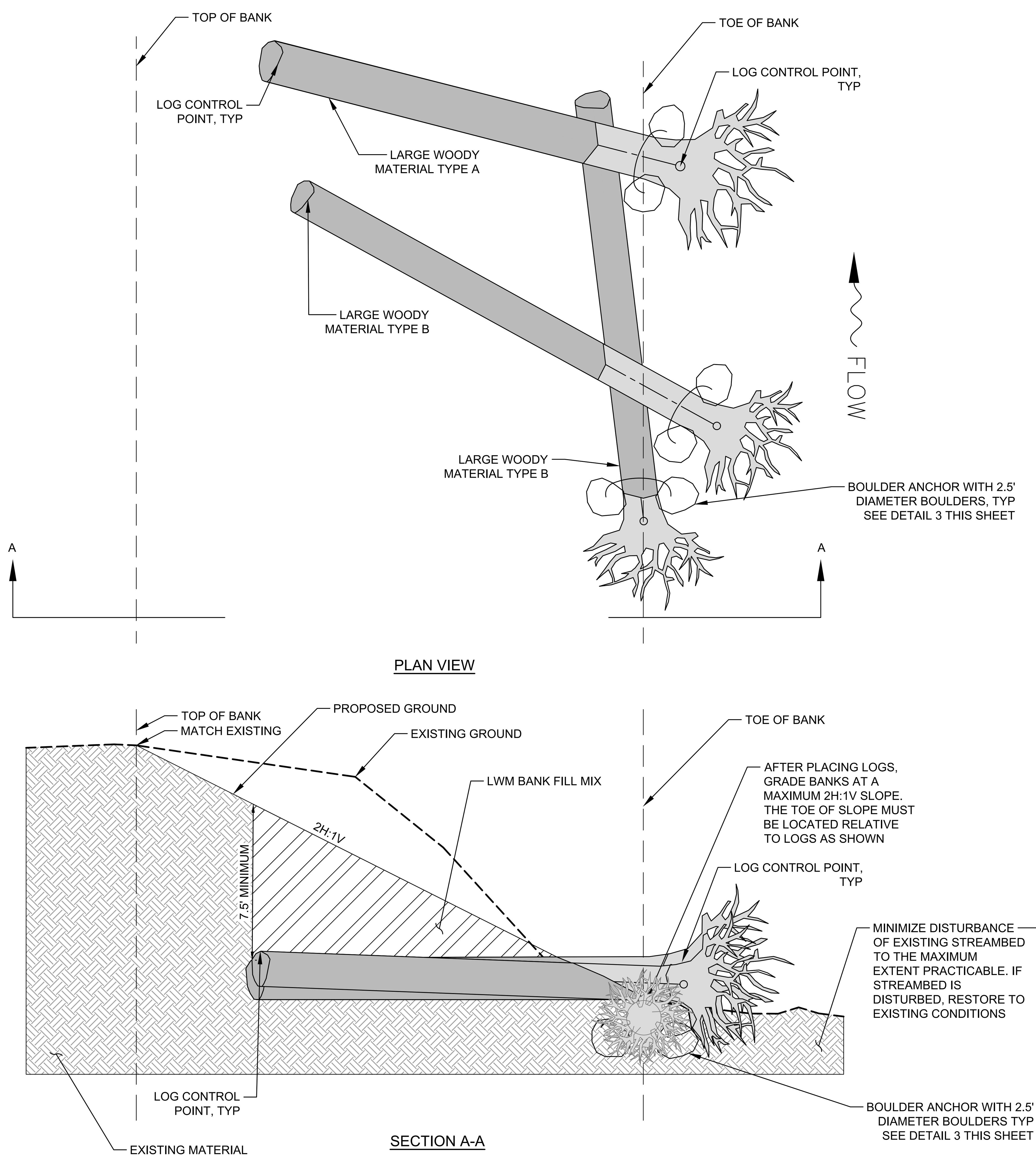
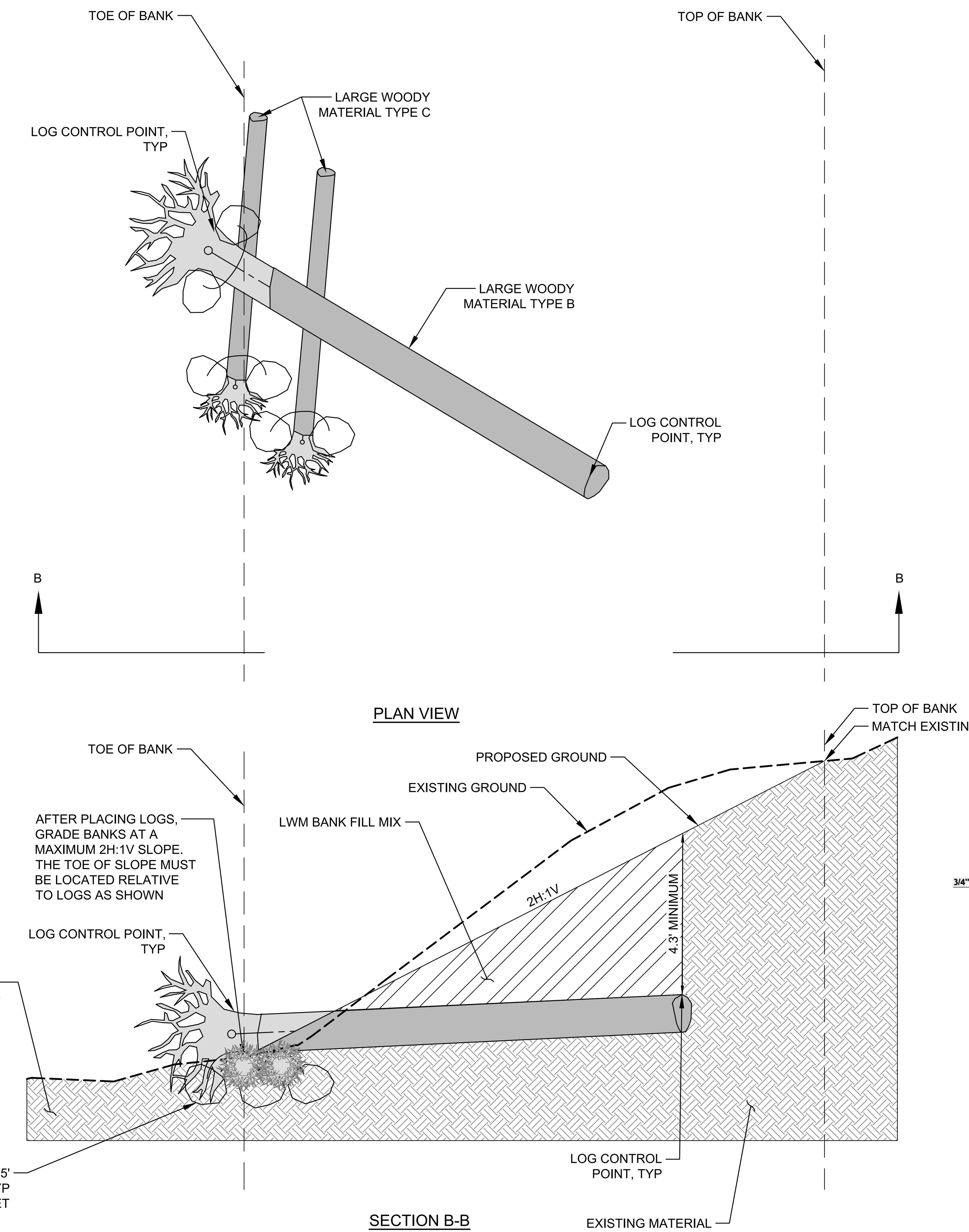




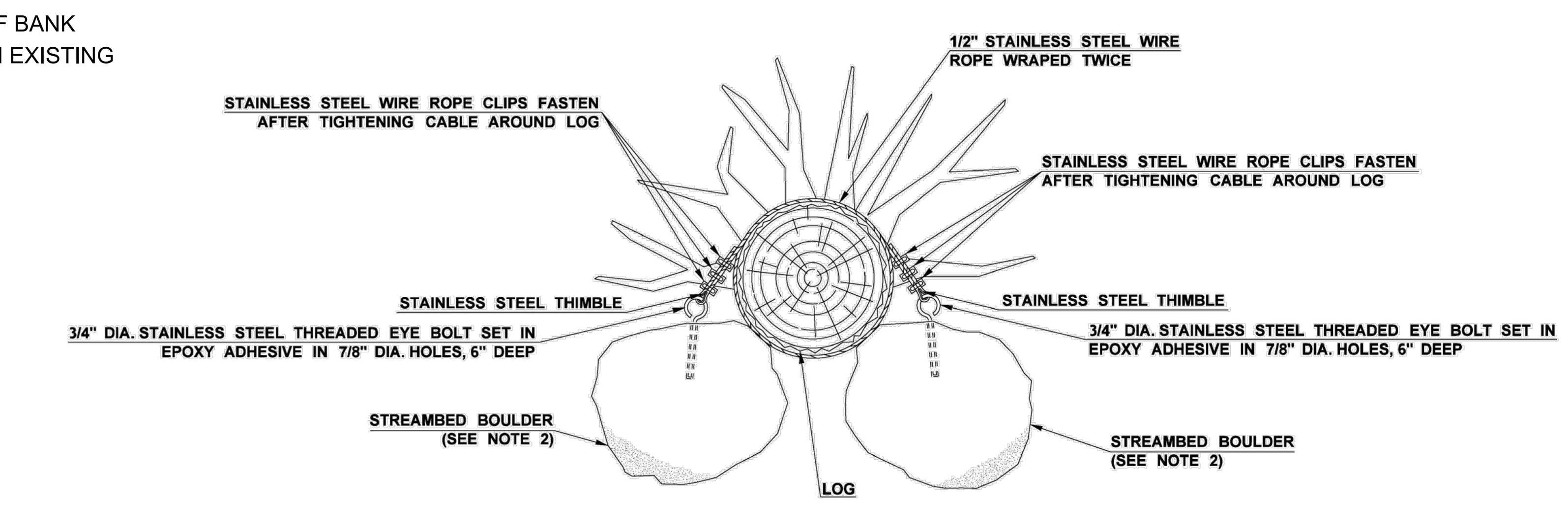
STREAM RECONSTRUCTION NOTES:

1. DETAILS SHOWN ON THIS SHEET MAY BE ROTATED OR MIRRORED. SEE SHEET 11 FOR LARGE WOODY MATERIAL (LWM) ORIENTATIONS.
2. SEE LWM LAYOUT TABLE AND LWM SCHEDULE ON SHEET 11 FOR LOG CONTROL POINTS, TOP OF LOG ELEVATIONS, AND LOG DIMMENSIONS.
3. SEE SPECIAL PROVISIONS 8-33 "LOG STRUCTURES" FOR LWM.
4. LOCATIONS AND ORIENTATIONS OF STREAMBED FEATURES ARE APPROXIMATE AND SHALL BE STAKED PER PLAN BY THE CONTRACTOR AND APPROVED BY THE FIELD STREAM DESIGN ENGINEER. FINAL LOCATION AND ORIENTATION OF THESE STREAMBED FEATURES SHALL BE APPROVED BY THE FIELD STREAM DESIGN ENGINEER.
5. BLENDED STREAMBED AGGREGATE IS 25% 4-INCH COBBLES AND 75% STREAMBED SEDIMENT. SEE STANDARD SPECIFICATIONS 8-30 "STREAM, RIVERS, AND WATERBODIES."
6. ALL LWM DETAIL SECTIONS ON THIS SHEET ARE LOOKING DOWNSTREAM.
7. LWM BANK FILL MIX IS 50% BLENDED STREAMBED AGGREGATE AND 50% ROCK FOR EROSION CONTROL AND SCOUR PROTECTION CLASS B

LEGEND:

LWM BANK FILL MIX

EXISTING MATERIAL



NOTES:

1. SEE SPECIAL PROVISIONS "WOODY MATERIAL" FOR DESCRIPTION OF MATERIALS AND CONSTRUCTION REQUIREMENTS.
2. SEE STANDARD SPECIFICATIONS 8-30 "WATER CROSSINGS" FOR BOULDER DESCRIPTION.

1/11 LARGE WOODY MATERIAL (LWM) LOG JAM - DETAIL 1
NOT TO SCALE

2/11 LARGE WOODY MATERIAL (LWM) LOG JAM - DETAIL 2
NOT TO SCALE

3/12 BOULDER ANCHOR - DETAIL 3
NOT TO SCALE

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WILDWOOD MP 10.14 BRIDGE SCOUR REPAIR

99% CONSTRUCTION PLANS
COUNTY ROAD PROJECT NO: 2159S
STREAM RECONSTRUCTION DETAILS

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Appendix F: Revetment Rock Sizing Calculations

Particle size for which 30% is finer by weight, ft (m)	d30		0.949	ft
Local depth of flow, ft (m)	y		21.36	ft
Safety factor (must be > 1.0)	Sf		2	
Stability coefficient (for blanket thickness = d100 or 1.5d50, whichever is greater, and uniformity ratio d85/d15 = 1.7 to 5.2)	Cs		0.3	<-- select which Cs to use
		angular rock	0.3	
		rounded rock	0.375	
Velocity distribution coefficient	Cv		1.08	<-- select which Cv to use
for straight channels or the inside of bends			1.00	Countermeasure not on bed. 2D model used
for the outside of bends (1.0 for Rc/W > 26)	Cv = 1.283 - 0.2log(Rc/W)		1.08	
downstream from concrete channels			1.25	
at the end of dikes			1.25	
Blanket thickness coefficient given as a function of the uniformity ratio d85/d15. CT = 1.0 is recommended because it is based on very limited data.	CT		1	
Characteristic velocity for design, defined as the depth-averaged velocity at a point 20% upslope from the toe of the revetment, ft/s (m/s)	Vdes		9.76	<-- select which Vdes to use
For natural channels	Vdes = Vavg(1.74 – 0.52log(Rc/W))		9.76	ft/s
	Vdes = Vavg for Rc/W > 26		6.24	ft/s Countermeasure not on bed. 2D model used
For trapezoidal channels	Vdes = Vavg (1.71 – 0.78 log (Rc/W))		9.02	ft/s
	Vdes = Vavg for Rc/W > 8		6.24	ft/s
	Rc/W		2.18	
Channel cross-sectional average velocity, ft/s (m/s)	Vavg		6.24	ft/s
Side slope correction factor	K1(see equation on right)		0.72	
bank angle in degrees	θ		33.70	degrees 1.5:1 slope = 33.7 degrees
Centerline radius of curvature of channel bend, ft (m)	Rc		240	ft
Width of water surface at upstream end of channel bend, ft (m)	W		110	ft
Specific gravity of riprap	Sg		2.65	
Acceleration due to gravity	g		32.2	ft/s2
	d50		1.139	ft

SMS Results - 500yr upstream observation line

Reach	Station	Velocity ft/s Ave	Water_Depth ft Max
reach_2	5+01	**6.24**	**21.36**

FHWA HEC 23 Volume 2 Design Guideline 4.2.2 (PDF page 74)

$$d_{30} = y(S_f C_S C_V C_T)\left[\frac{(V_{des})}{\sqrt{K_1(S_g - 1)gy}}\right]^{2.5} \quad (4.1)$$

where:

d_{30}	=	Particle size for which 30% is finer by weight, ft (m)
y	=	Local depth of flow, ft (m)
S_f	=	Safety factor (must be > 1.0)
C_S	=	Stability coefficient (for blanket thickness = d_{100} or $1.5d_{50}$, whichever is greater, and uniformity ratio d_{85}/d_{15} = 1.7 to 5.2) = 0.30 for angular rock = 0.375 for rounded rock
C_V	=	Velocity distribution coefficient = 1.0 for straight channels or the inside of bends = 1.283 - 0.2log(R_c/W) for the outside of bends (1.0 for R_c/W > 26) = 1.25 downstream from concrete channels = 1.25 at the end of dikes
C_T	=	Blanket thickness coefficient given as a function of the uniformity ratio d_{85}/d_{15}. C_T = 1.0 is recommended because it is based on very limited data.
V_{des}	=	Characteristic velocity for design, defined as the depth-averaged velocity at a point 20% upslope from the toe of the revetment, ft/s (m/s) For natural channels, $V_{des} = V_{avg}(1.74 - 0.52\log(R_c/W))$ $V_{des} = V_{avg}$ for $R_c/W > 26$ For trapezoidal channels, $V_{des} = V_{avg}(1.71 - 0.78\log(R_c/W))$ $V_{des} = V_{avg}$ for $R_c/W > 8$
V_{avg}	=	Channel cross-sectional average velocity, ft/s (m/s)
K_1	=	Side slope correction factor $K_1 = \sqrt{1 - \left(\frac{\sin(\theta - 14^\circ)}{\sin(32^\circ)}\right)^{1.6}}$ where: θ is the bank angle in degrees
R_c	=	Centerline radius of curvature of channel bend, ft (m)
W	=	Width of water surface at upstream end of channel bend, ft (m)
S_g	=	Specific gravity of riprap (usually taken as 2.65)
g	=	Acceleration due to gravity, 32.2 ft/s^2 (9.81 m/s^2)

$$d_{50} = 1.20\, d_{30}$$

Appendix G: Pier Rock Sizing Calculations

Particle size for which 50% is finer by weight, ft (m)	d50	0.57	ft
Design velocity for local conditions at the pier, ft/s (m/s)	Vdes	9.38	ft/s
Specific gravity of riprap (usually taken as 2.65)	Sg	2.65	
Acceleration due to gravity	g	32.2	ft/s2
Shape factor equal to	K1	1.5	<-- select which K1 to use
1.5 for round-nose piers		1.5	
1.7 for square-faced piers		1.7	
Vmax		6.25	ft/s

SMS results

Proposed Conditions		500yr
Reach	Station	Vel Max ft/s
reach_2	313.295	**6.25**

FHWA HEC 23 Volume 2 Design Guideline 11.3 (PDF page 216)

11.3 SIZING ROCK RIPRAP AT BRIDGE PIERS

To determine the required size of stone for riprap at bridge piers, NCHRP Project 24-23 recommends using the rearranged Isbash equation from the Federal Highway Administration's Hydraulic Engineering Circular No. 23 (Second Edition) (Lagasse et al. 2001) to solve for the median stone diameter:

$$d_{50} = \frac{0.692(V_{des})^2}{(S_g - 1)2g} \qquad (11.1)$$

where: d_{50} = Particle size for which 50% is finer by weight, ft (m)
V_{des} = Design velocity for local conditions at the pier, ft/s (m/s)
S_g = Specific gravity of riprap (usually taken as 2.65)
g = Acceleration due to gravity, 32.2 ft/s^2 (9.81 m/s^2)

It is important that the velocity used in Equation 11.1 is representative of conditions in the immediate vicinity of the bridge pier including the constriction caused by the bridge. If the cross-section or channel average velocity, V_{avg}, is used, then it must be multiplied by factors that are a function of the shape of the pier and its location in the channel:

$$V_{des} = K_1 K_2 V_{avg} \qquad (11.2)$$

If a velocity is distribution available from stream tube or flow distribution output of a 1-D model or directly from a 2-D model, then only the pier shape coefficient should be used. The maximum velocity in the active channel V_{max} is often used since the channel could shift and the highest velocity could impact any pier.

$$V_{des} = K_1 V_{max} \qquad (11.3)$$

where: V_{des} = Local velocity at pier, ft/s (m/s)
K_1 = Shape factor equal to 1.5 for round-nose piers or 1.7 for square-faced piers
K_2 = Velocity adjustment factor for location in the channel (ranges from 0.9 for a pier near the bank in a straight reach, to 1.7 for a pier located in the main current of flow around a sharp bend)
V_{avg} = Channel average velocity at the bridge, ft/s (m/s)
V_{max} = Maximum velocity in the active channel, ft/s (m/s)