Washington State Department of Transportation

SR 241 MP 1.12 Yakima River Bridge (241/2) Replacement: Hydraulics and Scour Analysis Report

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SR 241 MP 1.12 Yakima River
Final Hydraulic Design Report
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1.0 Introduction and Purpose

The Washington State Department of Transportation (WSDOT) is proposing a project to improve the weight rating of two State Route (SR) 241 bridge crossings of the Yakima River to make them compliant with current seismic standards. The first crossing (241/5) is on the main channel of the Yakima River and the other is in its floodplain (241/2). The project involves retrofitting bridge 241/5, which is located at Milepost (MP) 1.34, and replacing the existing bridge 241/2 at MP 1.12 with a new structure. The present report documents the hydraulic and scour analysis performed by Northwest Hydraulic Consultants (NHC) for the replacement of bridge 241/2.

Bridge 241/2 is located in Yakima County, WA approximately 1 mile north of the city of Mabton (Figure 1.1). At this location, SR 241 runs in the north to south direction, while the Yakima River flows west to east. This project proposes to replace the existing 241/2 bridge with a three-span structure that includes two abutment piers and two in-water piers. The bridge will meet design requirements for hydraulics based on criteria from the United States Federal Highway Administration (FHWA), Washington State Department of Transportation (WSDOT), and the Washington State Department of Fish and Wildlife (WDFW).

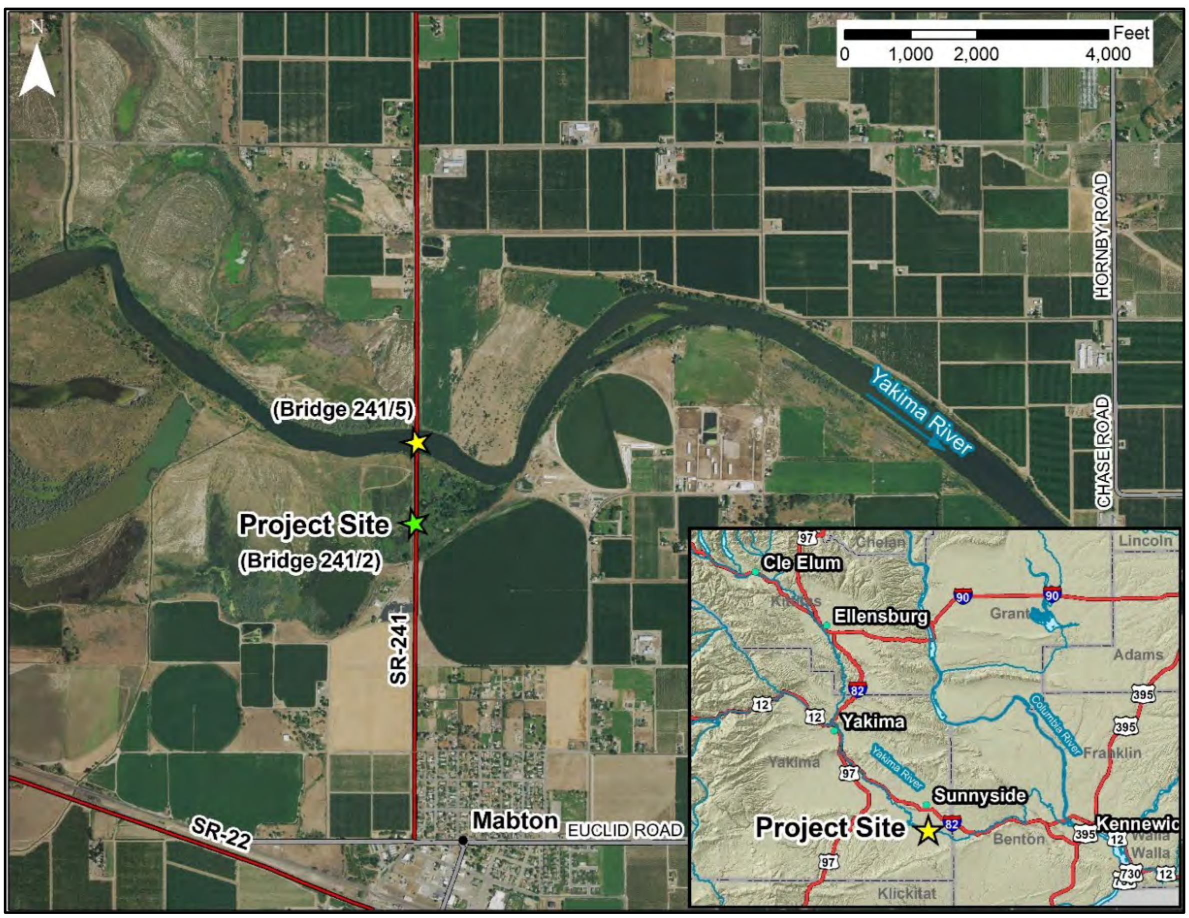

Figure 1.1 Vicinity Map

2.0 Site Assessment

2.1 Background

The existing 241/2 bridge crosses the Yakima River right floodplain on the south end of the river's main channel, which resembles a slough (see Section 2.2). Bridge 241/2 was constructed in 1961 and consists of a 6-span, 360-foot long Prestressed Concrete Bulb T-Girder structure (Appendix A). The structure, which is oriented in the south to north direction, is supported by two abutments at both ends and by five in-water intermediate bents. Bents 1 and 5 are located 59 feet away from the south and north bridge abutment walls, while the five in-water bents are spaced 60 feet apart from each other. Each bent is supported by seven 16-inch diameter piles, which are connected to a 29-foot long (in the flow direction), 2.5-foot wide, and 2-foot tall pile cap. The most upstream and downstream piles of each bent are battered, while the remaining 5 are vertical.

The existing 241/5 bridge crossing the Yakima River main channel, was constructed between 1953 and 1954, and is located approximately 1,200 feet north of the 241/2 bridge (which crosses the Yakima River slough). Bridge 241/5 is a 550-foot long, 5-span, concrete box bridge (Appendix A). It is supported by two abutments at each end as well as four in-water piers, with Pier 1 being the southernmost and Pier 4 the northernmost pier. Piers 1 and 4 are located 95 feet from the front face of the south and north abutments, while the four in-water piers are spaced 110 feet apart from each other. The piers are 22.5 feet long (along the flow direction) and 3 feet wide (perpendicular to the flow direction) and are founded atop 22.5-foot long, 5-foot wide and 11-foot tall pile caps. The pile caps are supported by sixteen 12-inch steel H-piles (Appendix A). Per the underwater inspection files (see Appendix B), the H-piles were used for construction in place of the 16-inch octagonal piles indicated on as-built plans (Appendix A). The south and north abutments are supported by thirteen 12-inch H-piles.

2.2 Site Reconnaissance

NHC visited the project site on October 17, 2018 to gather pertinent information to support the hydraulic design. The observations during the NHC site visit were combined with observations collected by WSDOT maintenance crews during the inspections of bridges 241/2 and 241/5. At the time of the visit, the Yakima River slough was inundated underneath all 6 spans of bridge 241/2 (Figure 2.1). The extensive algal growth on the water surface suggested that the flow velocities at the slough were low.

The piles supporting the south abutment of the 241/2 bridge were observed to be exposed (Figure 2.2). This suggests that flow may reach the south abutment bent cap, however the observed erosion may also be from runoff from surface water draining from the roadway or bridge deck.

Figure 2.1 SR 241 Yakima River Slough Bridge (241/2) Crossing

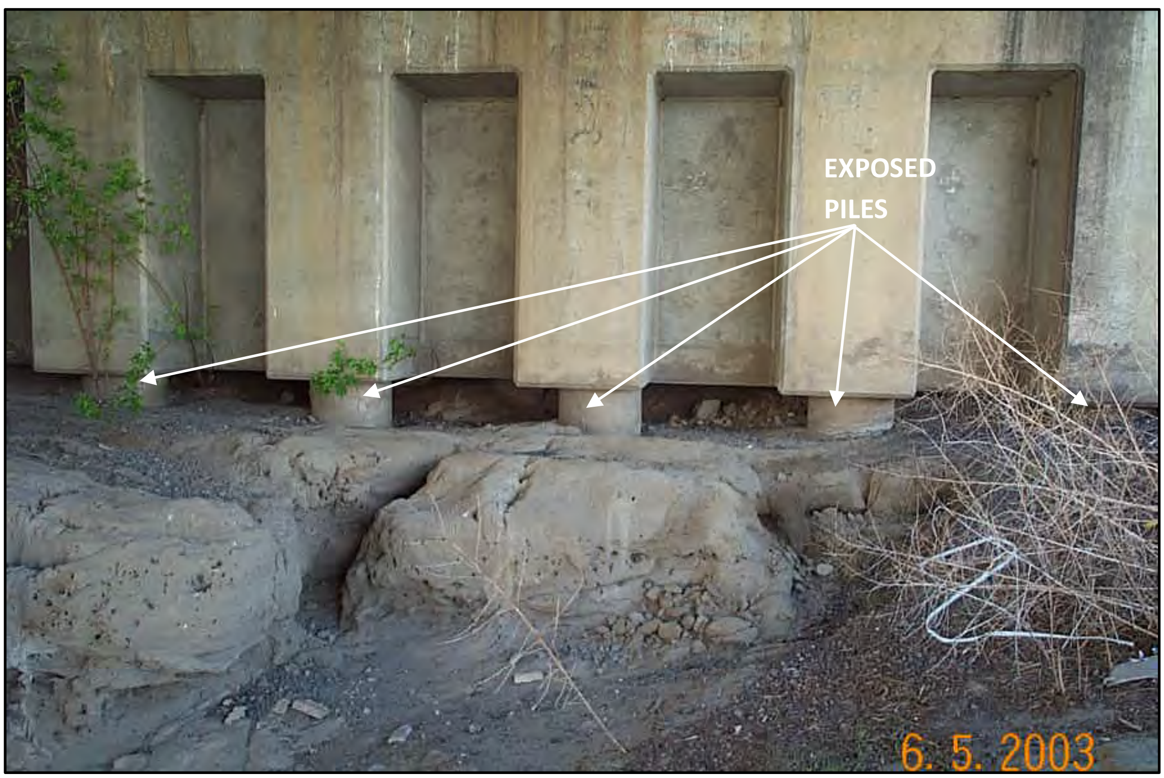

Figure 2.2 South Abutment of the SR 241 Yakima River Slough Bridge (241/2)

The lack of apparent erosion and the establishment of vegetation around the north abutment, suggests that the flow does not regularly reach the north abutment or the roadway and bridge deck drainage is routed to a different location (Figure 2.3).

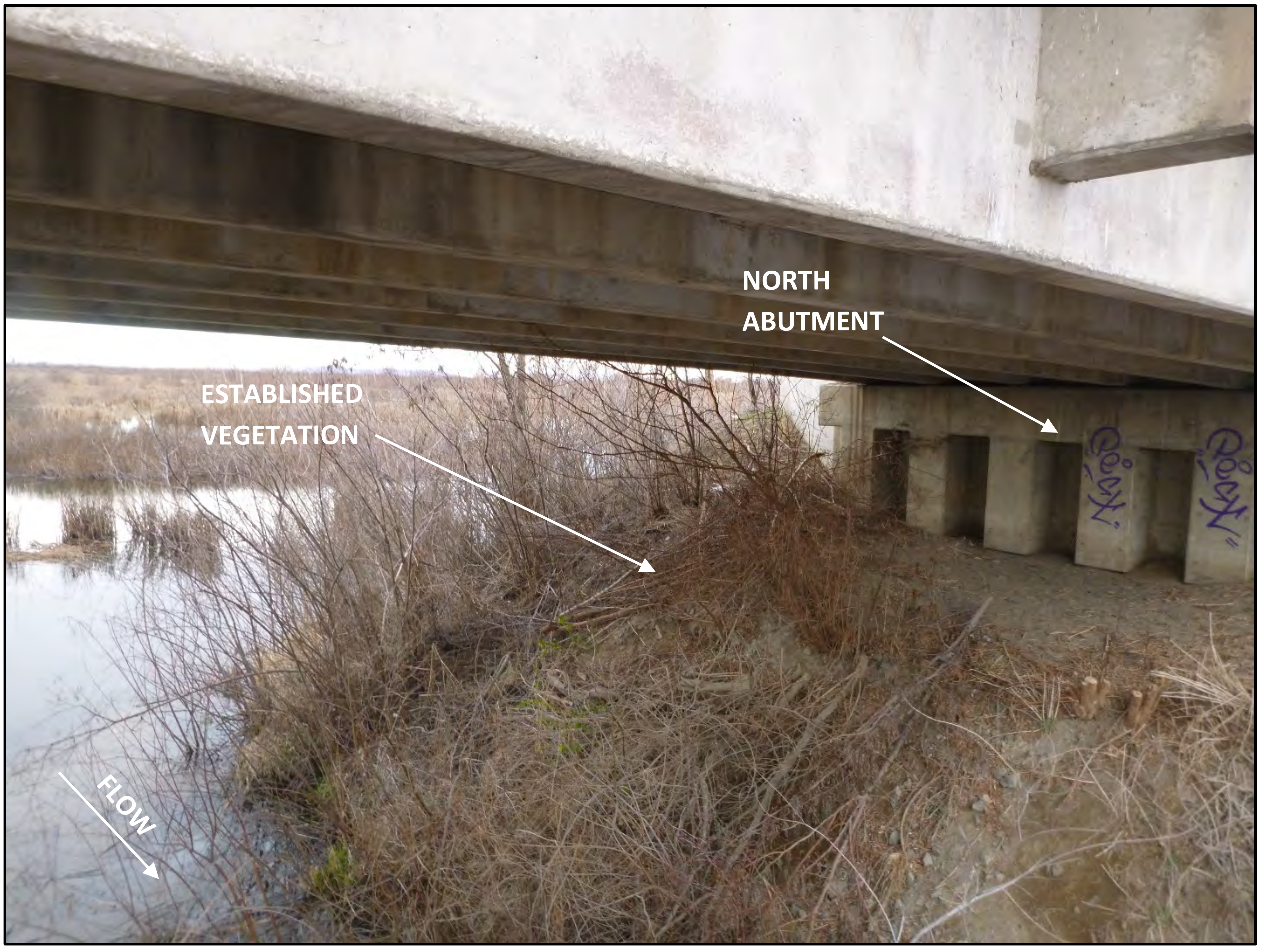

Figure 2.3 North Abutment of the SR 241 Yakima River Slough Bridge (241/2)

The main channel of the Yakima River was observed to flow under Spans 1, 2, 3, and 4 of bridge 241/5, whereas no flow was observed underneath the northernmost Span 5 (Figure 2.4). The establishment of vegetation underneath Span 5 of the bridge (see also Figure 2.5), especially in the vicinity of Pier 4, suggests that Span 5 is not regularly inundated.

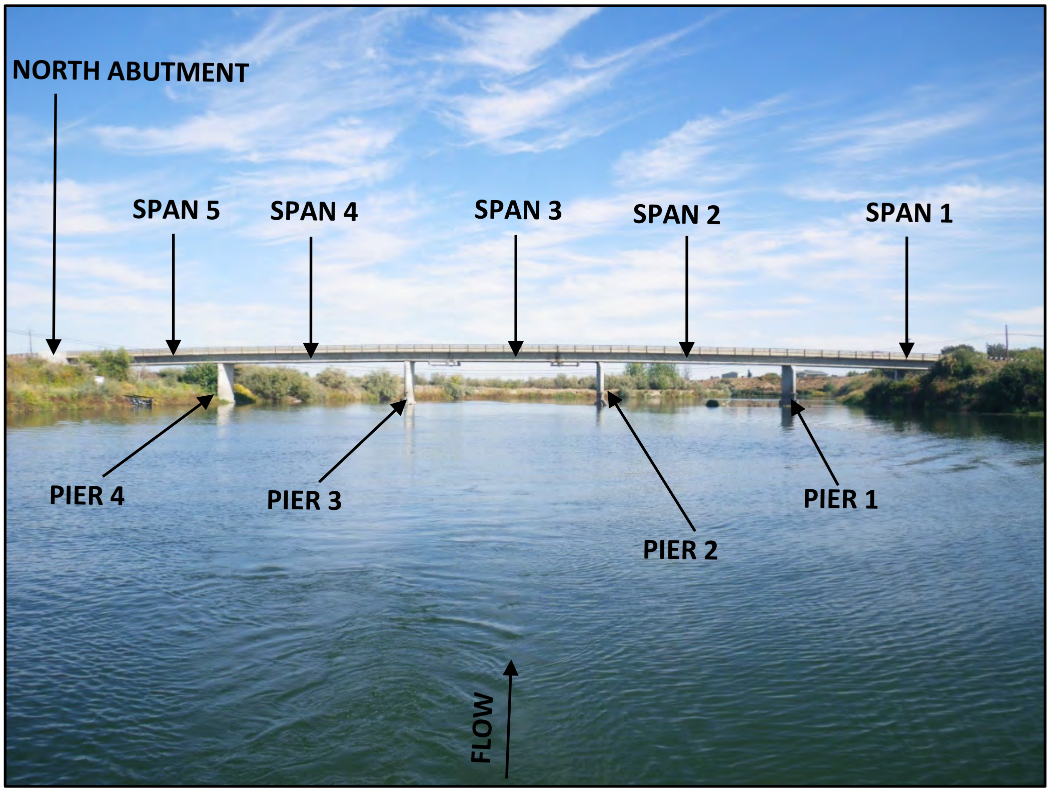

Figure 2.4 Bridge 241/5 Crossing of the Yakima River Main Channel from Upstream

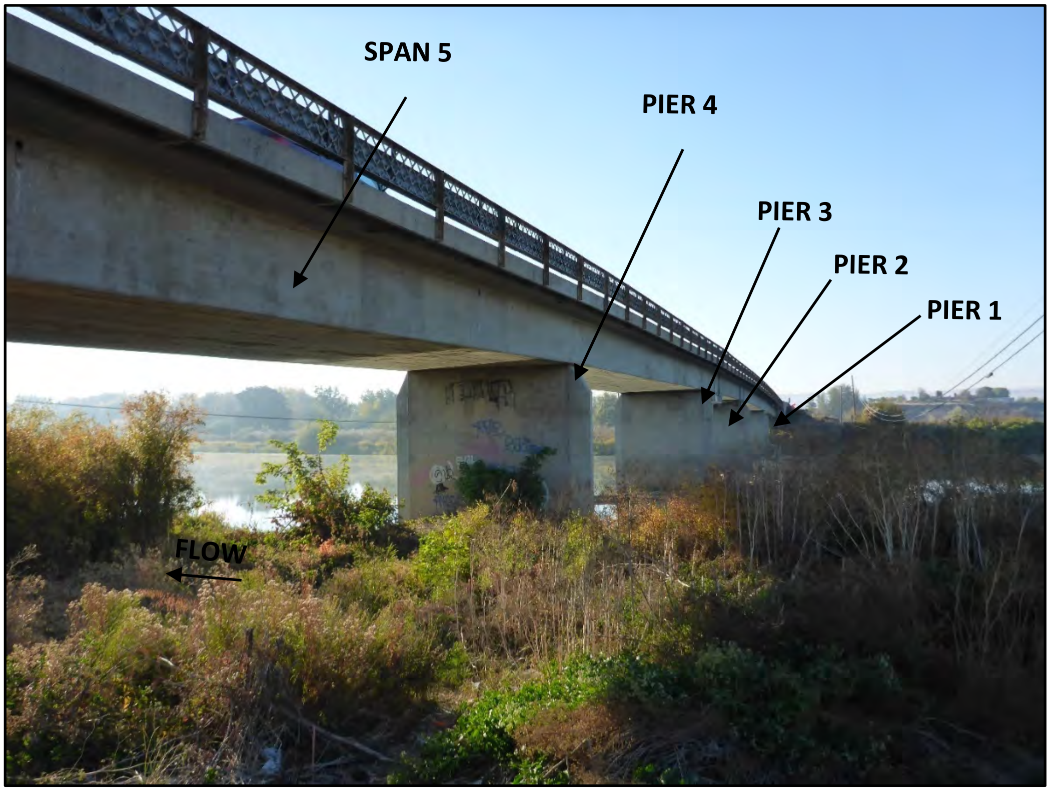

Figure 2.5 Pier 4 and Span 5 of Bridge 241/5 from the Left Bank of Yakima River

Piers 1, 2, and 3 are equipped with a debris deflector on their upstream end (Figure 2.6). A substantial amount of debris, mostly comprised of logs and branches, was observed to have accumulated around the debris deflector of Pier 3. No notable debris accumulations were observed around Piers 1 and 2.

Figure 2.6 Debris Collected Around the Debris Deflector of Pier 3 Viewed From the Left Bank (Left) and From Above (Right)

The Yakima River slough upstream and downstream of the 241/2 bridge is densely vegetated with shrubs and trees (Figure 2.7). The river floodplain to the north of the main channel and to the south of the slough appeared to be vegetated with pastures and cultivated areas (Figure 2.8).

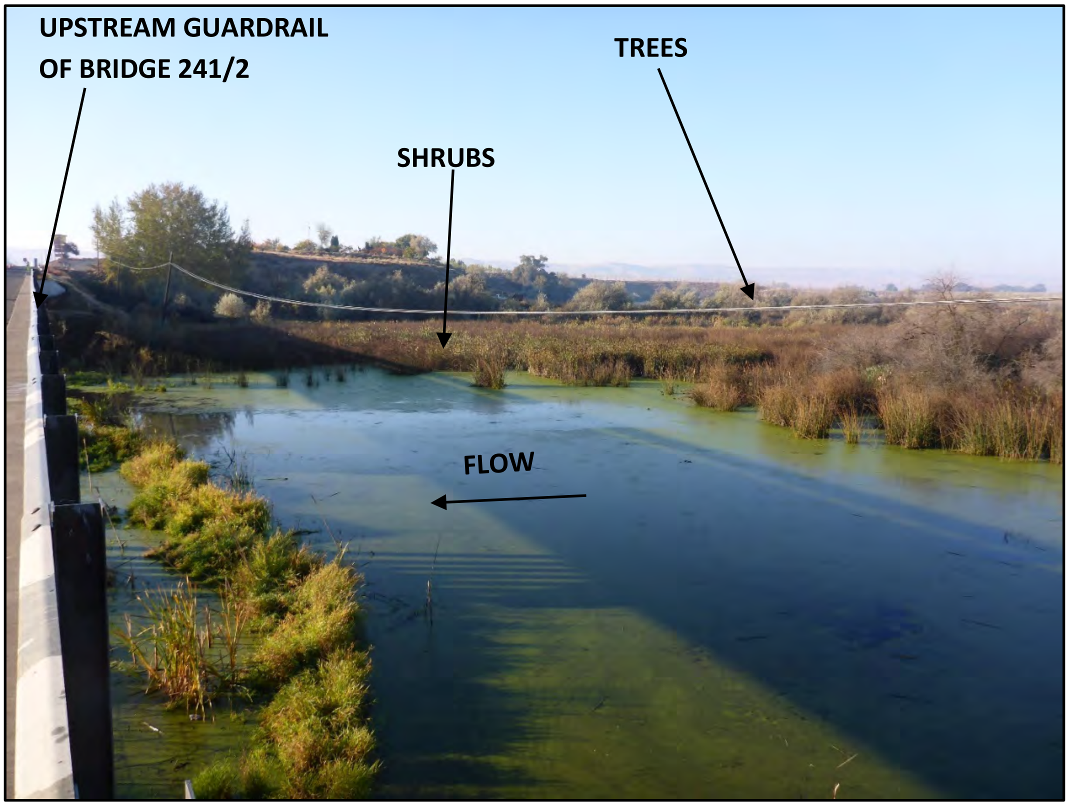

Figure 2.7 Yakima River Slough Upstream of Bridge 241/2

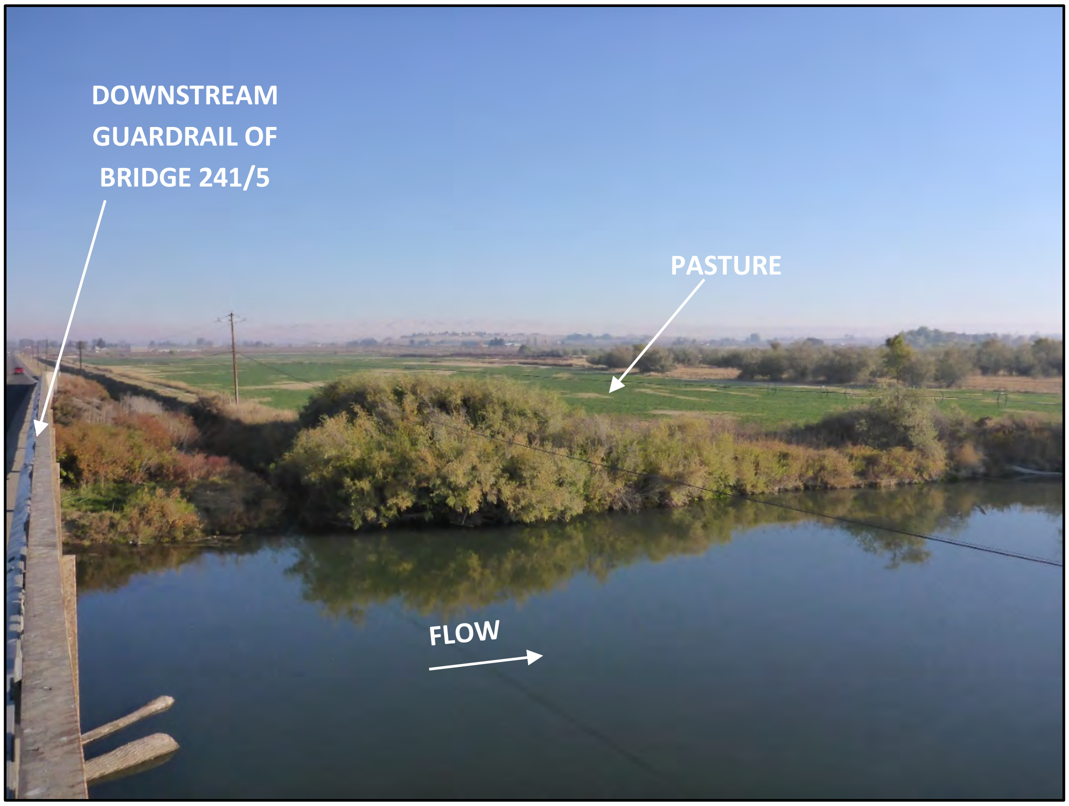

Figure 2.8 Yakima River Floodplain to the North of the Main Channel

3.0 Watershed Assessment

3.1 Watershed & Landcover

The project site is located at River Mile (RM) 59.7 of the Yakima River (measured upstream of its confluence with the Columbia River). The Yakima River originates from the south central portion of the eastern slopes of the Cascade Mountains, and at its crossing with SR 241 drains approximately 5,351 square miles (United States Geological Survey (USGS), 2018). The contributing basin ranges in elevation from about 650 feet to 8,170 feet, resulting in a high relief of 7,530 feet (Figure 3.1). The mean elevation of the drainage basin is approximately 2,600 feet and roughly 27% of the basin has areas that are steeper than 30%. The thalweg elevations near the 241/2 and 241/5 crossings are approximately 650 and 640 feet, respectively.

The mean annual precipitation of the Yakima River watershed is 30.3 inches, as determined from the PRISM rainfall dataset (PRISM, 2015). However, precipitation in the Yakima River watershed is spatially inhomogeneous, with high precipitation in the western portion of the watershed near the Cascade Mountains and low precipitation in the lowlands toward the east (Department of Ecology (DOE), 2012). Most of the precipitation is in the form of snow that falls between October and March. In late spring and early summer, precipitation is dominated by rainfall which, aided by the rising temperatures, melts the accumulated snow and produces snowmelt-driven runoff.

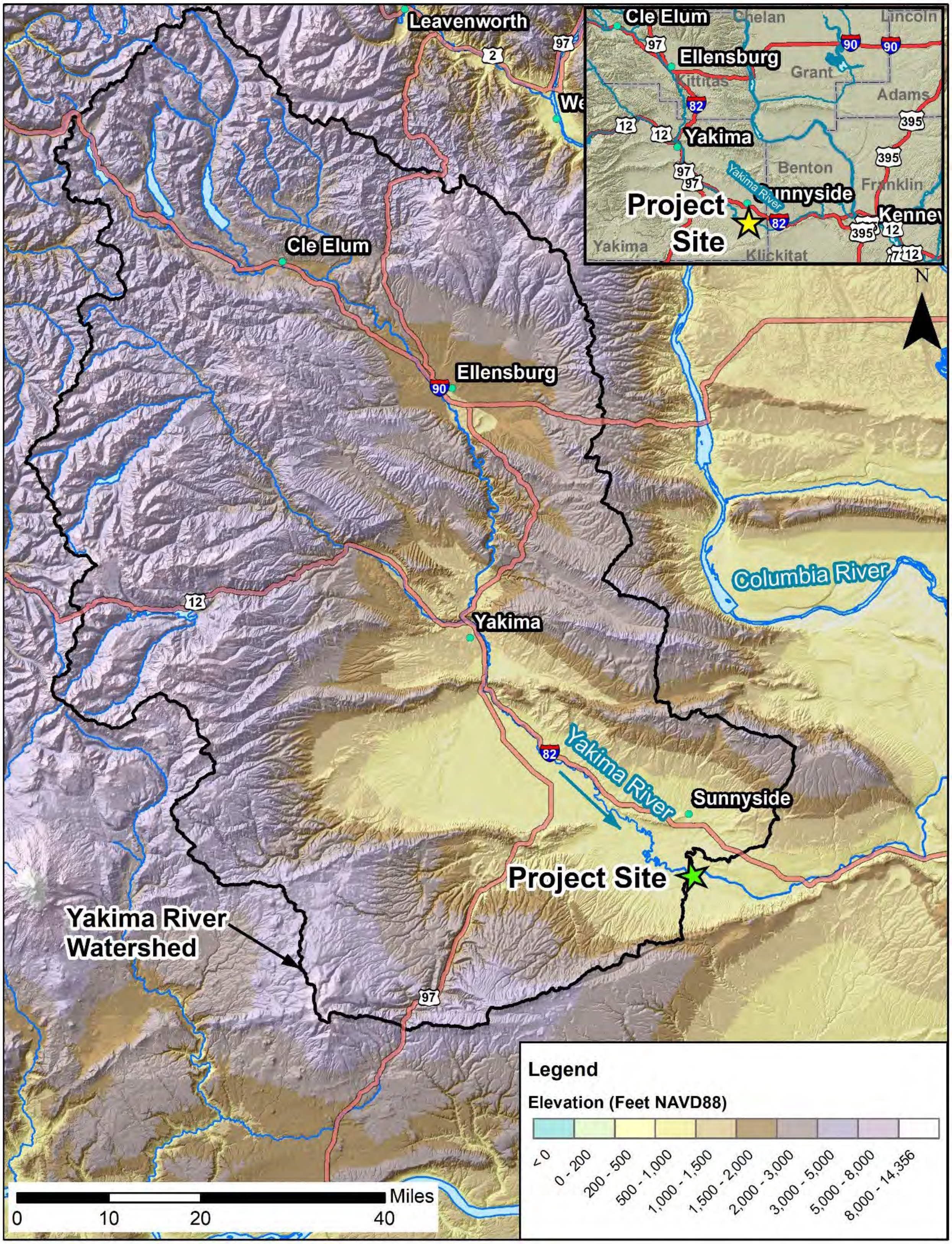

Figure 3.1 Yakima River Watershed Elevations

Landcover in the Yakima River watershed is largely characterized by shrubland (41%) (Figure 3.2). The shrubland encloses cultivated areas, which represent approximately 11% of the watershed, and are concentrated in the lower, flatter portions of the watershed along the Yakima River corridor. Per the StreamStats application (USGS, 2018) and the National Land Cover Database (Yang et al., 2018), the Yakima River watershed exhibits a canopy cover of approximately 26%. The canopy cover is almost entirely comprised of evergreen forest, which is encountered in the higher and steeper western part of the watershed towards the Cascade Mountains. Only 5% of the watershed is developed, with the developed areas concentrated at the cities of Ellensburg, Yakima and Cle Elum, as well as smaller cities along the Yakima River. An additional 9% of the watershed area is characterized by grassland and pastures that are primarily intended for grazing or hay crop production. The remaining 8% of the watershed is covered by water, perennial glaciers, barren soil, and wetlands.

3.2 Mapped Floodplains

The SR 241/2 and 241/5 crossings of the Yakima River are located within a Federal Emergency Management Agency (FEMA) Zone AE designated floodway (see Appendix C). As a result, any structure placed within the floodway must meet a no-rise requirement (see Section 7.4). Per the published FEMA Flood Insurance Rate Map (FIRM; panels 53077C2276D and 53077C2257D in Appendix C), the floodway has Base Flood Elevations (BFEs) for the 1% annual recurrence (100-year) peak flow, which were determined in the associated Flood Insurance Study (FIS No. 53077CV001C through 53077CV004C in FEMA, (2016)). The 1D model used for determining the BFEs in the effective FIS was originally developed by the US Army Corps of Engineers (USACE) in 1975 (see Appendix B in the Yakima County, 2019 and USACE, 1975) and was unavailable for this study. Per Yakima County (2019), the effective model inputs and the resulting BFEs in FEMA (2016) have remained largely unchanged since the original model development in 1975, other than two minor changes: 1) a conversion of the NGVD29 datum used in the original model to NAVD88; and 2) truncation of the model cross-sections between RM 82 and RM 100 (about 22- and 40-RM upstream of the project site) at the Interstate I-82 embankment.

3.3 Geology & Soils

The best available geologic mapping of the Yakima River watershed at the SR 241 crossing is depicted in Figure 3.3 (Schuster, 1994). Sections 3.3.1 and 3.3.2 examine the bedrock and surficial geology at the project site.

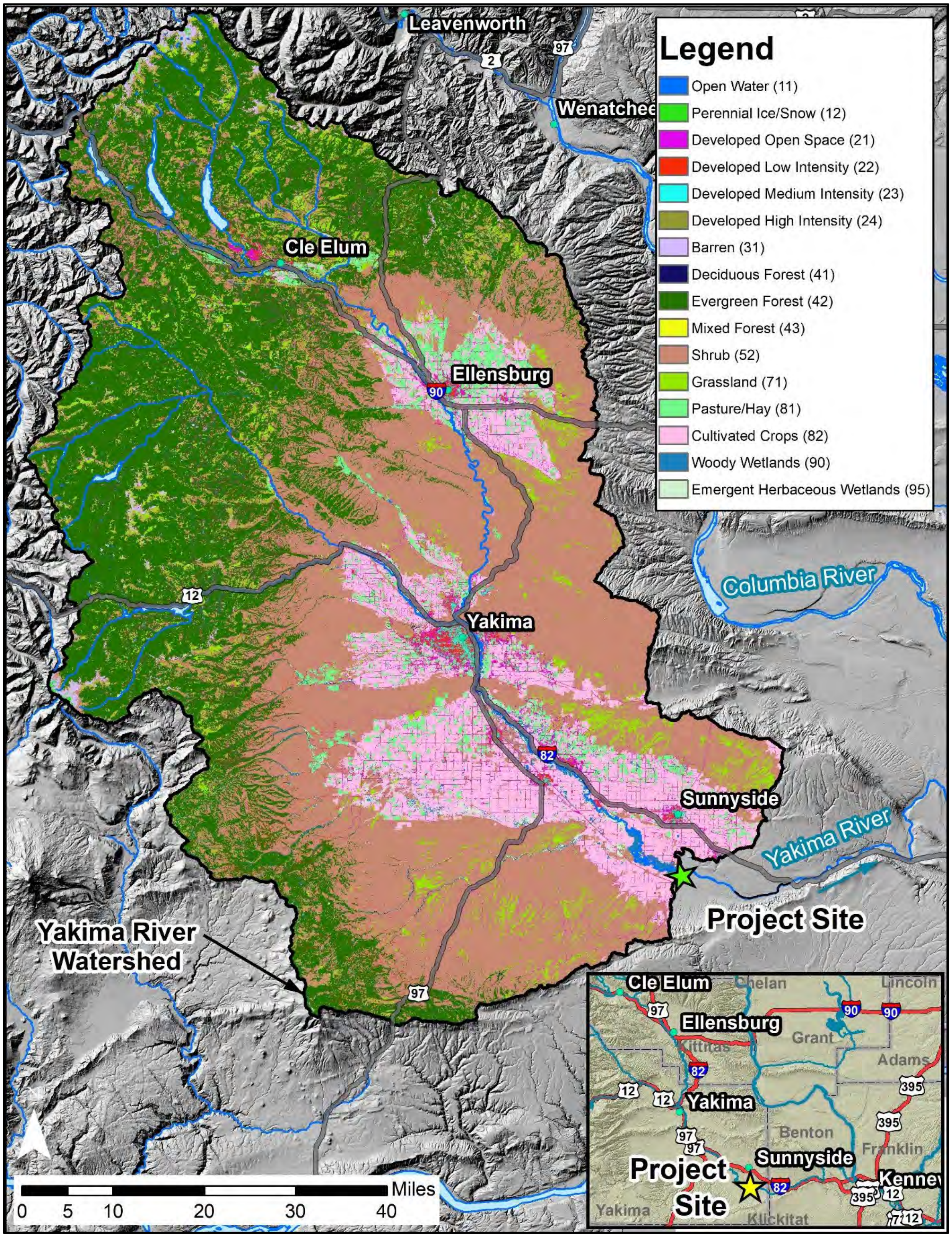

Figure 3.2 Yakima River Watershed Land Cover

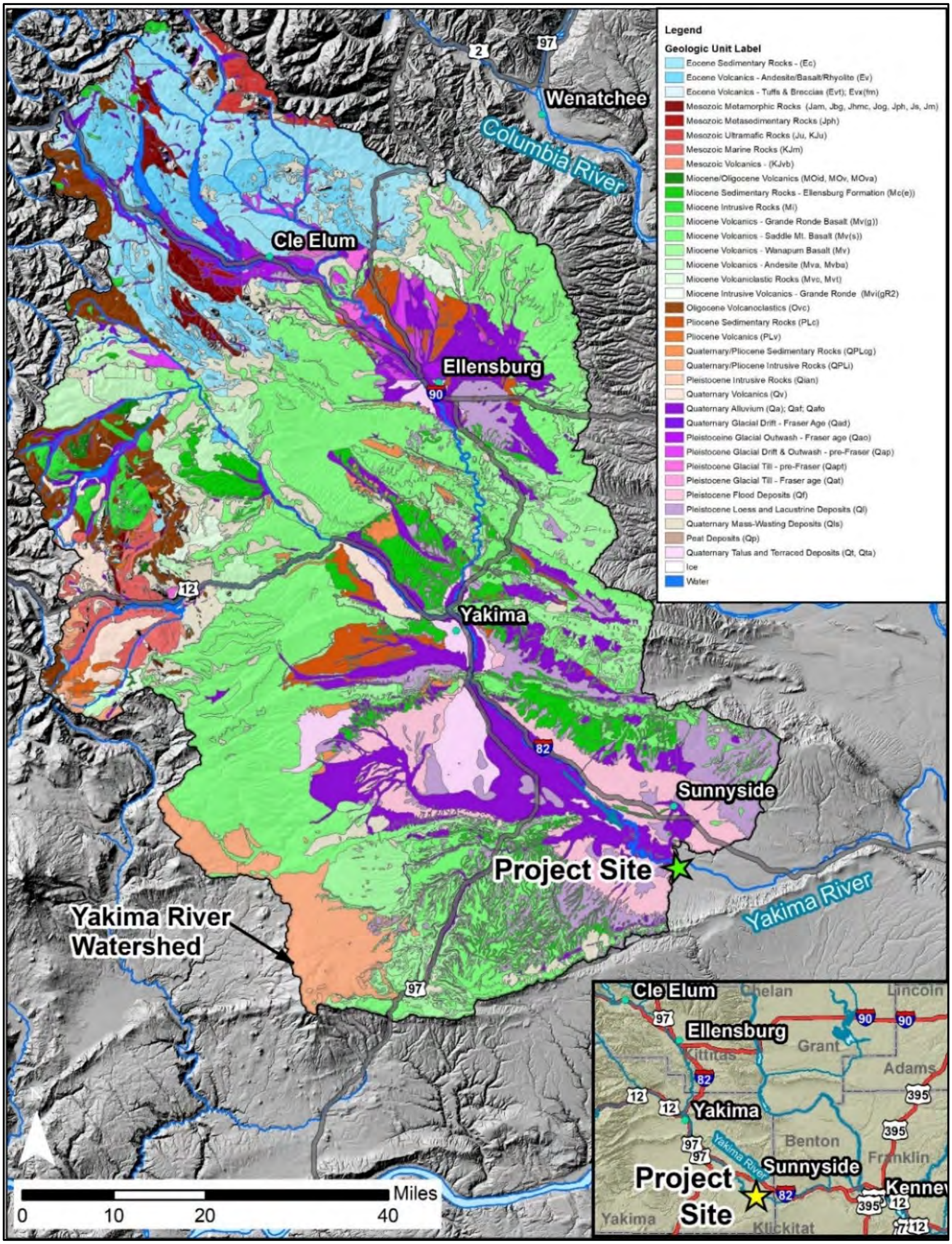

Figure 3.3 Geology of the Yakima River Basin at the Project Site

3.3.1 Bedrock Geology

The bedrock in the Yakima River's contributing basin is predominantly (~73%) comprised of rocks that have been formed during the Neogene and Quaternary periods, starting about 23 million years before present. Most of these rocks consist of basalt, formed by volcanic lava flows during the Miocene Epoch, and collectively are known as the Columbia River Basalt Group. The oldest basalt type of the group, which is also the most prevalent in the contributing watershed (32% of the bedrock area), is the Grande Ronde Basalt (unit Mv(gR2)). Unit Mv(gR2) is located towards the center of the basin to the west of the cities of Ellensburg and Yakima, as well as along the northeastern boundary of the watershed. The Grand Ronde Basalt is black to gray-black rock, with some weathering and fine- or medium-grained texture, and was formed between 15.6 and 17 million years before present during the early mid-Eocene epoch. Approximately 12% of the bedrock in the basin is comprised of Wanapum Basalt, mostly of the Frenchman Springs and Roza Members, which were formed during the mid-Miocene Epoch, roughly 15.3 and 14.8 million years ago. This basalt is overlain by the newest basalt of the Saddle Mountains Group that was formed in the mid- to upper Miocene Epoch between 10 and 14.5 million years before present and represents about 9% of the basin bedrock. The Saddle Mountain basalts are fine grained, black or blue-black in color and exhibit gray or red/orange weathering. Roughly 5% of the bedrock in the contributing basin, and mostly surrounding the modern-day city of Yakima, is comprised of the volcaniclastic sedimentary rocks of the Ellensburg formation (Bingham and Grolier, 1966; Bentley et al., 1993). These sedimentary rocks are believed to have formed in the mid- to upper-Miocene Epoch between roughly 6 and 10 million years before present. The remaining 15% of the bedrock in the contributing basin is composed of sedimentary and volcanic rocks formed during the Pliocene and Pleistocene Epochs between 11,000 and 5.3 million years ago, with the most notable being the volcanic rock of the Simcoe Mountains in the southwestern portion of the contributing basin.

A smaller portion (approximately 27%) of the contributing basin, mostly near its northwestern region, is underlain by rocks that were formed prior to the Miocene Epoch. Most of these rocks (~22%) were formed during the Eocene and Oligocene epochs between roughly 23 and 66 million years before present. Most notably, 5% of the bedrock is Eocene Epoch volcanic rocks, which were formed by basalt, andesite and rhyolite flows. Another 5% is sedimentary rock of the Swauk formation, mostly found along the northern edges of the basin. The remaining 5% of the older rocks are much older, having been formed during the Cretaceous and Jurassic periods between 66 and 200 million years ago.

3.3.2 Surficial Geology

Approximately 33% of the Yakima River basin contributing to the project site is covered by loose sediments. These sediments, which were formed during the Quaternary Period between 12,000 and 2.6 million years ago, are concentrated around the modern-day city of Ellensburg and in the southeastern portion of the contributing basin along the Yakima River alluvial fan.

Approximately 40% of the loose sediments are alluvium, as well as alluvial fan material, which was directly deposited by the Yakima River (units Qa, Qaf, and Qafo). These are dominated by sand and gravel, with the gravel-sized particles being mostly of basaltic origin. These particles were dissected from the surrounding basaltic bedrock (see Section 3.3.1) and transported to the Yakima River by its tributaries. The older alluvial fan material may have been cemented by clay, while the alluvial material

outside the alluvial fan may also include finer, silt-sized sediment as well as lacustrine and eolian deposits. The alluvial deposits are underlain by terrace deposits (unit Qt), which have accumulated in the older stages of the Pleistocene epoch.

The Yakima River floodplain south of the modern-day City of Yakima also has outburst flood deposits (unit Qf), which are sediments that were transported by outburst floods originating from the glacial Lake Missoula. These outburst flood deposits are mostly comprised of silt and gravel with small amounts of sand.

Approximately 17% of the contributing basin is underlain by Loess deposits (unit Ql), which are mostly found to the northeast of Sunnyside and southeast of Ellensburg. The Loess deposits are composed of fine-grained sediment, such as silt and sand that were deposited through eolian transport, and may also contain some tephra.

About 18% of the contributing basin area is composed of mass-wasting deposits (unit Qls). These mass-wasting deposits are mostly found in the western portion of the basin, where they have deposited at the base of the steeper slopes or along low-grade slopes by slides and debris flow. Most often they are found to be in contact with Wanapum Basalt (unit Mv(w)). The landslide deposits are composed of a poorly sorted unstratified mixture of sediment, which range between clay and gravel in size.

3.4 Geomorphology

3.4.1 Channel Geometry

The channel geometric information is based on data from 3 sources:

1. Bathymetric surveys that were collected by WSDOT in July 2018, October 2018, and April 2019;
2. Bathymetric LiDAR data collected by the US Bureau of Reclamation in 2004 and 2005 (Hilldale and Mooney, 2007) and utilized by Inner City Fund (ICF, 2012); and
3. The best available LiDAR mapping for the project area (Department of Geology and Mineral Industries, 2015).

A longitudinal profile extending for approximately 59 RM's was extracted along the Yakima River (Figure 3.4). The profile begins 12 RM's downstream of the project site and extends upstream to the Wapato Dam, located 47 RM's upstream of the project site.

The longitudinal profile of the Yakima River channel, in the examined 59-mile long segment, exhibits a convex shape with its slope gradually decreasing with downstream distance. Based on the local slope, the segment may be distinguished into five reaches. The most upstream reach (Reach 5), spans between RM 90 and the Wapato Dam at RM 107, and has an approximate slope of 0.2%; Reach 5 exhibits the steepest slope of the five reaches. Further downstream, the slope decreases to 0.10% in Reach 4, between RM 76 and RM 90, and then to 0.03% in Reach 3, extending from RM 68 to RM 76. Further downstream in Reach 1 (between RM 48 and RM 55.5) and Reach 2 (between RM 56 and RM 68), the channel slope is nearly horizontal. Reaches 1 and 2 are separated by a 0.5-mile long portion, where the profile exhibits a 6-foot drop. This drop may be due to a localized constriction caused by the

presence of a vegetated island within the Yakima River main channel, or due to bedrock outcropping at that location.

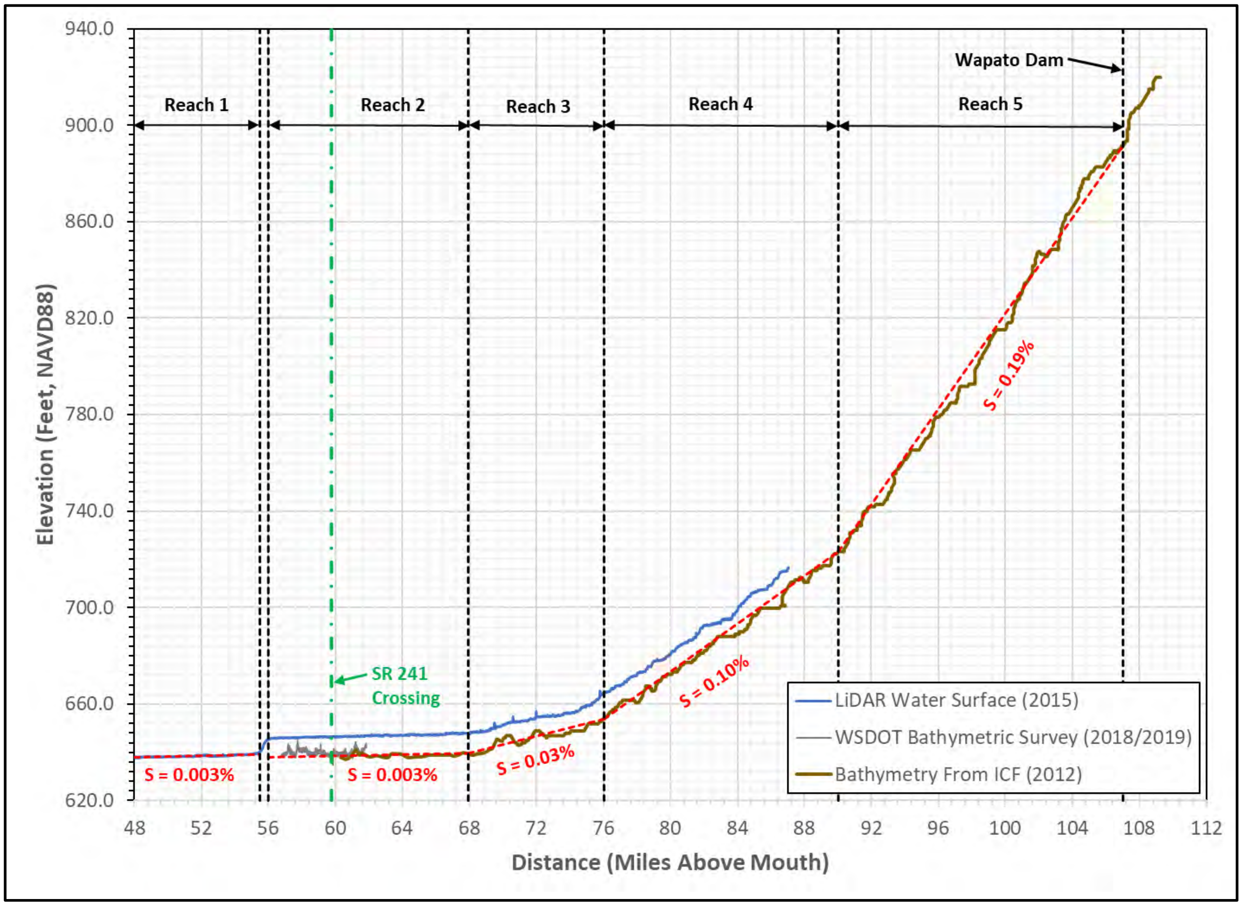

Figure 3.4 Yakima River Channel Longitudinal Profile

A longitudinal profile extracted from the WSDOT survey data, along a 4,500-foot long flowpath on the Yakima River slough through the SR 241/2 crossing, is illustrated in Figure 3.5. The plan view location of the slough flowpath is depicted in Figure 3.6. The profile in Figure 3.5 shows that the slope along this flowpath at the Yakima River slough is nearly horizontal downstream and upstream of the 241/2 crossing. The profile exhibits a 3-foot drop at the location of the 241/2 crossing, which may be attributed to contraction scour that has occurred from the constriction of flow through the crossing (see also Section 7.2).

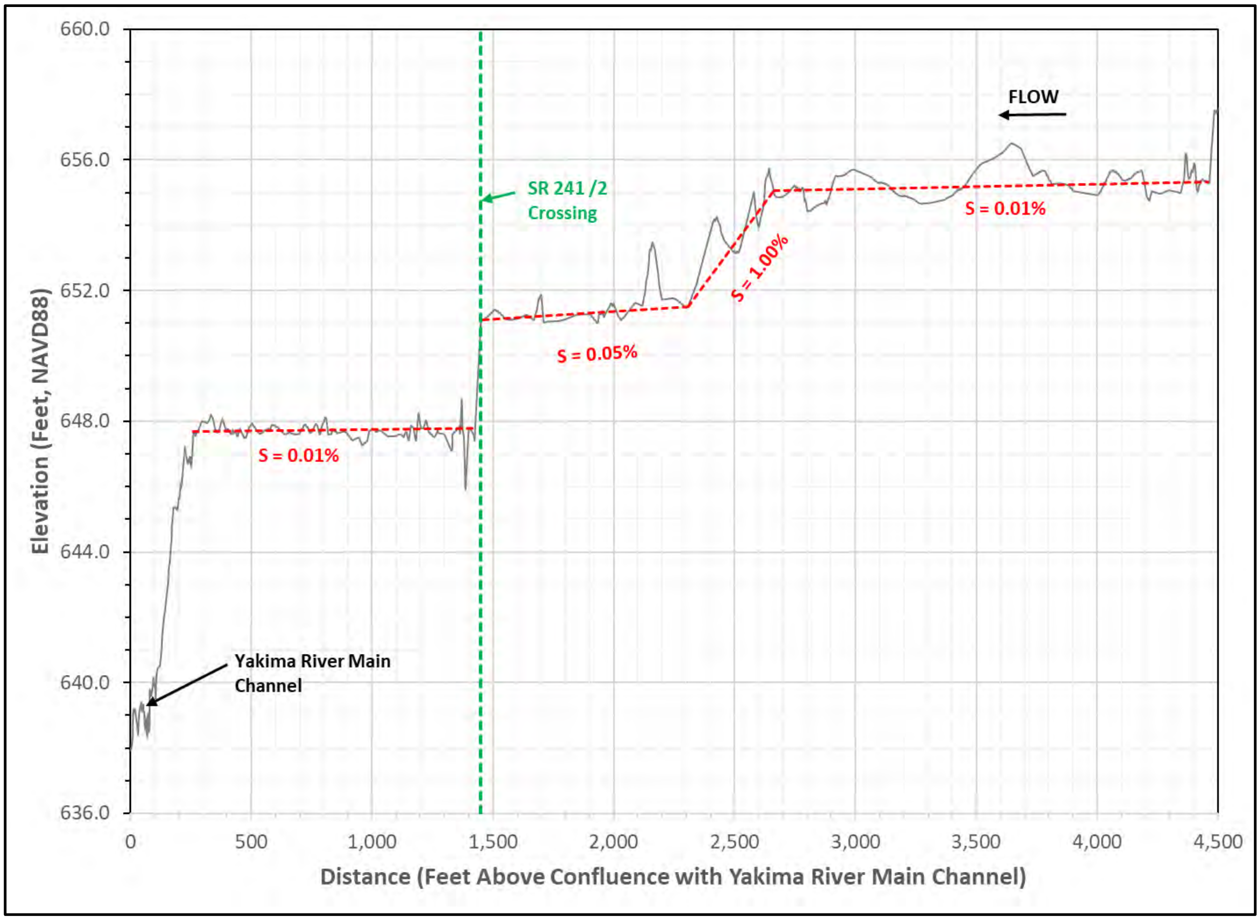

Figure 3.5 Longitudinal Profile Along the Yakima River Slough Through the SR 241/2 Crossing (WSDOT Survey Data)

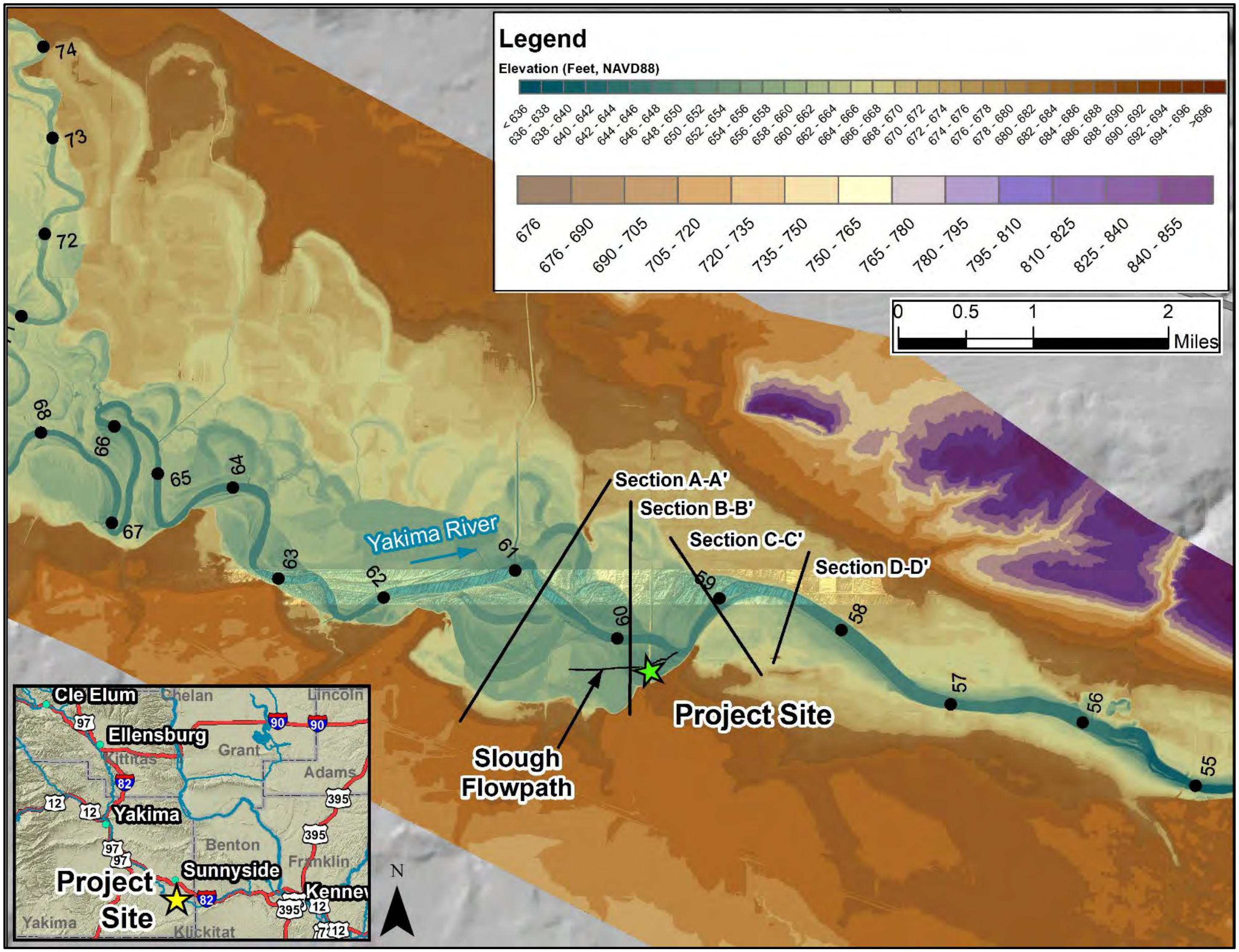

Figure 3.6 Topography of Yakima River Near the Project Site

Figure 3.6 illustrates the ground topography near the project site, derived by combining bathymetric data collected by WSDOT within the Yakima River main channel and LiDAR data on the floodplains. The Yakima River floodplain upstream of SR 241 reaches 7,500 feet in width roughly 1 mile upstream (see Section A-A' in Figure 3.7), but may reach a width of 20,000 feet about 12 RM's upstream (Figure 3.6). The floodplain within this 12-mile segment is scarred by old remnant channels (Figure 3.7) that the Yakima River historically occupied (see Sections 3.4.3 and 3.4.4). The river downstream of the SR 241 crossing becomes more channelized, with its floodplain gradually decreasing in width until it becomes approximately 2,500 feet wide (Figure 3.6 and Figure 3.8). The river floodplain downstream of SR 241 does not exhibit any remnant channels.

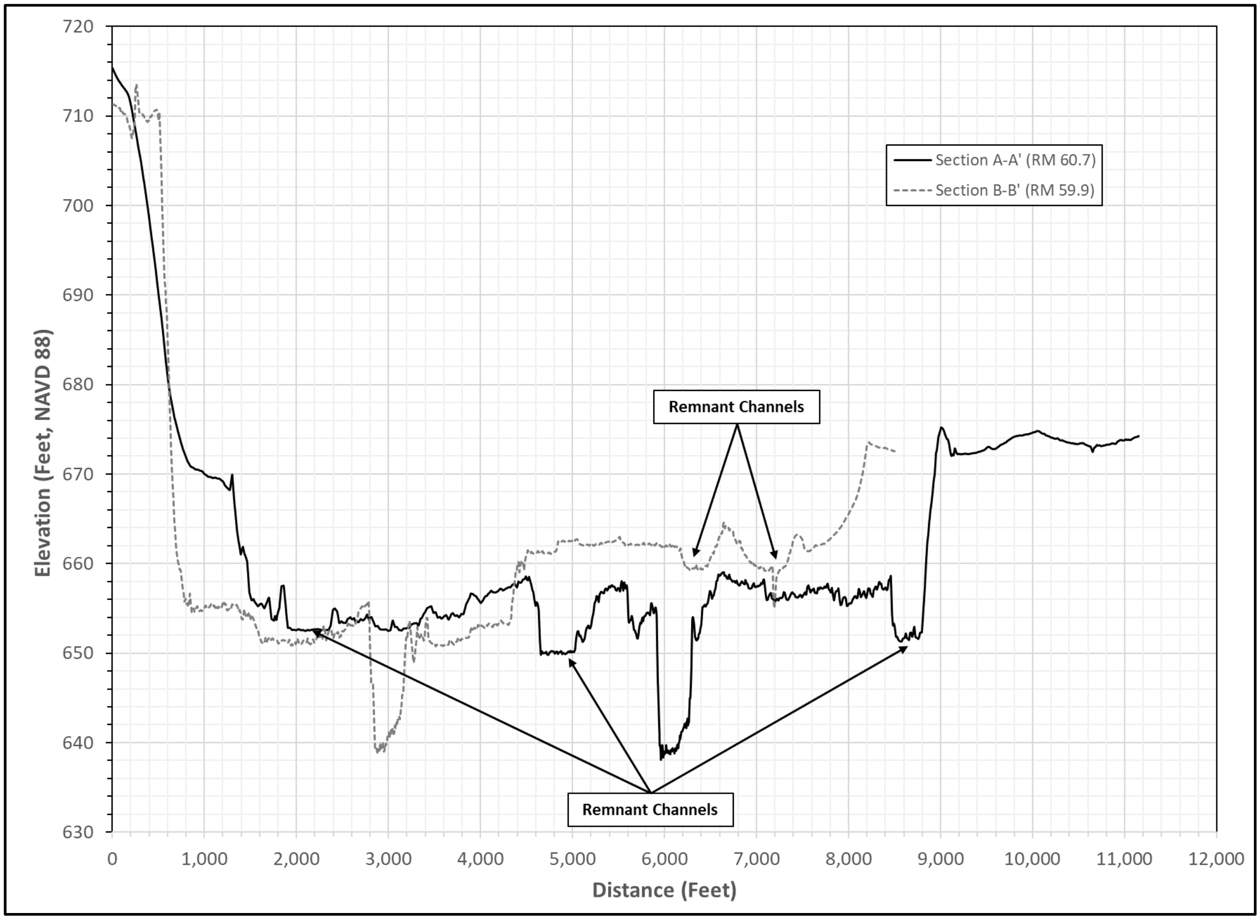

Figure 3.7 Typical Sections of the Yakima River Floodplain Upstream of SR 241

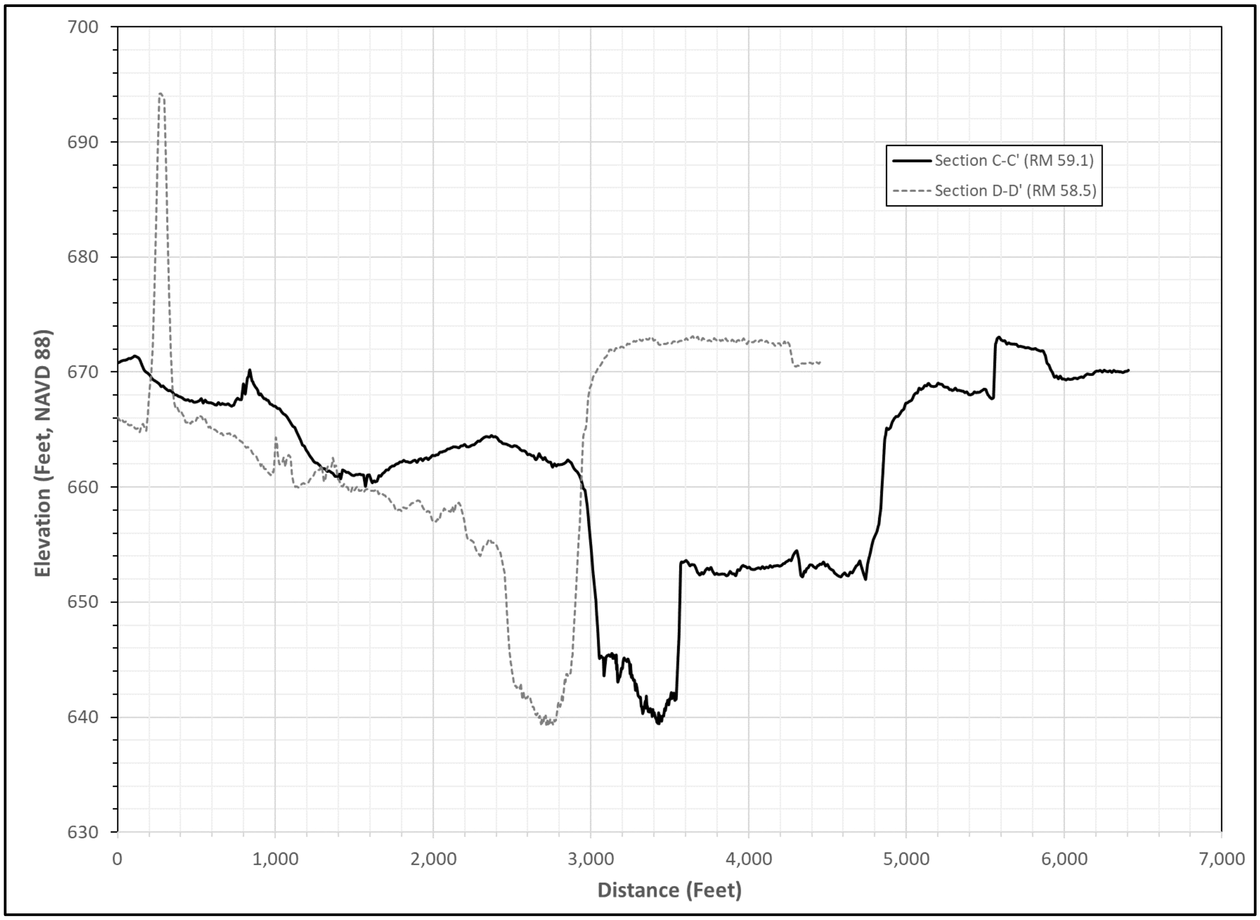

Figure 3.8 Typical Sections of the Yakima River Floodplain Downstream of SR 241

The main channel of the Yakima River, both upstream and downstream of SR 241, is prismatic with steep, nearly vertical banks. The main channel is between roughly 350 feet and 600 feet wide throughout the project site (Figure 3.7 and Figure 3.8).

In the 20-mile long reach (Reach 2) between RM 55 and RM 75, the Yakima River exhibits a single thread meandering channel. Between RM 55 and RM 65, within Reach 2 (i.e. within roughly 5 miles downstream and upstream of the SR 241 crossing), the channel exhibits an average meander radius of 1,850 feet and an average sinuosity of 1.2. Between RM 65 and RM 75, the channel becomes more sinuous, exhibiting meanders with a smaller 600-foot average radius and a larger sinuosity of about 1.9.

3.4.2 Potential for Aggradation, Incision and Headcutting

The project site is characterized by nearly-flat slopes upstream and downstream of the 241/2 bridge crossing (Figure 3.5) and a large flow width (Section 3.4.1). The flat slope and large flow width lead to low velocities at the slough, which are not capable of eroding the sandy material of the slough surface (see Section 3.4.6), other than in the immediate vicinity of the crossing where the velocities are higher due to the flow constriction (see Section 7.2). However, after higher flow events, the bed surface material will likely be replenished over time by suspended incoming material from upstream, which will

settle out of suspension as it encounters low-flow velocities at the slough. It is thus anticipated that in the long-term, degradation and aggradation at the 241/2 crossing will be minimal.

The assessment that potential degradation and aggradation at the crossing will be minimal in the future is supported by the historic groundline surveys performed by WSDOT at the 241/2 bridge crossing during previous scour inspections (Appendix D). Figure D-1 shows that between 1962 and 1993, other than in the vicinity of Bent 1, the groundline was lowered by up to approximately 6 feet, likely due to contraction scour. However, in the 17 years from 1993 to the next inspection in 2010, up to 3.5 feet of aggradation occurred almost uniformly throughout the crossing. The groundline at the crossing remained unchanged until the last inspection in 2016, other than between Bent 4 and the north bridge abutment where up to 2.5 feet of degradation was observed.

3.4.3 Floodplain Flow Paths

Upstream of the SR 241 crossing, both the south and north Yakima River floodplains exhibit numerous remnant channels. In the more distant past, the Yakima River main channel actively occupied these floodplain locations and formed the remnant channels (see Section 3.4.4). These remnant channels become activated and convey flow during higher peak flow events (see Section 7.2). Downstream of the SR 241 crossing there are no floodplain flow paths outside of the active channel zone.

3.4.4 Channel Migration

The detailed topography of the Yakima River floodplain, approximately 3 miles upstream and 1 mile downstream of SR 241, is illustrated in Figure 3.9. The topography map indicates the presence of remnant channels on the south and north floodplains upstream of SR 241. These remnant channels, which are enclosed by the area labeled as the Historic Migration Zone, represent historic locations occupied by the Yakima River channel within the Holocene Epoch (from approximately 11,700 years ago to present). Upstream of RM 59, the Historic Migration Zone varies between 7,500 and about 20,000 feet in width, while downstream its width is approximately 3,000 feet. The present active channel has incised by approximately 8 to 15 feet into the Historic Migration Zone, forming an inset floodplain, and is denoted in Figure 3.9 as the Post-Downcutting Migration Zone. Downstream of RM 59.5, the Post-Downcutting Migration Zone is up to 3,000 feet wide, does not enclose any evident remnant channels, and collapses well with the older Historic Migration Zone. These observations suggest that lateral migration downstream of RM 60.5 has been historically limited. Upstream of RM 59.5, however, the Post-Downcutting Migration Zone becomes wider, ranging in width between 4,500 and 10,000 feet and contains numerous remnant channels. This indicates that the Yakima River has been migrating within this area.

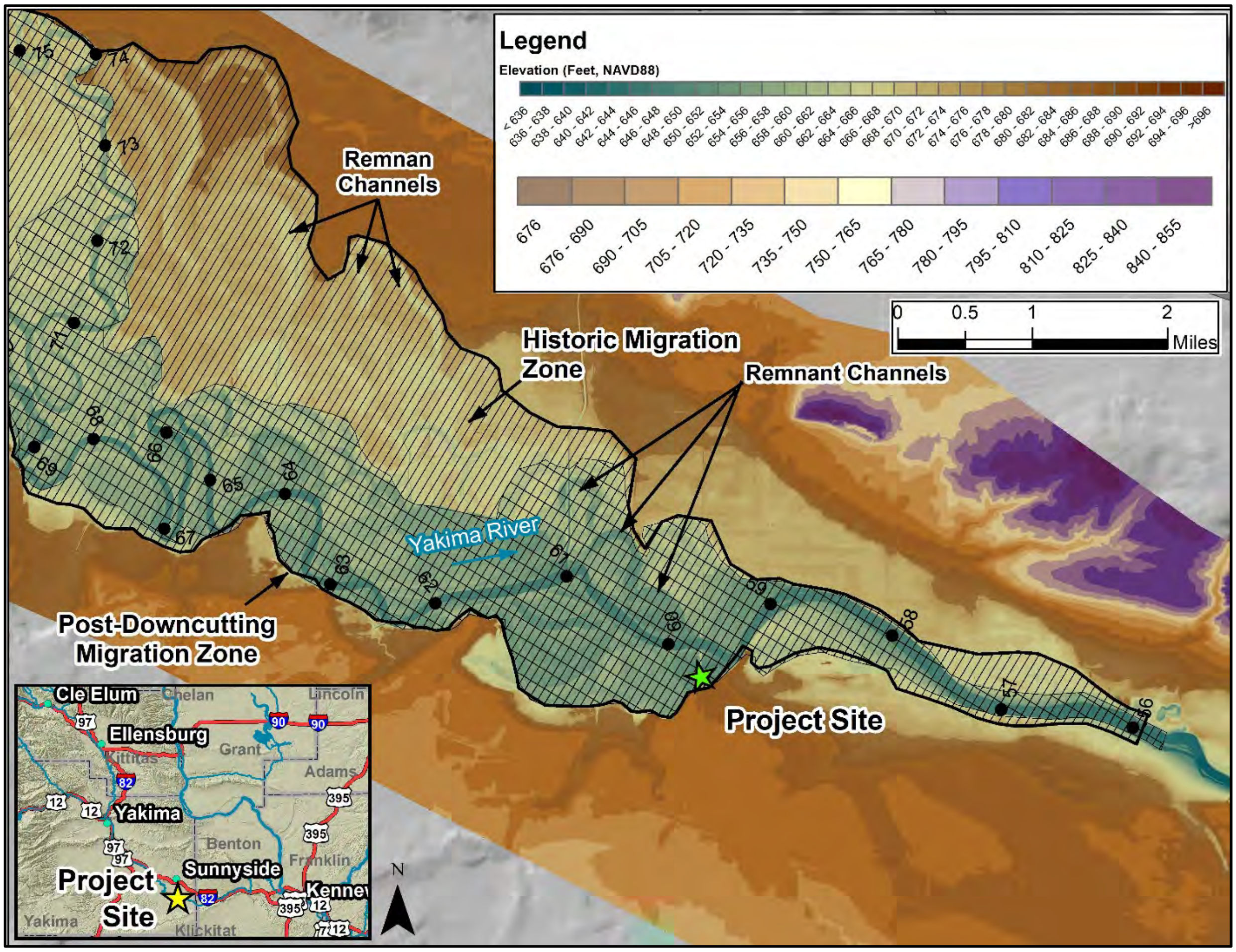

Figure 3.9 Historic Channel Positions of the Yakima River Near the Project Site

The present channel has incised approximately 10 feet below its Post-Downcutting Migration Zone (Figure 3.7). To evaluate if the river channel has actively migrated in recent years, available historic aerial photos from 1952 to 2017 were evaluated. The locations of the river's main channel, as digitized in these historic aerial photos, are presented in Figure 3.10. Downstream of RM 60.5, which is approximately 3,500 feet upstream of SR 241, the main channel of the Yakima River shows negligible lateral migration. It is also noted that negligible lateral migration was observed at the Yakima River slough, near the 241/2 crossing, in all historic aerial images.

Between RM 60.5 and RM 61, the main channel appears to have migrated by up to 250 feet between 1952 and 1982, but shows minimal lateral migration after 1982. Upstream of RM 61.5, the main Yakima River channel migrated laterally by approximately 600 feet between 1952 and 1982, but only by up to 250 feet between 1982 and 2017. It is possible, however, that the large migration observed above RM 60.5, between 1952 and 1982, is overestimated due to digitization errors in the oldest aerial images from 1952; which exhibit the poorest quality amongst the available datasets. Similar lateral migration patterns of the main Yakima River channel were derived in the analysis performed by ICF (2012). Based on the historic aerial image analysis, the potential for lateral migration of the main Yakima River channel and the flowpath on its slough near SR 241 is low.

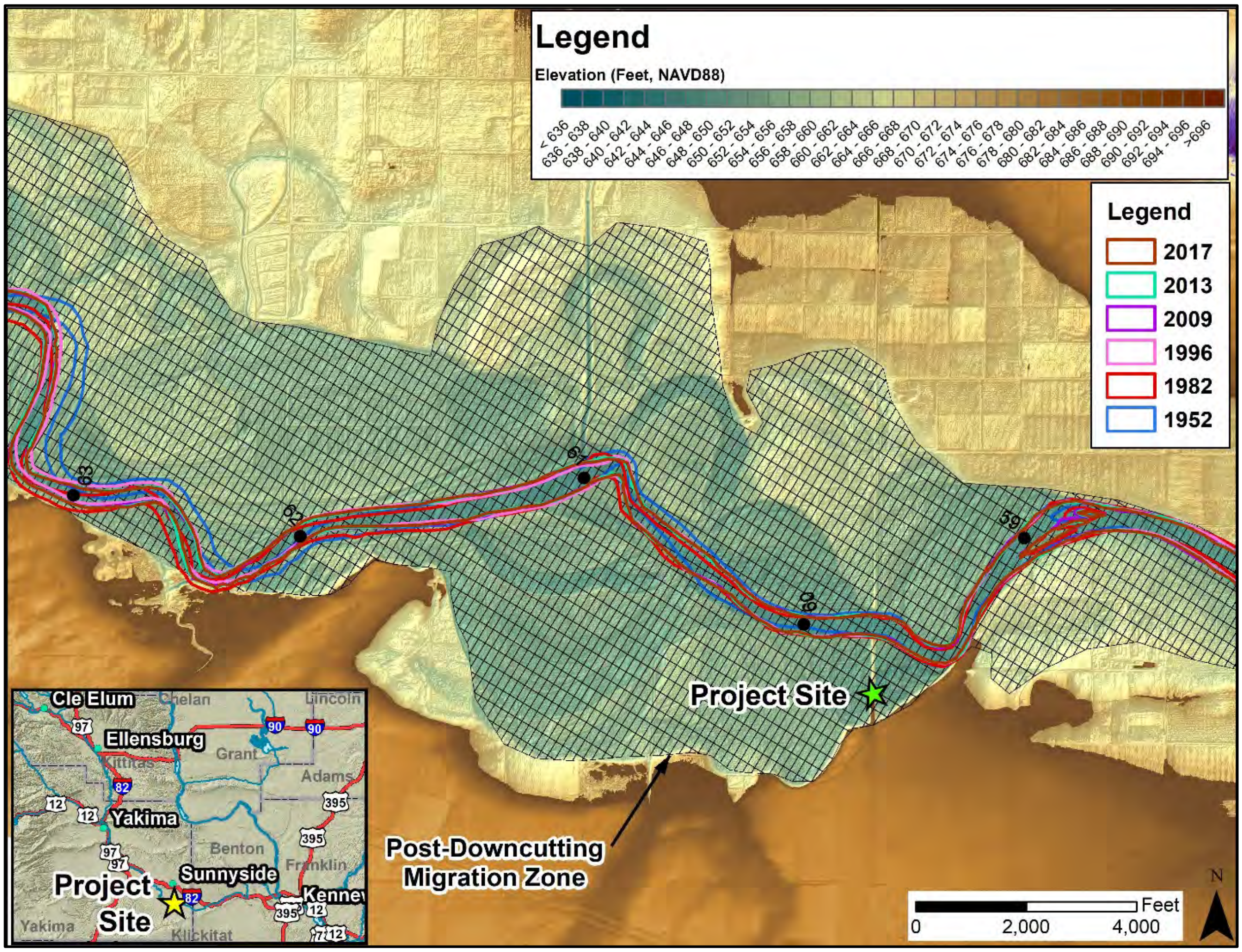

Figure 3.10 Historic Locations of the Yakima River Channel

3.4.5 Existing LWM and Potential for Recruitment

Observations during the site visit (see Section 2.2 and Figure 2.8) revealed that LWM had accumulated at the debris deflector at Pier 3 of bridge 241/5 (the crossing of the main channel of the Yakima River). The largest logs captured at the deflector were 1 to 2 feet in diameter, while the length of the entrapped logs was up to about 25 feet. It is anticipated that LWM with comparable size to that captured at the Pier 3 deflector will continue to be recruited from the vegetated floodplains of the river near the project site (see Section 2.2).

3.4.6 Sediment Load and Size Distribution

Information on the bed surface material near the 241/2 crossing of the slough and the 241/5 crossing of the main Yakima River channel was retrieved from samples taken from the top layer of six geotechnical borings, conducted by WSDOT in the vicinity of the crossings between June 4 and 22, 2019. Because the riverbed surface near the two crossings is mostly comprised of sand or silt, it is expected to exhibit minimal armoring. Due to the negligible armoring, it is likely that the samples taken between 1 and 4 feet below the surface of the river and slough beds would provide an adequate representation of the

surface material. The available grain size distributions of 3 samples taken downstream of the 241/2 crossing (see Appendix E for their exact locations) are presented in Figure 3.11, and their characteristic diameters are summarized in Table 3.1.

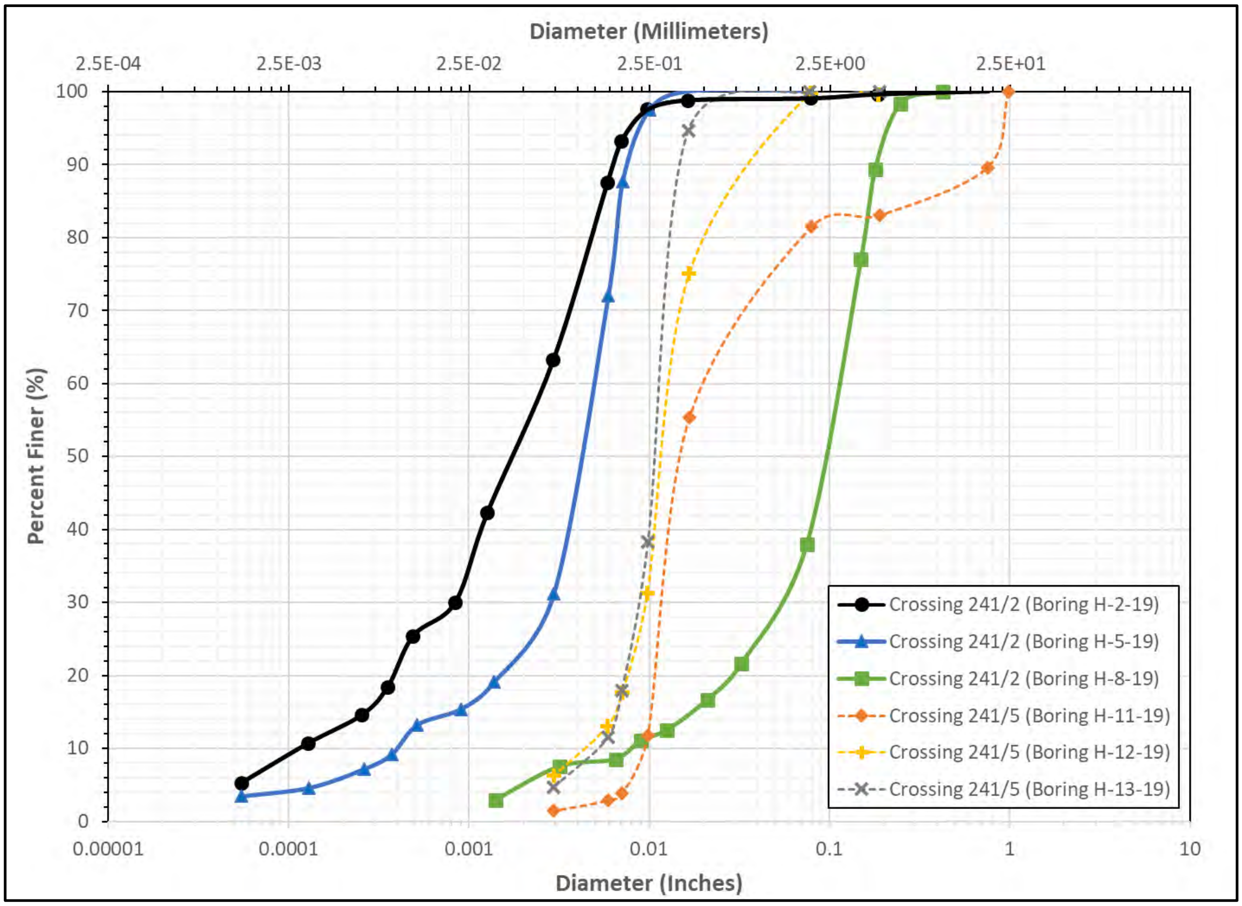

Figure 3.11 Grain Size Distribution of the Bed Near Crossings 241/2 and 241/5

The results in Figure 3.11 and Table 3.1 show that the bed material at the slough near the 241/2 crossing is silty sand, comprised between 62% and 69% of sand and 31% to 38% of silt. It becomes a sandy silt near the north abutment (Boring H-2-19), however, with 63% silt and 36% sand. In the main river channel near crossing 241/5, the bed material is comprised predominantly of sand in percentages varying between 81% and 95%. Near the south abutment (Boring H-11-19), the remainder of the bed surface material contains approximately 17% gravel and 2% silt, whereas near the center and northern side of the channel, it contains only 5% to 6% silt.

Table 3.1 Characteristic Grain Sizes of the Bed Material Near Crossings 241/2 and 241/5

Particle Percent Smaller Than	Particle Diameter (Inches) at Crossing 241/2			Particle Diameter (Inches) at Crossing 241/5		
	H-2-19	H-5-19	H-8-19	H-11-19	H-12-19	H-13-19
D_{16}	0.00064	0.001	0.02	0.01	0.007	0.007
D_{50}	0.0016	0.004	0.0035	0.016	0.012	0.011
D_{84}	0.005	0.007	0.007	0.25	0.023	0.013
D_{100}	0.08	0.017	0.017	1.25	0.75	0.080

3.5 Groundwater

During the October 17, 2018 site visit, the slough near the 241/2 crossing was observed to be inundated by water with low flow velocities (see Section 2.2 and Figure 2.1). This nearly stagnant water was interpreted to be present due to the emergence of groundwater throughout the project site. An analysis of existing wells around the project site, taken from the database of the Washington State Department of Ecology (DOE, 2019), revealed that the groundwater horizon is at an elevation of approximately 646 feet. Additional information on groundwater in the Yakima River watershed may be found in ICF (2012).

4.0 Hydrology and Peak Flow Estimates

4.1 Overview

The drainage basin of the Yakima River contributing to the project site is highly regulated by dams, irrigation diversions and hydropower facilities (DOE, 2012). Runoff is stored in five main reservoirs with a combined storage capacity of more than 1,000,000 acre-feet and a smaller sixth reservoir with a capacity of 5,300 acre-feet, mostly intended for recreation. Releases from these five reservoirs, which are located in the Upper Yakima River (above RM 128), are coordinated to provide adequate water supply for the various types of uses along the system. The most important of these uses is irrigation, which utilizes approximately 1.6 and 1.2 million acre-feet of water for drought and non-drought years, on an average annual basis (DOE, 2012). In addition to this irrigation volume, water is supplied to smaller private irrigation diversions as well as for municipal and industrial uses. The watershed also includes seven hydropower facilities that operate such that they meet the demands for irrigation (DOE 2012). As a result, power generation from these facilities is subordinated to the various flows throughout the year. More details on the hydropower plants at the Yakima River watershed are provided in DOE (2012).

4.2 Peak Flow Estimation

The flow discharge on the Yakima River is monitored at USGS streamgage no. 12508990, which is located at the south bank of the Yakima River main channel, downstream of the 241/5 bridge (Figure 4.1). Streamgage no. 12508990 has been active since 1970 and its record contains 47 annual peak flows between water years (WY's) 1971 and 2017, except for WY's 2003 and 2006. As discussed in Section 3.1, the area of the Yakima River watershed draining to gage no. 12508990 is approximately 5,351 square miles.

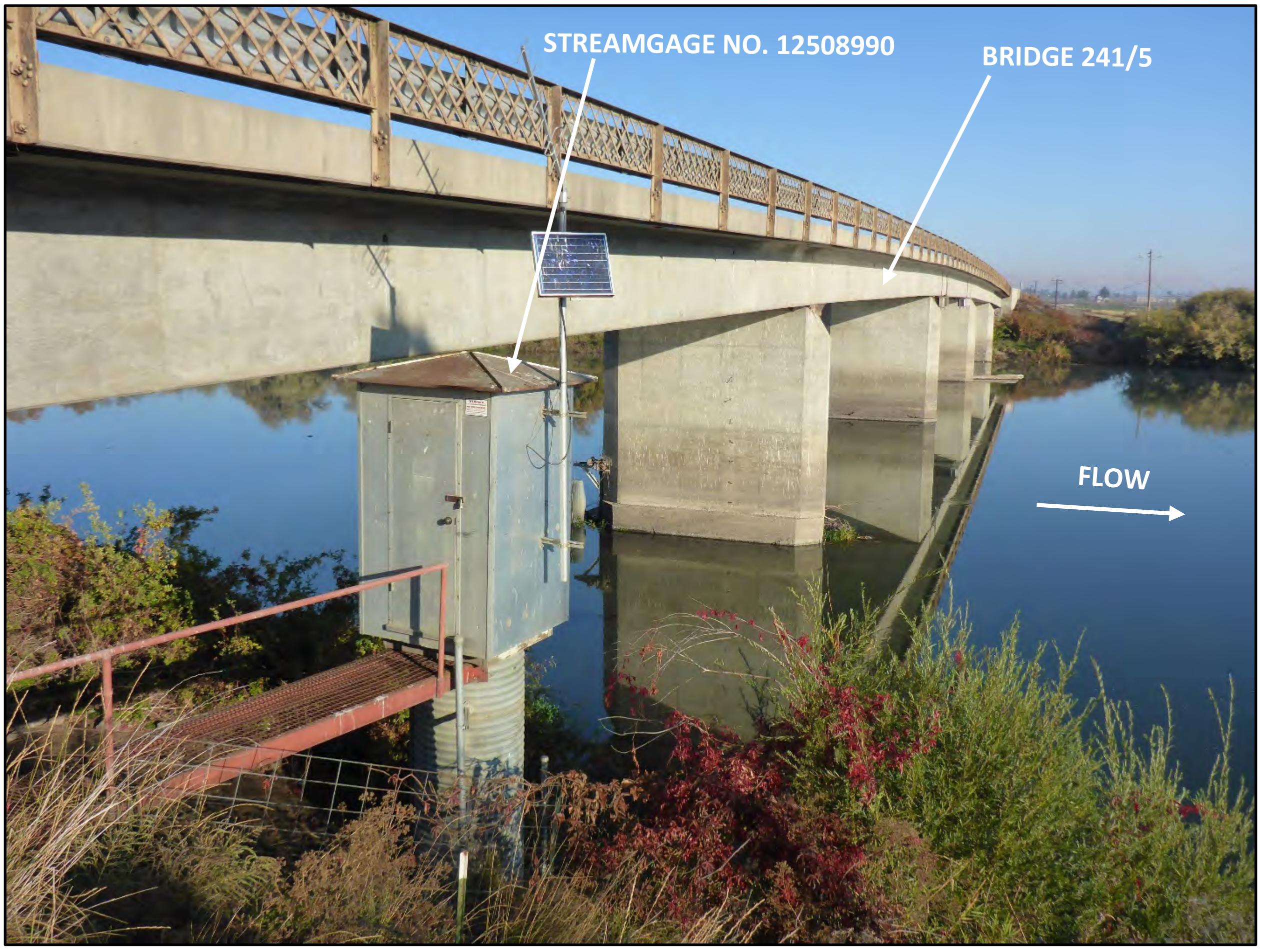

Figure 4.1 USGS Streamgage No. 12508990 on the Yakima River Right Bank Downstream of Bridge 241/5

A flow-frequency analysis of the annual peak flow record for the gage was performed by using the HEC-SSP software (USACE, 2017). The flow-frequency analysis followed the guidelines of USGS Bulletin 17C (England et al., 2018) and utilized the Expected Moments Algorithm and the Multiple Grubbs-Beck low-outlier test. Per the recommendations of Mastin et al. (2016), the flow-frequency analysis incorporated an improved estimate of the skew coefficient. The improved skew coefficient was derived as the weighted average between the regional skew coefficient and the skew coefficient from the gage

record. The peak flow estimates resulting from the HEC-SSP flow-frequency analysis are presented in Table 4.1.

Through the project site, the Yakima River is in a FEMA regulated Zone AE Designated Floodway (see Section 3.2 and Appendix C), with effective BFEs for the 1% annual recurrence (100-year) flow (FEMA, 2016). The peak flows used in the FEMA FIS are provided in Table 4.1. The no-rise requirement was evaluated utilizing the 100-year peak flow and corresponding BFEs from the FIS (see Section 7.4 for additional discussion on the no-rise analysis). Since the FIS 100-year peak flow was comparable and slightly higher than the gage analysis, the FIS 100-year peak flow was also utilized for the hydraulic and scour analyses (see Section 12.0). The 2- and 500-year peak flows that were derived from the flow-frequency gage analysis were utilized for the hydraulic and scour analyses, as the FIS did not include a 2-year peak flow and seemed to overestimate the 500-year peak flow based on the gage analysis.

Table 4.1 Peak Flows for Yakima River at the Project Site

Mean Recurrence Interval (MRI)	Flow-Frequency Analysis of Streamgage No. 12508990	FEMA FIS
(Years)	(Cubic Feet per Second)	(Cubic Feet per Second)
2	**12,900***	-
10	28,700	26,000
25	37,700	-
50	44,700	44,600
100	51,800	**56,300***
500	**69,500***	100,000

***Bold values are those used in the hydraulic and scour analyses**

5.0 Fish Resources and Site Habitat Assessment

An assessment of Fish Resources and Site Habitat was not required for this project.

6.0 Reference Reach Selection

The proposed crossing does not include a stream design and therefore no reference reach information was collected.

7.0 Hydraulic Analysis

The hydraulic analyses of the existing and proposed SR 241/2 Yakima River crossings were performed with the Sedimentation and River Hydraulic - 2D (SRH-2D) (U.S. Bureau of Reclamation, 2016), a two-dimensional, depth-averaged hydraulic model. The SRH-2D model allowed for a detailed understanding of the hydraulics through the existing and proposed crossings and was utilized for the no-rise (Section 7.4) and scour analyses (Section 12.0).

7.1 Model Development

The development of SRH-2D models for the existing and proposed SR 241/2 crossings of the Yakima River involved the following four successive steps: 1) gathering terrain data at the project site (Section 7.1.1); 2) delineating the domains and constructing the meshes for the existing and proposed conditions models (Section 7.1.2); 3) specifying the appropriate boundary conditions (Section 7.1.3); and 4) selecting the appropriate hydraulic roughness values (Section 7.1.4).

7.1.1 Terrain Data

Topographic data within the Yakima River channel near the SR 241/2 crossing was obtained from two sources:

1. Combining LiDAR data from surveys conducted in 2004, 2005, and 2015, and
2. Bathymetric surveys conducted by WSDOT in 2018, and 2019.

WSDOT personnel combined the topographic data within the main river channel and the slough with topographic LiDAR in the river floodplains. This resulted into a single surface of the terrain at the project site, which was delivered to NHC in digital (LandXML) format.

7.1.2 Model Domain and Mesh Development

The provided surface was imported into the Surface-water Modeling System (SMS) (Aquaveo, 2019). SMS is a computer program which provides a user interface for building and running hydraulic models, including SRH-2D. A mesh is a collection of computational elements, which simulate the terrain data within the hydraulic model domain. The mesh is then utilized by SRH-2D to calculate water depth, velocity, and other hydraulic parameters. The SRH-2D model was run assuming a fixed bed; therefore the mesh represents the terrain data used for its development and does not change in response to flow and sediment transport, as would be expected under natural conditions.

Hydraulic models with two different domains were constructed for the analyses of the SR 241/2 crossing. The first domain included all floodplain areas near the SR 241/2 crossing that were expected to be inundated by the simulated flows and thus was between roughly 11,900 feet and 2,000 feet wide near its upstream and downstream ends, respectively (Figure 7.1). Models developed with this first, entire floodplain domain were utilized for the hydraulic design (Section 7.3), the no-rise, per the County's request (Section 7.4) and the scour (Section 12.0) analyses of the SR 241/2 crossing. From an interpretation of the Code of Federal Regulations (CFR), it was deemed necessary to evaluate the no-rise

condition with a model replicating the FEMA regulatory floodway (see Appendix C), in addition to the floodplain assessment. This second model domain was defined such that its lateral extents coincided with the limits of Effective FEMA regulatory floodway (see Figure 7.2 and Appendix C).

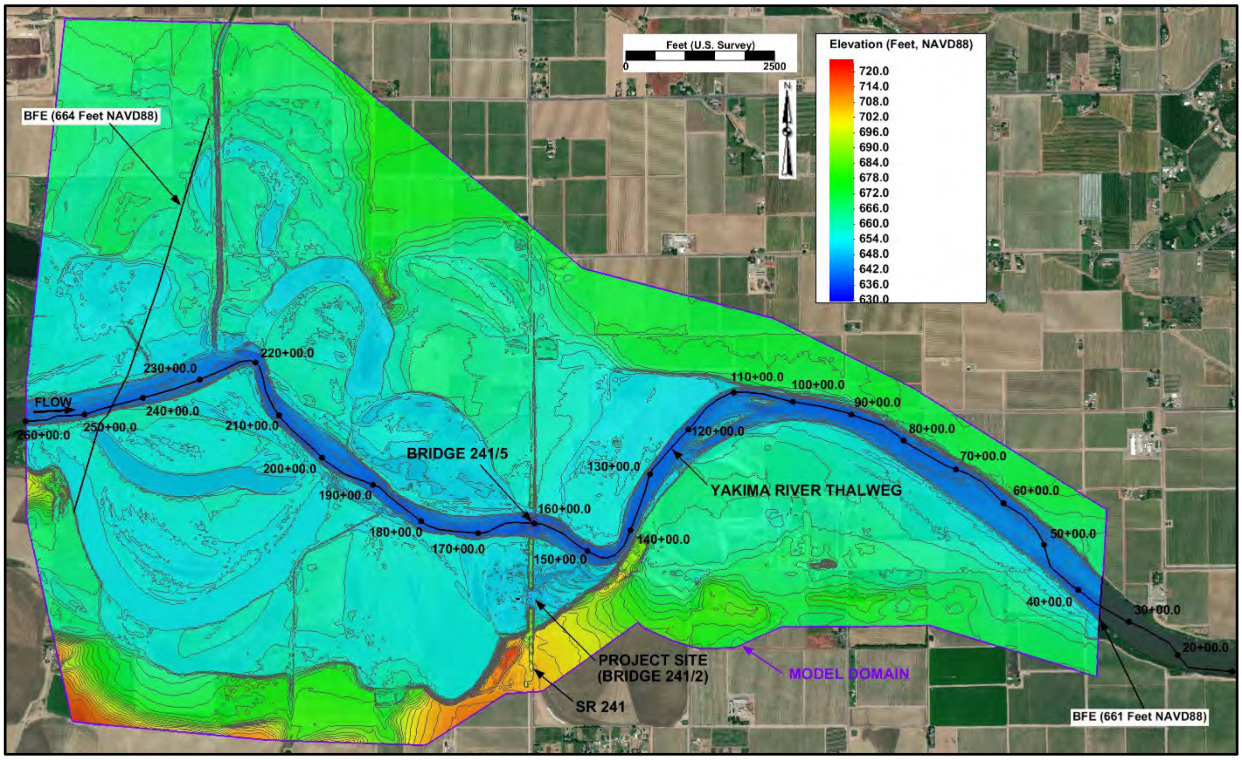

Figure 7.1 SRH-2D Domain for the Existing and Proposed Conditions Yakima River Floodplain Models

Both the entire floodplain and floodway domains extended approximately 12,500 feet downstream and 10,000 feet upstream of the SR 241/2 bridge (Figure 7.1 and Figure 7.2). The downstream end of both domains was aligned with the 661-foot BFE contour (see Figure 7.1 and Figure 7.2), which is the same for both the regulatory floodplain and floodway, as determined by the FEMA FIS (See Section 3.2). To provide a sufficient distance upstream for showing a no-rise, the two domains also include the 664-foot BFE contour. Both domains also included the 241/5 bridge across the Yakima River main channel (see Section 7.1.2). The streamwise extents of the two model domains were set sufficiently far enough away from the SR 241 crossings, in order to minimize any effects on the project site hydraulics.

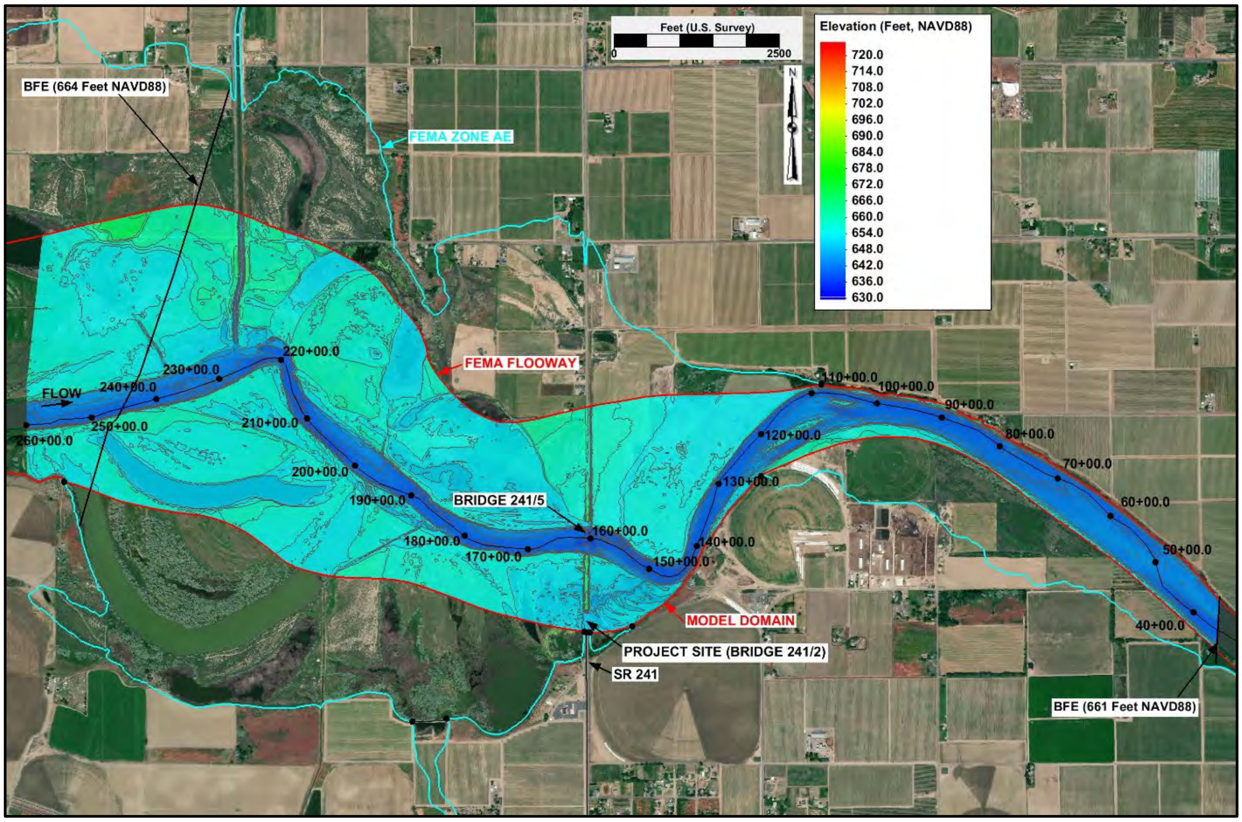

Figure 7.2 SRH-2D Domain for the Existing and Proposed Conditions Yakima River Floodway Models

Based on channel and floodplain topography, the existing and proposed conditions meshes have an element density that represents the terrain for both the entire floodplain and floodway model domains. The existing and proposed meshes with the entire floodplain domain consisted of approximately 375,000 and 360,000 elements, respectively. The existing and proposed floodway model meshes consisted of approximately 170,000 and 155,000 elements, respectively. In the vicinity of Piers 1-4 of the main channel bridge 241/5, the element spacing was approximately 5 feet in both the existing and proposed conditions meshes. The element spacing in the existing condition meshes around the 1.6-foot diameter piles of the existing bridge 241/2 bents was roughly 0.4 feet in order to accurately capture their geometry (Appendix A). In the proposed conditions meshes for both domains, the element vertex spacing around Piers 2 and 3 of the proposed bridge was approximately 2 feet. In the overbank areas, where the flow hydraulics and topography are expected to be less variable, the mesh vertex spacing was roughly 40 feet. The mesh element spacing transitioned gradually between these element resolutions to ensure model stability. The elements in the main channel and at the slough for all meshes were designated as quadrilaterals, whereas elements elsewhere on the floodplains were triangular.

The Piers 1, 2, 3, and 4 of the existing bridge 241/5 across the Yakima River main channel were simulated with holes in the mesh in all models. The locations and size of these holes coincided with those of the piers, which were supplied by WSDOT to NHC in electronic format. Abutments were incorporated into the surface and were thus directly represented in the mesh (Figure 7.3).

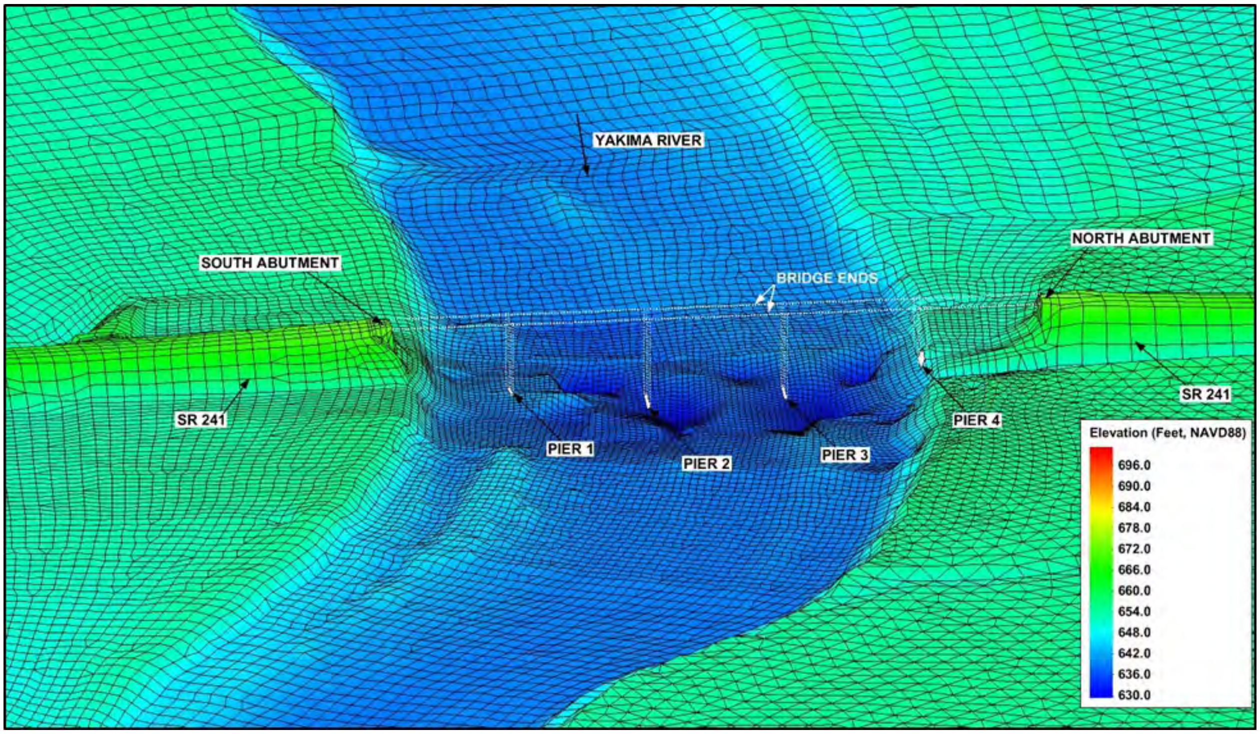

Figure 7.3 Existing and Proposed Conditions Mesh Near Bridge 241/5 Across the Yakima River Main Channel

The abutments of the existing and proposed 241/2 bridges across the Yakima River slough were also incorporated in the supplied surface and were thus directly reflected in the existing and proposed conditions meshes (Figure 7.4 and Figure 7.5). The existing conditions mesh had holes at the locations of the piles supporting the 5 bents of the existing bridge 241/2 (Figure 7.4). Similarly, the proposed conditions mesh had holes at the locations of the Piers 2 and 3 of the proposed bridge (Figure 7.5). The locations and size of the existing bridge bent piles and Piers 2 and 3 of the proposed bridge were based on plans supplied to NHC in electronic format by WSDOT.

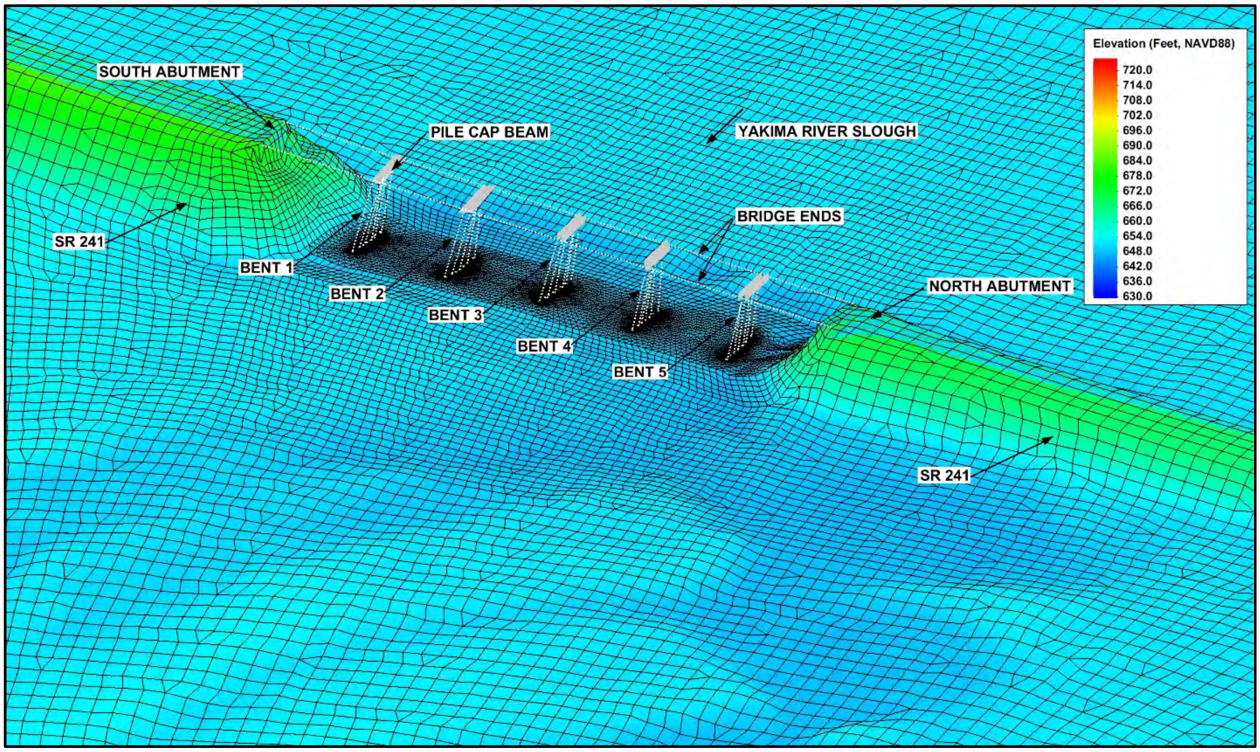

Figure 7.4 Existing Conditions Mesh Near Bridge 241/2 Across the Yakima River Slough

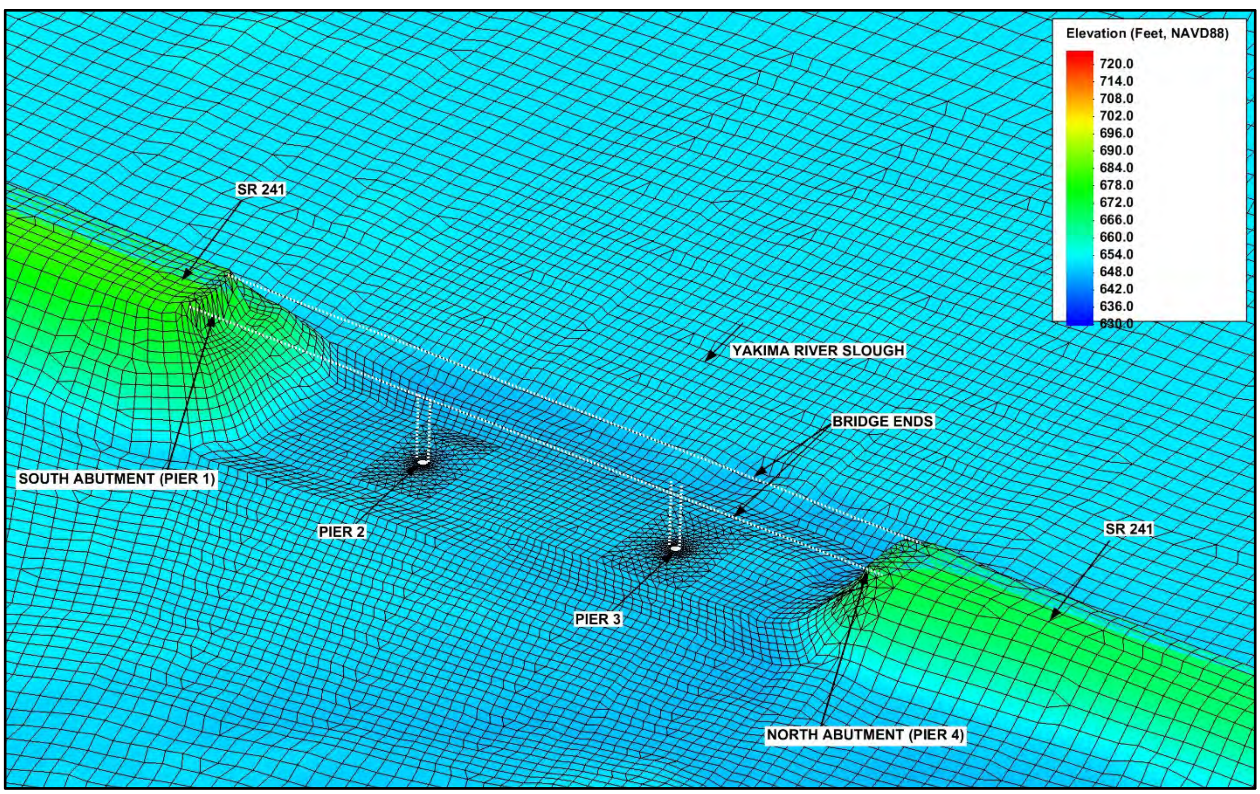

Figure 7.5 Proposed Conditions Mesh Near Bridge 241/2 Across the Yakima River Slough

7.1.3 Boundary Conditions

The simulations for both the existing and proposed conditions required the specification of two boundary conditions: 1) the steady inflow rate at the upstream end of the model domain; and 2) the water surface elevation (WSE) at the downstream end of the domain.

The inflow rates for the 2-, 100-, and 500-year peak flows, were specified as the upstream boundary conditions and are provided in Table 4.1. The location of the upstream boundary conditions were sufficiently far enough upstream of the project site that any influences on hydraulic results near the SR 241 crossings were negligible (see Section 7.1.1). The inflow for all peak flow simulations was designated subcritical to match the expected flow regimes in the Yakima River. The model was run in a steady-state mode for all modeled simulations.

The downstream boundary condition for the existing and proposed conditions models consisted of the FEMA BFE for the simulated peak flow; as the downstream end of the domain coincided with the location where FEMA BFEs were provided in the FIS. It was verified that the specified BFEs were similar to the normal flow conditions at the downstream boundary of the domain for the simulated peak flows. Furthermore, a sensitivity analysis was also performed on the specified WSE to ensure that the water surface profile did not exhibit rapid drawdown or backwater characteristics near the downstream end of the domain. It also ensured that the selection of the WSE did not affect the hydraulics at the SR 241 bridge crossings.

7.1.4 Roughness Values

The Manning's hydraulic roughness coefficient (n) values in the existing and proposed models were iteratively estimated by calibrating the 100-year WSEs predicted by the existing conditions model to the FEMA BFEs. Specifically, the n values of the river main channel, banks, and floodplains were iteratively adjusted until the discharge-averaged 100-year WSEs calculated by the existing conditions entire floodplain model at the locations of the 661- and 664-foot BFEs matched these BFE values (see Figure 7.1 and Figure 7.2). The hydraulic roughness coefficients for other land uses were estimated based on established values in the engineering literature (Chow, 1959) and recommended by FHWA (2008) for the observed conditions. Table 7.1 contains the Manning's n values that were determined by this calibration procedure and were utilized for the modeling. These Manning's n values are in agreement with those used in the 2D model of Yakima County (2019). The general roughness boundaries were delineated using the provided survey data and aerial imagery.

Table 7.1 Hydraulic Roughness Values

Land Cover Type	Manning's n
Main Channel	0.024
Channel Banks	0.035
Floodplains	0.055
Forested Areas	0.08
Cultivated Areas	0.02
Pavement and Concrete	0.015
Embankment Fill Material	0.05
Open Spaces	0.03
Side and Irrigation Channels	0.045

7.2 Existing Conditions Results

The calculated WSE, velocity, and depth for the 2-, 100- and 500-year peak flows under existing conditions from the entire floodplain model are provided in Appendix G (Figures G-1 through G-9). The calculated 100-year depth in the Yakima River floodplain upstream of the existing Bridge 241/2 is between 12 and 13 feet (Figure G-6). Roughly 70 feet upstream of the crossing, the depth increases, ranging in values from 15 to 17 feet, and then slightly decreases through the crossing, with values ranging between 13 and 16 feet. Based on the model results, the 241/2 crossing and the SR 241/2 embankments near the crossing are not overtopped during the 100-year peak flow. However, the model predicts that a roughly 3,060-foot long segment of SR 241 located about 335 feet to the north of the main stem SR 241/5 crossing becomes inundated under the 100-year peak flow. The 500-year flow depth near the SR 241/2 crossing follows a similar pattern to that of the 100-year flow depth, but is deeper by 2 to 3 feet. However, under the 500-year peak flow the central 320-foot long segment of the SR 241 roadway between the SR 241/2 and 241/5 crossings becomes overtopped. Furthermore, under the 500-year peak flow, the length of SR 241 north of the main stem 241/5 crossing that becomes inundated, increases to about 4,050 from 3,060 feet under the 100-year peak flow. The WSDOT South Central Region Project Engineer's Office (PEO) elected to not construct rock protection for the SR 241 segments that are being overtopped.

The 100-year velocities in the Yakima River slough upstream of the 241/2 crossing are approximately 1 foot per second, but their magnitude starts increasing to about 2 feet per second within 200 feet upstream of the bridge (Figure G-5). This increase is attributed to the constriction of the flow through the crossing. The velocities increase further and reach their largest magnitude near the middle of the 6 spans, where the flow constriction is maximized. Specifically, the velocity through Spans 2, 3, and 4 (between Bents 1 and 2, 2 and 3, and 3 and 4, respectively) increases to approximately 2.5 feet per second, while the velocities near the middle of Spans 5 and 6 reach about 3 feet per second. The results in Figure G-5 show that the incoming flow between the 241/2 and the 241/5 crossing impinges on the SR 241 embankment and splits approximately 310 feet north of the 241/2 crossing. The flow to the south of this splitting point is redirected and flows southward along the SR 241 embankment. From

there, it flows around the north 241/2 abutment and merges with the main flow core through the 241/2 crossing. It is likely that this flow portion increases the maximum velocities at Spans 5 and 6 relative to those at Spans 2, 3, and 4. The flow to the north of the splitting point is redirected towards the north and flows around the south abutment of the 241/5 crossing, before it enters the Yakima River main channel.

The velocity map in Figure G-5 indicates relatively high velocities reaching 2.5 feet per second over a 150-foot distance downstream of the 6 spans of the existing bridge, as well as velocity shadows in the wake (downstream) of the 5 bents. The flow velocity 150 feet downstream of the crossing maintains values between 1 and 2 feet per second for approximately 450 feet but then decreases to about 1 foot per second before it enters the main Yakima River channel.

7.3 Proposed Conditions Results

The calculated WSE, velocity, and depth for the 2-, 100-, and 500-year peak flows for the proposed conditions with the floodplain model are provided in Appendix H (Figures H-1 through H-9). Figure 7.6 illustrates the proposed 2-, 100-, and 500-year WSEs extracted along cross-section XS-1 at the upstream face of the proposed 241/2 crossing (see Figures H-1, H-4 and H-7 in Appendix H). Furthermore, the discharge-weighted average WSE along cross-section XS-1 for the proposed 2-, 100-, and 500-year peak flows are provided in Table 7.2.

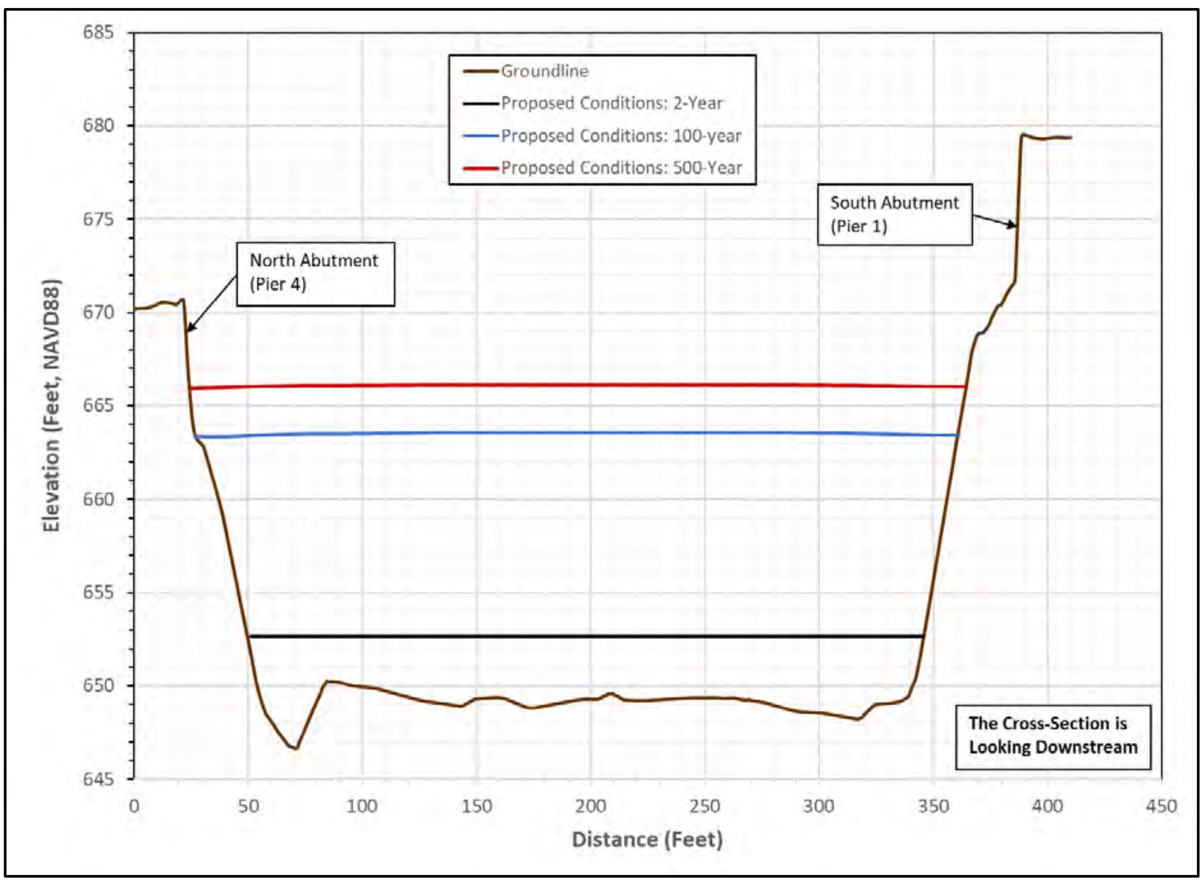

Figure 7.6 Proposed Water Surface Elevations (WSEs) at the Upstream Face of the Proposed Bridge 241/2

Table 7.2 Proposed Water Surface Elevations (WSEs) at the Upstream Face of the Proposed Bridge 241/2

Mean Recurrence Interval (MRI) (Years)	Discharge Weighted Average Water Surface Elevation (WSE) (Feet, NAVD88)
2	652.7
100	663.6
500	666.1

Upstream of the 241/2 crossing, the proposed conditions 100-year velocity results (Figure H-5 in Appendix H) exhibit similar magnitude and patterns with the existing conditions (Figure G-5 in Appendix G). About 200 feet upstream of the crossing, the 100-year velocity attains values ranging between 1 and 1.5 feet per second or less, but gradually increases in magnitude closer to the crossing. Through the proposed crossing, the largest velocities are observed between the north abutment (Pier 4) and Pier 3, where the velocity reaches up to 3.2 feet per second. Between Piers 2 and 3, and between Pier 2 and the south abutment (Pier 1), the velocities reach values up to about 2.5 feet per second. The location with the highest 100-year proposed conditions velocities, between Pier 3 and the abutment of Pier 4, roughly coincides with that for existing conditions. Furthermore, similar to the existing conditions, a portion of the floodplain flow under the proposed conditions splits approximately 310 feet to the north of the crossing, flows along the SR 241 embankment, and then reenters the main flow core through the crossing. It is likely that, similar to the existing conditions, the merging of the flow along the SR 241 embankment north of the crossing, with the main flow core, leads to the increased velocities between Pier 3 and the abutment of Pier 4. It is also noted that the 100-year velocity (Figure H-5) is larger than the 500-year velocity (Figure H-8) near the 241/2 crossing. This is attributed to the larger increase in flow area (about 20%) than the increase in flow discharge (only about 6%) through the 241/2 crossing from the 100-year to the 500-year peak flow.

Downstream of the crossing, the 100-year velocity magnitude ranges between 2 and 2.5 feet per second, except for downstream of Piers 2 and 3 where it attains smaller values due to the pier velocity shadow effect. Figure 7.7 illustrates the 100-year velocity for existing and proposed conditions along XS-2 (see Figure H-5 in Appendix H), which is extracted along the downstream end of the proposed bridge. The results in Figure 7.7 show that under proposed conditions, the 100-year velocity along XS-2 exhibits velocity shadows only downstream of Piers 2 and 3, whereas the existing conditions 100-year velocity exhibits shadows downstream of all Bents 1 through 5. Furthermore, the reduction in the 100-year velocity (due to the velocity shadow) is in general smaller for the proposed conditions than it is for the existing conditions. The fewer occurrences and smaller magnitude of the velocity shadows for proposed conditions suggest that the proposed bridge would introduce smaller impacts to the flow field than the existing bridge. By reducing these impacts, the proposed bridge is expected to promote the transport of wood, sediment, and debris through the crossing.

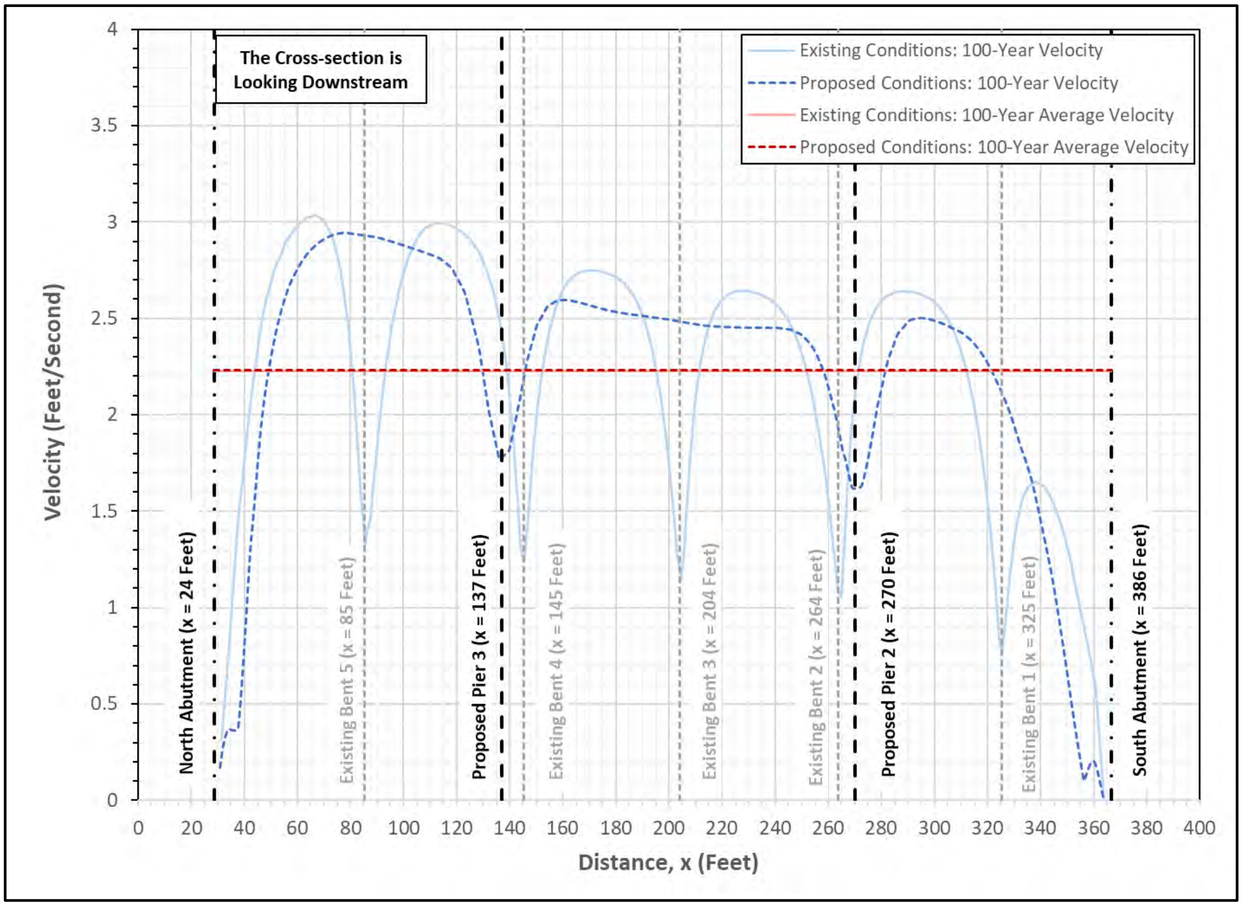

Figure 7.7 Existing and Proposed Conditions 100-Year Velocity at the Downstream End of the Proposed Bridge

The unit discharge (units of cubic feet per second per foot, or square feet per second), which is considered a measurement of the flow conveyance, was calculated as the product of the calculated water depth, D, (units of feet) and the velocity, V, (units of feet per second) for existing and proposed conditions. The difference of the proposed conditions unit discharge relative to existing conditions is illustrated in Figure 7.8. Red shades in Figure 7.8 indicate an increase in unit discharge, whereas blue shades indicate a decrease, compared to existing conditions. The results in Figure 7.8 show an increase in the unit discharge (and thus in flow conveyance) from existing to proposed conditions downstream of the locations where Bents 1 to 5 are located in existing conditions. In contrast, the unit discharge decreases downstream of the proposed bridge Pier 2 and 3 locations. The average unit discharge along XS-2 at the downstream end of the proposed bridge increases from 30.4 under existing conditions to 31.2 in proposed conditions. This increase in the average unit discharge suggests that the proposed structure is anticipated to improve the continuity of flow, sediment, and debris transport through the SR 241/2 crossing.

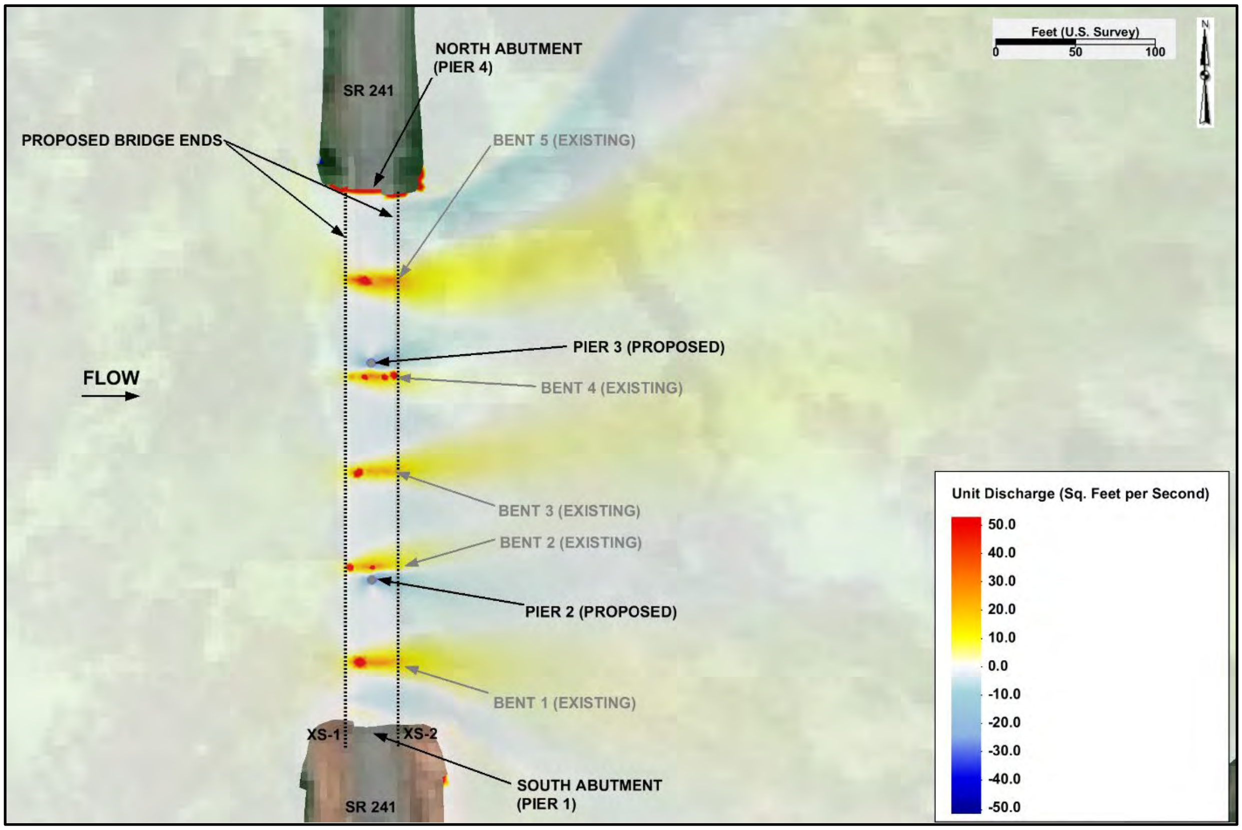

Figure 7.8 Unit Discharge Difference Between Existing and Proposed Conditions for the 100-Year Peak Flow

7.4 No-Rise Analysis

As discussed in Sections 3.2 and 4.2, the proposed project is within a FEMA regulated Zone AE Floodway. Therefore, any fill or structure placed within the floodway must meet a no-rise requirement. It was determined through communication with Yakima County that the effective FIS model was unavailable for this study. Per the findings of Yakima County (2019) the use of the BFEs derived from the effective FIS model may be inappropriate, due to its 1D nature, outdated inputs and potentially not including the SR 241 crossing. Therefore, corrected duplicate effective models were developed utilizing the 2D model domains described in Section 7.1.2 to represent the existing conditions. The corrected duplicative effective models followed FEMA Region X requirements (FEMA, 2013), which state the models need to be calibrated to reproduce the FIS profiles of the effective model within 0.5 feet (FEMA, 2016). Potential changes in WSEs from the existing to proposed conditions were evaluated by comparing the WSE calculated by the proposed conditions floodplain and floodway models (see Section 7.3 and Appendix H) to the existing conditions WSEs predicted by the respective model under the same 100-year peak flow (see Section 7.2 and Appendix G). Following the recommendations of FHWA (FHWA, 2019), this comparison considered the discharge-weighted average of the 100-year proposed conditions WSEs along paths that were defined by the whole-foot increment contours of the existing conditions WSE. The discharge-weighted averaging is recognized by FEMA (2019) as the equitable method for producing average WSEs. Furthermore, per FHWA (2019), selecting the existing 100-year WSE whole-foot contours for this comparison reduces the subjectivity in the selection of locations for comparing the WSE for

existing and proposed conditions. Additionally, the whole-foot WSE contours of the existing conditions 2D model provide more accurate BFEs estimates than the BFE estimates derived from the outdated 1D FIS effective model (Yakima County, 2019). The proposed conditions 100-year WSEs were extracted along the paths defined by the 661-, 662-, 663-, and 664-foot WSE contours determined by the existing conditions floodplain and floodway models. These paths are indicated in Figure G-10 of Appendix G as well as with red color in Figure 7.9 for the floodplain model and in Figure 7.10 for the floodway model. The discharge-weighted average of the extracted 100-year proposed conditions WSE along these paths is summarized in Table 7.3 for the floodplain model and in Table 7.4 for the floodway model. As requested by Yakima County, the FEMA Region X "no-rise" certification is provided in Appendix K.

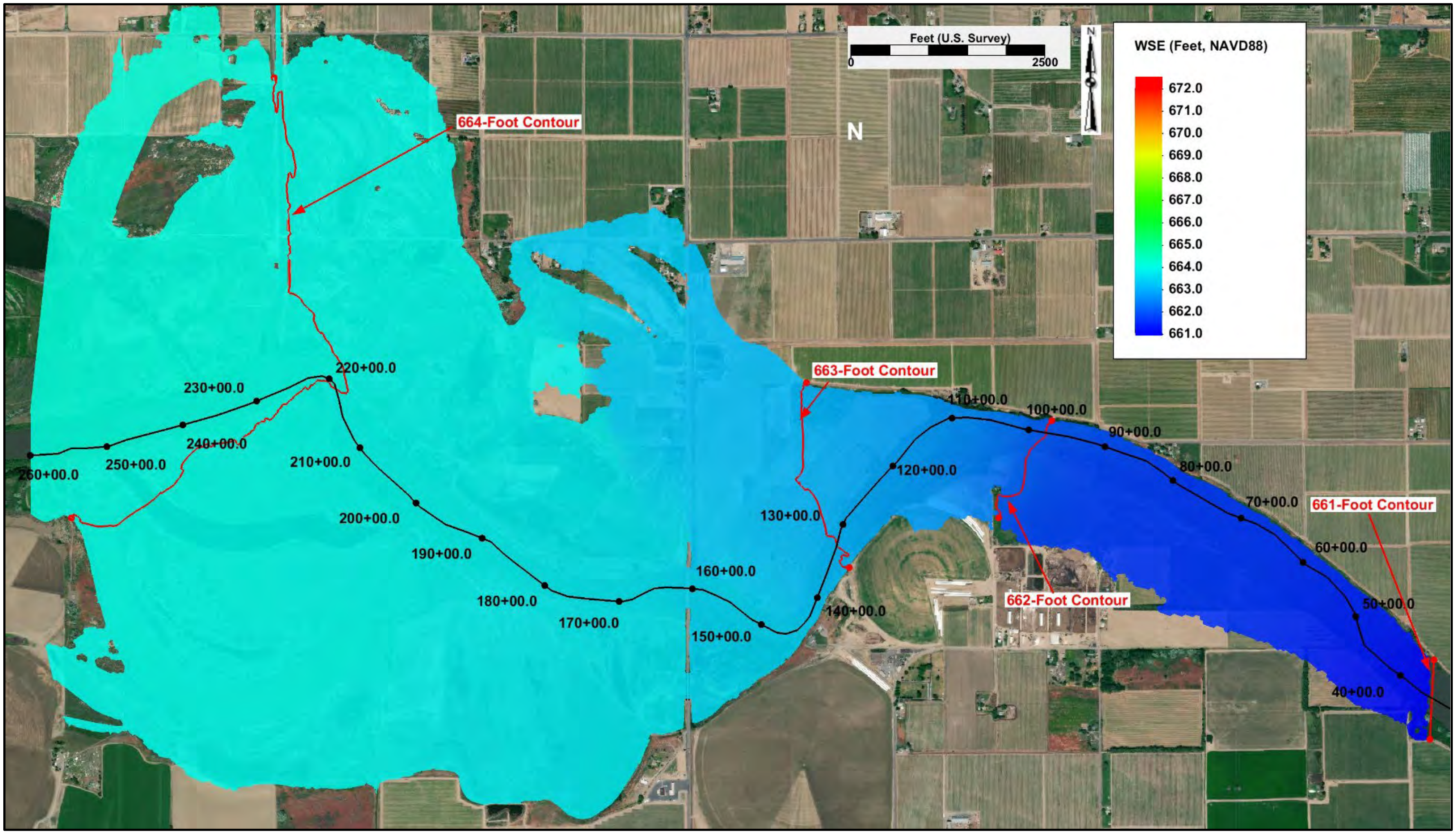

Figure 7.9 Whole-Foot Contours of the 100-Year Peak Flow Water Surface Elevation (WSE) Predicted by the Existing Conditions Floodplain Model

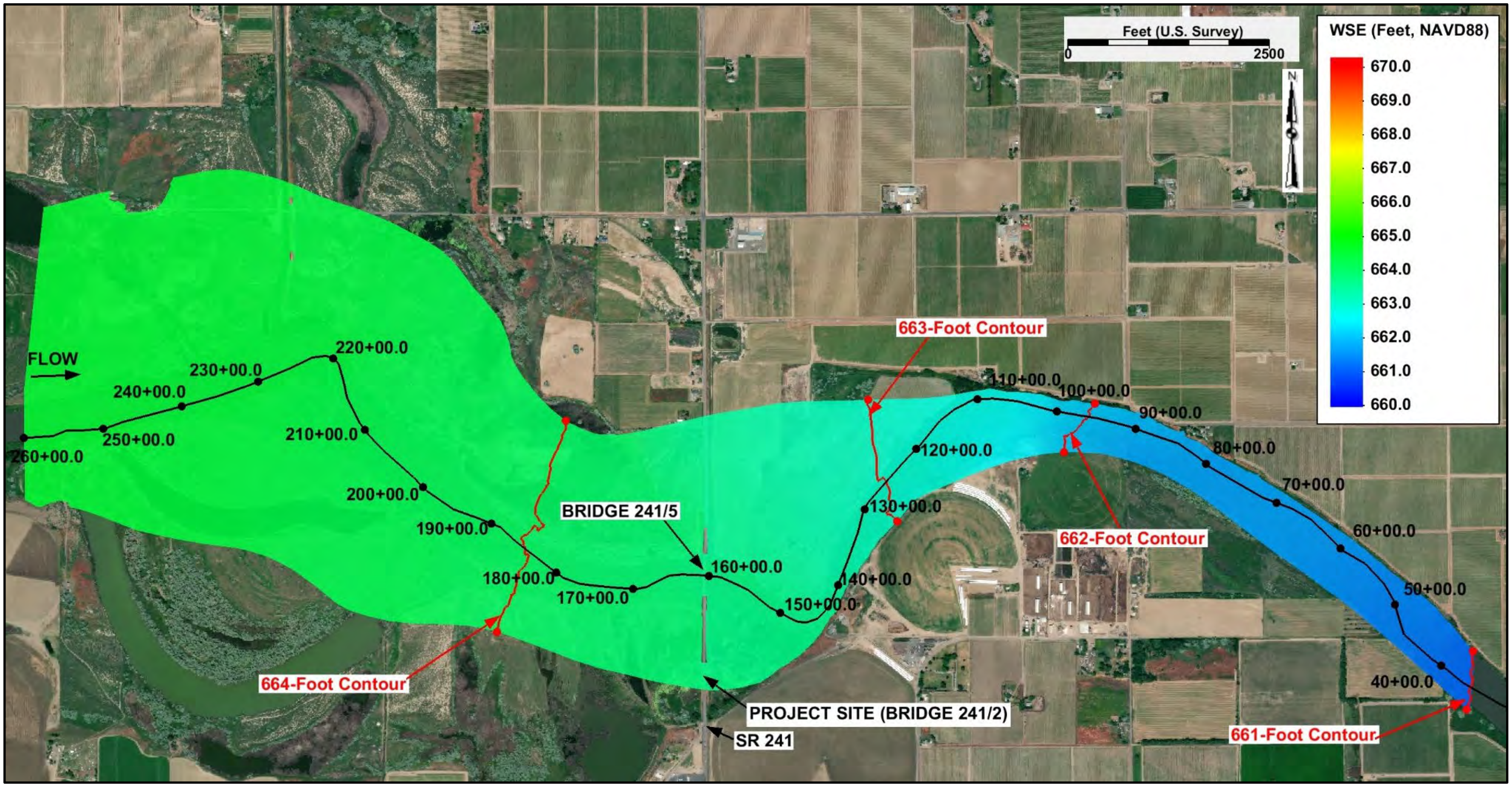

Figure 7.10 Whole-Foot Contours of the 100-Year Peak Flow Water Surface Elevation (WSE) Predicted by the Existing Conditions Floodway Model

Table 7.3 Discharge-Weighted Average 100-Year Water Surface Elevations (WSEs) Predicted by the Floodplain Model

Whole-Foot Contour Elevation	Discharge-Weighted Average Water Surface Elevation (Feet, NAVD88)		Difference (Feet)
	Existing Conditions	Proposed Conditions	
661	661.00	661.00	0.00
662	662.00	662.00	0.00
663	663.00	663.00	0.00
664	664.00	664.00	0.00

Table 7.4 Discharge-Weighted Average 100-Year Water Surface Elevations (WSEs) Predicted by the Floodway Model

Whole-Foot Contour Elevation	Discharge-Weighted Average Water Surface Elevation (Feet, NAVD88)		Difference (Feet)
	Existing Conditions	Proposed Conditions	
661	661.00	661.00	0.00
662	662.00	662.00	0.00
663	663.00	663.00	0.00
664	664.00	664.00	0.00

The results in Table 7.3 and Table 7.4 indicate that the 100-year discharge-weighted average WSEs for the proposed bridge predicted by both the floodplain and floodway duplicated effective models are not greater than the corresponding existing conditions WSEs. Therefore, the proposed bridge meets the FEMA no-rise requirement based on the results from either the floodplain or the floodway duplicative effective models, as requested by Yakima County.

8.0 Bridge Design Selection Methods

8.1 Design Methodology Selection

WAC 220-660-190 states that appropriate methods for designing water crossings over fish-bearing waters are available in the WDFW Water Crossing Design Guidelines (WCDG) (Barnard et al., 2013) or other published manuals and guidelines. Designing the structure using the 2013 WDFW bridge design methodology, as outlined in the WCDG, was determined to be the best alternative for the project site. Per the WCDG, a bridge should be considered for a site if the Floodplain Utilization Ratio (FUR) is greater than 3.0, the stream has a bankfull width greater than 15 feet, or the channel is believed to be unstable.

The proposed bridge will be constructed at the Yakima River slough where a well-defined channel does not exist at the crossing location. Furthermore, flow through the crossing is seasonal and is only present when the flows at the main Yakima River channel exceed the bankfull flow. When flow is present, the wetted width at the Yakima River slough near the 241/2 crossing is approximately 400 feet. Because this width is larger than 15 feet, the bridge design criteria was selected for this crossing.

8.2 Bridge Design Criteria

The 2013 WDFW Water Crossing Design Guidelines (WCDG) present two methodologies for designing a bridge crossing—confined bridge design and unconfined bridge design. The method to be used is defined by the FUR. The FUR is defined as the ratio of the flood-prone width (FPW) divided by the bankfull width (BFW). The FPW is the water surface width at twice the bankfull depth, or the width at the 50-year to 100-year flood. A ratio under 3.0 is considered a confined channel and a ratio above 3.0 is considered an unconfined channel. The proposed bridge will be constructed at the Yakima River slough where a well-defined channel does not exist at the crossing location, therefore the WDFW guidance is not applicable for this crossing.

8.2.1 Backwater and Freeboard

The WAC and WCDG recommend the prevention of excessive backwater rise and increased main channel velocities during floods that might lead to scour of the streambed or over-coarsening of the stream substrate. Additionally, both the WAC and WCDG state that a proposed structure should allow for the free passage of large woody material and sediment expected to be encountered, and generally suggests a minimum 3-foot freeboard above the 100-year peak flow for a river of this size. Based on the hydraulic analysis results for the proposed conditions, the 100-year WSE at the upstream end of the proposed 241/2 bridge is 663.6 feet (see Section 7.3 and Table 7.2). Based on the preliminary bridge layout (see Appendix F) provided by the WSDOT South Central Region PEO, the proposed bridge provides on average 4.5 feet of freeboard from the 100-year WSE elevation, varying between 9 feet at the south end (Pier 1) to approximately 2.3 feet at the north end (Pier 4) of the structure. The minimum 3-foot freeboard is not maintained only over the northernmost 30 feet of the proposed bridge, which represents 8.3% of its total 360-foot length. The reduced freeboard in this 30-foot long segment of the bridge is deemed by WSDOT Headquarters Hydraulics to be sufficient, based on minimal to no history of maintenance due to debris loading at the 241/2 bridge (see Appendix F).

8.2.2 Floodplain Continuity and Lateral Migration through Structure

The WCDG requires that bridges account for lateral channel movement that will occur in their design life and that the design channel maintains floodplain continuity. As described in Section 3.4.4, the risk for lateral migration of the Yakima River main channel and the flowpath on the slough through the 241/2 crossing is low. Based on the results from the proposed conditions hydraulic analysis (see Section 7.3), the proposed bridge is expected to maintain and potentially improve the continuity of flow, sediment, and wood through the crossing.

8.2.3 Channel Gradient

The WCDG recommends, to the extent compatible with the safety of the bridge, its approach roads, and adjacent private property, to allow for the natural evolution of the channel planform and longitudinal profile. The proposed crossing does not include a stream design with a typical channel section. The bed at the Yakima River slough near the 241/2 crossing should be left at its natural grade and allowed to freely evolve over time based on future flow and sediment supply conditions.

9.0 Streambed Design

The proposed crossing does not include a stream design with a typical channel section. However, it is recommended that the WSDOT South Central Region PEO utilize a well-graded mix of streambed sediment that is similar to the gradation of the observed streambed material (see Section 3.3.6) to fill in the channel wherever needed.

10.0 Floodplain Changes

This project is within a Federal Emergency Management Agency (FEMA) Zone AE designated floodway (see Section 3.2), per the published FEMA FIRM (panels 53077C2276D and 53077C2257D in Appendix C). The pre-project and expected post-project conditions were evaluated through a no-rise analysis to determine whether or not there would be a change in water surface elevation (see Section 7.4). The results of the no-rise analysis (Table 7.3) showed that there will not be any changes in the water surface elevation due to the project near SR 241.

11.0 Climate Resilience

WSDOT recognizes climate change as a risk to the long-term success of its structures and approaches the design of bridges, buried structures, and fish passable culverts through a risk-based assessment. WSDOT also completes a hydraulic model for all water crossings on fish bearing streams, regardless of design methodology, to ensure that the structure is appropriately sized.

Climate resilience is evaluated at each crossing using the Climate Impact Assessment Maps, created by WSDOT, to assess risk level of infrastructure across the state. The 241/2 crossing of the Yakima River slough has been evaluated and was determined to be a low risk site based on the Climate Impacts Vulnerability Assessment Maps. Due to this determination, no additional considerations have been made to the design to account for additional climate resilience, other than those listed above.

12.0 Scour Analysis

Utilizing the results of the hydraulic analysis and considering the potential for lateral channel migration, scour calculations were performed based on the proposed hydraulic model following the procedures outlined in *Evaluating Scour at Bridges HEC No. 18* (Arneson et al., 2012). Scour components considered in the analysis include:

1. Long-term aggradation/degradation
2. General scour (i.e., contraction scour)
3. Local scour

In addition to the three scour components above, potential lateral migration of a channel must be assessed when evaluating total scour at a highway infrastructure. A channel moving laterally may affect the stability of structural elements or increase total scour by changing the orientation of flow. These various scour components will be discussed in the following sections.

12.1 Lateral Migration

As described in Section 3.4.4, the potential of the main Yakima River channel to migrate southward toward the project site is low. Furthermore, the analysis of the historic aerial images (see Section 3.4.4) and the groundline surveys during the previous bridge inspections (see Section 3.4.2 and Appendix D) revealed that the flow path of the Yakima River slough through the 241/2 crossing has remained laterally stable. Therefore, risk for lateral migration at the 241/2 crossing is considered low.

12.2 General Scour at the Bridge (i.e., Contraction Scour)

Contraction scour is expected to occur through the proposed 241/2 crossing developed by WSDOT. The Laursen method as detailed in HEC-18 (Arneson et al., 2012) was applied for estimating the contraction scour at Piers 2 and 3 and for the design of a scour countermeasure at the abutments of Piers 1 and 4, if the WSDOT South Central Region elects to construct a scour countermeasure (see Sections 12.4 and 13.0 for more details). If the WSDOT South Central Region does not elect to construct a properly designed scour countermeasure at the abutments of Piers 1 and 4, the contraction scour for Piers 1 and 4 was accounted for jointly with abutment scour by utilizing the National Cooperative Highway Research Program (NCHRP) 24-20 abutment scour equations (see Section 12.3.1). Application of the Laursen method, assessed at several locations upstream, determined that clear-water conditions are applicable at the 241/2 crossing for both 100- and 500-year peak flows. The depth of clear-water contraction scour was calculated to be 15.0 and 14.2 feet for the 100- and 500-year peak flows, respectively (see Appendix I). The depth of contraction scour for the 500-year peak flow is smaller than its depth for the 100-year peak flow, as the velocities upstream of the crossing for the 500-year peak flow are lower than the 100-year velocities (see Section 7.3).

12.3 Local Scour

The local scour around the abutments of Piers 1 and 4 at the south and north ends of the proposed bridge was estimated by utilizing the NCHRP 24-20 abutment scour method and is discussed in Section

12.3.1 (Ettema et al., 2010). Local scour around Piers 2 and 3 of the proposed bridge was estimated by using the HEC-18 CSU pier scour equation, as detailed in Section 12.3.2.

12.3.1 Abutment Scour

The NCHRP 24-20 abutment scour equations that appear in HEC-18 (Arneson et al., 2012) were utilized to estimate local scour for the abutments of Piers 1 and 4 of the proposed bridge. These equations apply an amplification factor to contraction scour in order to account for the effects of large-scale turbulence on scour along an abutment. Predictions of the scour around the abutments of Piers 1 and 4 of the proposed bridge were performed for both scour condition A (abutment is near the main channel) and B (abutment is set back from the main channel). The predicted depths of abutment scour for scour condition B were approximately 5% larger, and thus more conservative, than those predicted with the assumption of scour condition A. Therefore scour condition B was utilized for estimating abutment scour. The depth of abutment scour (including contraction scour) for scour condition B was determined to be 20.6 and 20.1 feet during the 100-year and 500-year peak flow events, respectively. Refer to Appendix I for calculations.

12.3.2 Pier Scour

The HEC-18 CSU pier scour equation was utilized for calculating local scour around the 5-foot diameter columns for Piers 2 and 3 of the proposed crossing. The flow depths and velocities predicted by the model through the SR 241/2 crossing were evaluated and their combination that produced the largest pier scour was selected. The depths of pier scour resulting from the selected combination of depth and velocity are 6.2 and 5.9 feet for the 100- and 500-year flows, respectively. The pier scour calculations are provided in Appendix I. The smaller depth of pier scour for the 500-year peak flow compared to the100-year peak flow, is due to the smaller velocities upstream of the crossing for the 500-year event (see Section 7.3).

12.4 Total Scour for SR 241/2

The total depth of scour for the abutments of Piers 1 through 4 of the proposed 241/2 bridge was determined for the 100- and 500-year peak flow events by combining all applicable scour components outlined in the preceding Sections 12.2 and 12.3, excluding the potential for lateral migration, which was determined to be negligible (see Section 12.1). If the WSDOT South Central Region PEO elects to not construct a local scour countermeasure for the abutments of Piers 1 and 4, then the resulting total depths of scour and expected scour elevations for the 100- and 500-year peak flow events are summarized in Table 12.1. If the rock revetment for the abutments of Piers 1 and 4 is constructed in accordance to the design provided in this section, total scour is anticipated to be mitigated (FHWA, 2018).

Table 12.1 Scour Analysis Summary for Piers 1 and 4 Without a Scour Countermeasure

Scour Component	SR 241/2 Yakima River Bridge			
	Pier 1 (South Abutment)		Pier 4 (North Abutment)	
	100-Year	500-Year	100-Year	500-Year
Long-Term Degradation (Feet)	0.0	0.0	0.0	0.0
Contraction Scour[1] (Feet)	-	-	-	-
Abutment Scour (Feet)	20.6	20.1	20.6	20.1
Total Depth of Scour (Feet)	20.6	20.1	20.6	20.1
Thalweg Elevation (NAVD88)	647.7	647.7	647.7	647.7
Scour Elevation (NAVD88)	627.1	627.6	627.1	627.6

[1]Contraction scour for Piers 1 and 4 was accounted for jointly with the abutment scour, per the NCHRP 24-20 approach of HEC-18.

The resulting total depths of scour and predicted scour elevations for Piers 2 and 3, under the 100- and 500-year peak flow events, are summarized in Table 12.2.

Table 12.2 Scour Analysis Summary for Piers 2 and 3

Scour Component	SR 241/2 Yakima River Bridge	
	Piers 2 and 3	
	100-Year	500-Year
Long-Term Degradation (Feet)[1]	0.0	0.0
Contraction Scour (Feet)	15.0	14.2
Pier Scour (Feet)	6.2	5.9
Total Depth of Scour (Feet)	21.2	20.1
Thalweg Elevation (NAVD88)	647.7	647.7
Scour Elevation (NAVD88)	626.5	627.6

13.0 Scour Countermeasure Design

To assist in the protection of the SR 241 roadway embankment near the project site against potential scour, NHC recommends a scour countermeasure for the abutments of Piers 1 and 4. The scour countermeasure, which consists of a rock revetment with toe, was designed and evaluated (Section 13.1) utilizing guidance outlined in FHWA (2018). Calculations for the scour countermeasure were based on the proposed channel hydraulics, modeled utilizing SRH-2D, as described in Section 7.3 and presented in Appendix J. The scour countermeasure design also included the design of a filter, which is presented in Section 13.2.

13.1 Abutments of Pier 1 and 4 Scour Countermeasure

To appropriately size the rock for the revetment at the abutments of Piers 1 and 4, the Isbash relationship, as documented in HEC-23 (Equation 14.1), was utilized (Lagasse et al. 2009). Equation 14.1, which was selected as the Froude number (Fr) through the 241/2 crossing, does not exceed the value of 0.8, yielded a required median revetment rock size (D_{50}) of approximately 1 inch (see Appendix J for calculations). Therefore, the rock revetment for the abutments of Piers 1 and 4 should be constructed utilizing a well-graded mix of Class A Rock for Erosion and Scour Protection (in accordance to WSDOT Standard Specification 9-13.4(2) in WSDOT (2020)). The toe of the rock revetment should be placed at an elevation that is a minimum of 15.0 feet below the thalweg elevation to match the expected depth of long term degradation plus 100-year contraction scour (Table 13.1). The rock revetment should be placed at a 2(H):1(V) bank angle and be at least 1.5 feet thick. The scour countermeasure should be constructed along both the southern and northern embankments of the SR 241 near the project site and should extend for at least 27 feet along the embankment (see detail in Appendix F). The top of the scour countermeasure should extend up to an elevation of 664.6, such that its surface is at a minimum 1 foot above the 100-year WSE (Table 7.2) through the crossing (WSDOT, 2019).

Table 13.1 Scour Analysis Summary for Scour Countermeasure Design

Scour Component	SR 241/2 Yakima River Bridge			
	Pier 1 (South Abutment) Scour Countermeasure		Pier 4 (North Abutment) Scour Countermeasure	
	100-Year	500-Year	100-Year	500-Year
Long-Term Degradation (Feet)	0.0	0.0	0.0	0.0
Contraction Scour (Feet)	15.0	14.2	15.0	14.2
Total Depth of Scour (Feet)	15.0	14.2	15.0	14.2
Thalweg Elevation (NAVD88)	647.7	647.7	647.7	647.7
Scour Elevation (NAVD88)	632.7	633.5	632.7	633.5

13.2 Filter Design

If the WSDOT South Central PEO decides to construct a countermeasure, a filter, which would reduce the effects of piping by limiting the loss of fines, must be installed beneath the scour countermeasure. The filter also allows for a permeable, free-flowing interface between the scour countermeasure and existing material of the SR 241 embankment. Because of the considerable depth of excavation required to construct the scour countermeasure around the abutments of Piers 1 and 4, the fine sediment composition of the embankment material, and the challenges of underwater construction, it is recommended that a geotextile filter and a granular blanket be assessed to determine which is the most appropriate for the site. Based on geotextile requirements contained in HEC-23, the Apparent Opening Size (AOS) of the geotextile must be less than approximately 0.17 millimeters with a hydraulic conductivity greater than 0.009 centimeters per second (0.0035 inches per second). It is recommended that a Non-Woven, High Survivability Geotextile for Permanent Erosion Control be utilized (in accordance to WSDOT Standard Specification 9-33.2(1), Table 4 in WSDOT (2020)). If a scour countermeasure were to be constructed, the geotextile filter constructability under water should be evaluated.

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Appendices

Appendix A – Existing Bridge 241/2 and 241/5 As-Built Plans

Appendix B – Underwater Inspection of Bridge 241/5

Appendix C – FEMA Floodplain Map

Appendix D – WSDOT Scour Inspections of Bridge 241/2

Appendix E – WSDOT Geotechnical Borings

Appendix F – Preliminary Layout of the Proposed 241/2 Structure

Appendix G – Existing Conditions SRH-2D Model Results

Appendix H – Proposed Conditions SRH-2D Model Results

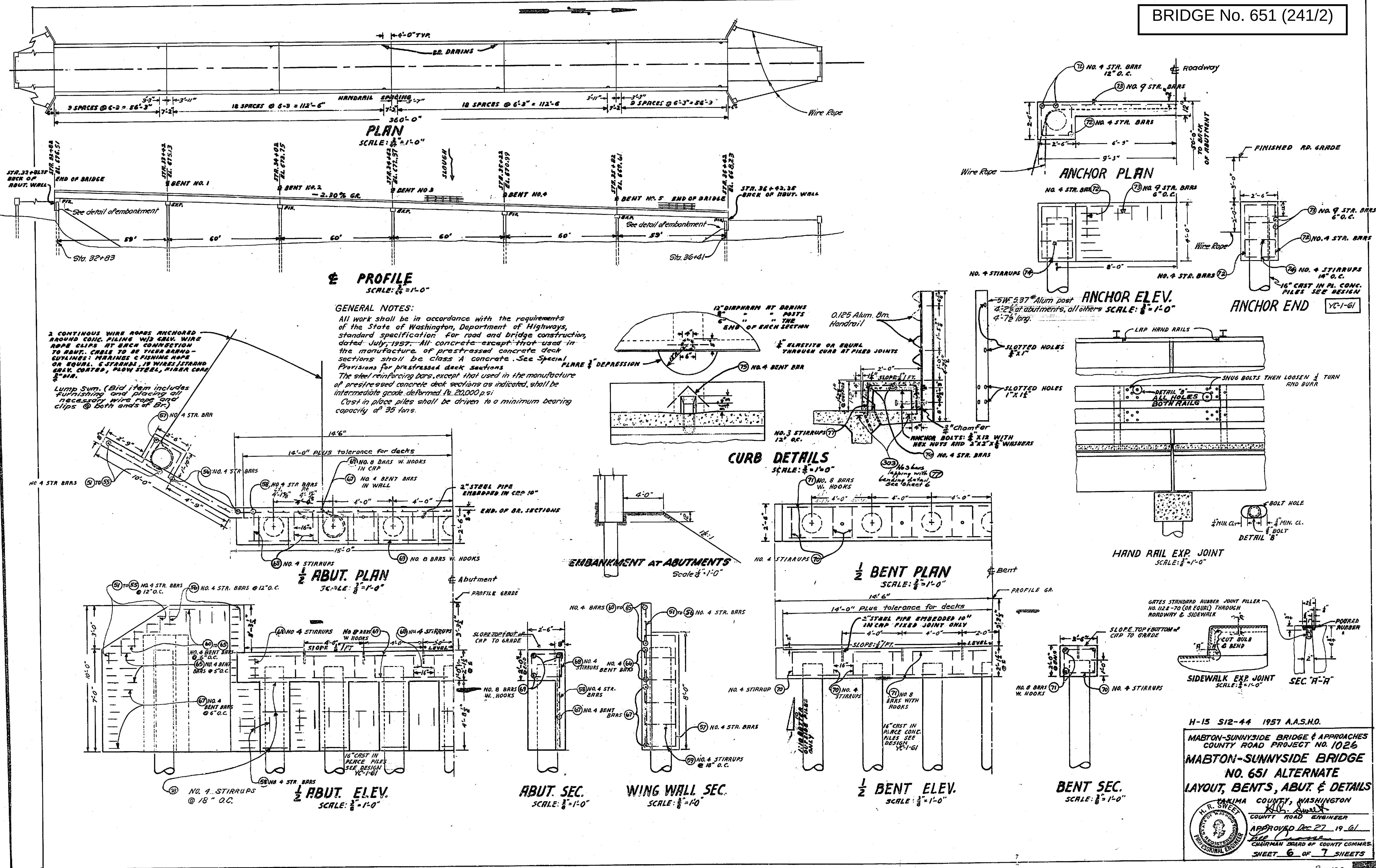
Appendix I – Scour Calculations

Appendix J - Rock Revetment and Filter Sizing Calculations

Appendix K - FEMA Region X "No-Rise" Certification

Appendix A – Existing Bridge 241/2 and 241/5 As-Built Plans

BRIDGE No. 651 (241/2)



GENERAL NOTES:

All work shall be in accordance with the requirements of the State of Washington, Department of Highways, standard specification for road and bridge construction, dated July, 1957. ~~All concrete except that used in~~ the manufacture of prestressed concrete deck sections shall be class A concrete. See Special Provisions for prestressed deck sections

The steel reinforcing bars, except that used in the manufacture of prestressed concrete deck sections as indicated, shall be intermediate grade deformed fs 20,000 p.s.i

Cast in place piles shall be driven to a minimum bearing capacity of 35 tons.

H-15 S12-44 1957 A.A.S.H.O.

MABTON-SUNNYSIDE BRIDGE & APPROACHES
COUNTY ROAD PROJECT NO. 1026

MABTON-SUNNYSIDE BRIDGE
NO. 651 ALTERNATE
LAYOUT, BENTS, ABUT. & DETAILS

YAKIMA COUNTY, WASHINGTON

H. R. SWEET — STATE OF WASHINGTON — REGISTERED PROFESSIONAL ENGINEER

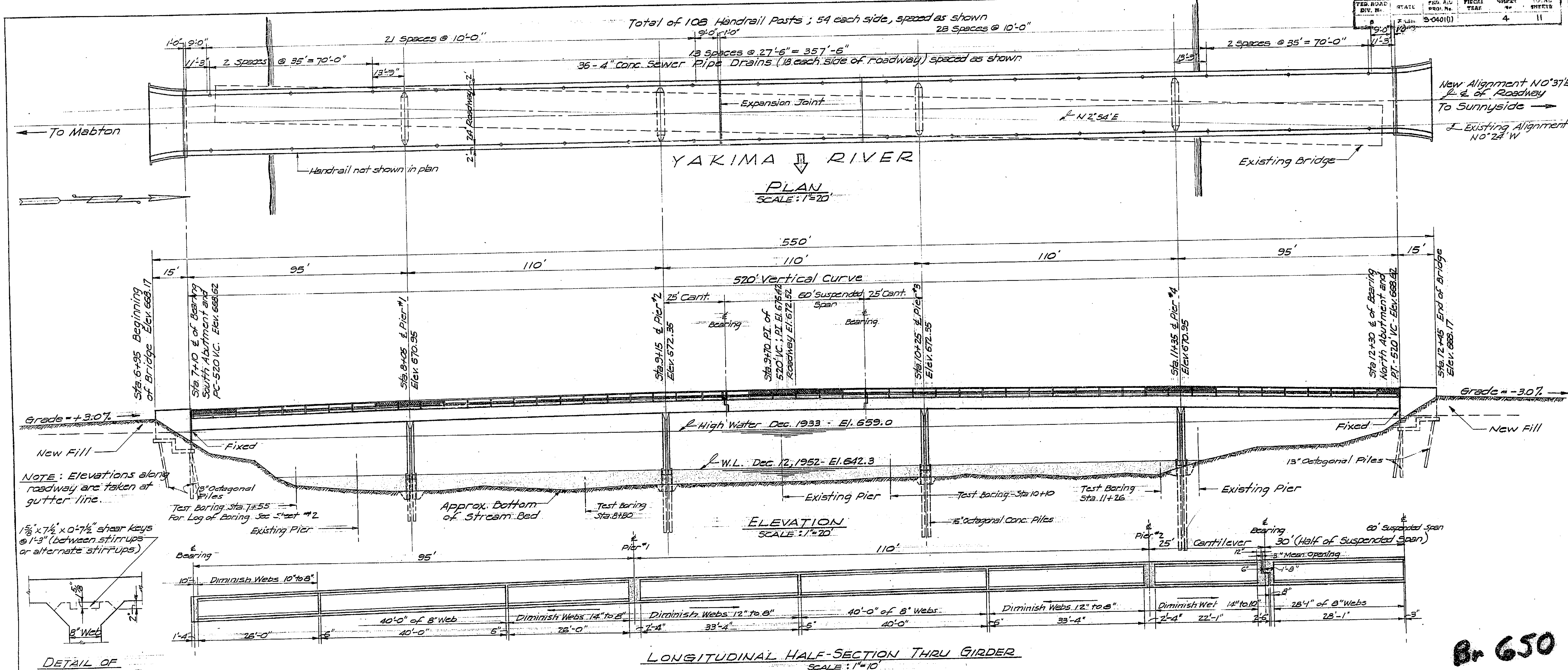
COUNTY ROAD ENGINEER

APPROVED Dec 27 19 61

CHAIRMAN BOARD OF COUNTY COMMRS.

SHEET 6 OF 7 SHEETS

B-100



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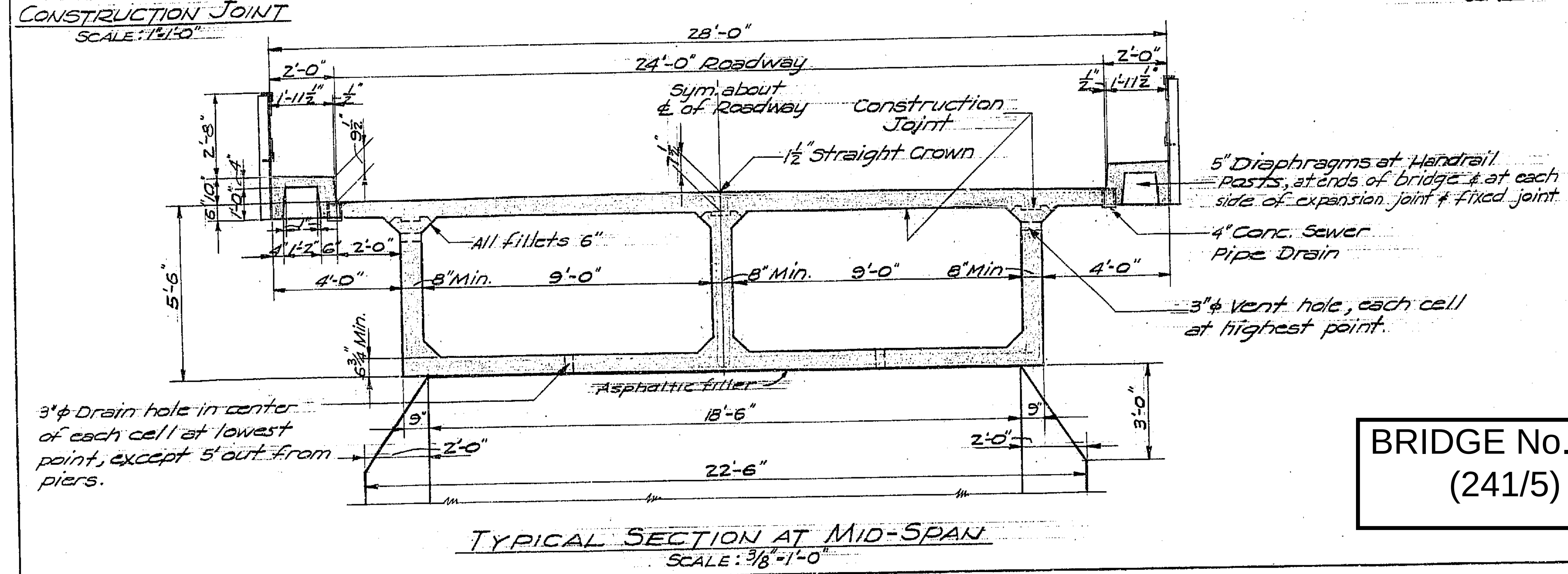


BRIDGE No. 650
(241/5)

GENERAL NOTES

All material & workmanship shall be in accordance with the requirements of the State of Washington, Department of Highways, Standard Specifications for Road & Bridge Construction dated April 1948.

Falsework shall not be released until all concrete, except curbs, has been in place the required length of time and has developed sufficient strength in accordance with the Standard Specifications. Falsework shall be carefully released to prevent impact or undue stresses in the structure.

Loading: H15-S12-44, A.A.S.H.O.

Concrete: Seals Class "D" - 3600 psi. at 28 days. f_c = 1200 psi; n = 10. Pier Shafts, Class "B" - 3000 psi. at 28 days. f_c = 1000 psi; n = 10. Remainder, Class "A" - 3600 psi. at 28 days. f_c = 1200 psi; n = 10

Steel Reinforcing: Intermediate grade deformed, as per A.S.T.M. Spec. A-305-49 except for 1½ ⌀ bars; f_s = 20,000 psi.

All concrete piles shall be driven to a depth sufficient to develop a minimum load bearing capacity of 40 tons per pile for 16" piles & 30 tons per pile for 13" piles

MABTON BRIDGE & APPROACHES

YAKIMA COUNTY, WASHINGTON
F.A.S. S-0401(1)

SUNNYSIDE - MABTON BRIDGE

GENERAL LAYOUT

Date Approved
Sheet No. 3 of 10 Sheets

County Road Engineer
Ch. Board of County Comm.

CONT. 4509
B-44

Appendix B – Underwater Inspection of Bridge 241/5

Washington State Department of Transportation
Bridge Preservation Dive Team

UNDERWATER INTERIM INSPECTION REPORT FOR

MABTON-SUNNYSIDE #650

BRIDGE NO. 241/5 **STRUCTURE ID 08336200**

Prepared For WSDOT

Inspection Date August 24, 2017

Lead Inspector/Diver Michael B. Smith
Cert. # G1623

Inspector/Diver David R. Bruce

MICHAEL B. SMITH STATE OF WASHINGTON 54323 REGISTERED PROFESSIONAL ENGINEER

11/1/2017

Status: Released | Printed On: 10/31/201 | Agency: Washington State

CD Guid: 6f478b25-5ae5-46d6-80bf-4bb1767723da | CD Date: 10/31/2017 | Program Mgr: Harvey L. Coffman

UNDERWATER INTERIM INSPECTION REPORT
FOR THE
MABTON-SUNNYSIDE #650

BRIDGE NO. 241/5
STRUCTURE ID 08336200

EXECUTIVE SUMMARY

The WSDOT Bridge Preservation Dive Team completed an underwater interim inspection of the Mabton-Sunnyside #650 Bridge on August 24, 2017. This inspection was to update groundlines around Pier 4 where undermining was previously noted. The bridge is oriented south to north per plan and route direction. Pier 1 (south abutment) is closest to Mabton and Pier 6 (north abutment) is closest to Sunnyside.

Local scour at the NE quadrant of Pier 4 has undermined the seal up to 19" vertically along the east half of the pier, exposing five steel H-piles. Previous underwater inspections have revealed varying degrees of undermining and pile exposure. This is mainly due to the transient nature of the channel materiel and the continued timber debris build up around the pier. Even though exposure exits we find that no further in depth underwater inspection is needed at this time due to the calculated maximum scour depth of 626.5 is well above the deep pile tip elevations of 589.25.

It is recommended that scour mitigation be provided for the undermined seal and exposed H-piling at Pier 4 (REPAIR #14086). It is also recommended that timber debris be removed around the pier (REPAIR #14087).

The interim inspection type has been obsoleted due to deep pile foundations well below the maximum calculated scour depth and transient nature of the channel groundline.

Washington State Department of Transportation

Daily Site Dive Log

Status: Released | Printed On: 10/31/201 | Agency: Washington State

CD Guid: 6f478b25-5ae5-46d6-80bf-4bb1767723da | CD Date: 10/31/2017 | Program Mgr: Harvey L. Coffman

Inspector Michael B. Smith **Date** 8/24/2017

Bridge No. 241/5 **Bridge Name** MABTON-SUNNYSIDE #650

Bridge Type Box beam/box girder - multiple **Waterway Name** YAKIMA RIVER

Dive Objective Inspection of submerged substructure elements.

Diving Operation

Type of Operation ☐ SCUBA ☑ Surface Supplied Air ☐ Snorkel ☐ ROV ☐ Other ______

Equipment

- **Suit** Wet suit
- **Air Supply** Surface Supplied
- **Site Access** 24 ft. Duckworth Boat via a primitive launch at the NW shoreline of the bridge
- **Inspection Tools** GoPro camera, UW light, survey rod, and dive computer

Conditions

Water	☐ Salt	☑ Fresh	☐ Brackish	Temperature 68 °F	Visibility 4 ft	
Surface	☑ Calm	☐ Choppy	☐ Rough			
Tide	☐ High	☐ Low	☐ Flood	☐ Ebb	☑ N/A	
Current	☐ Fast	☐ Moderate	☑ Slow	Velocity <0.5 ft/sec		
Weather	☑ Clear	☐ Cloudy	☐ Overcast	☐ Rain	☐ Windy	Air Temp 78 °F

Diver Checks

- ☑ First Aid Equipment on Site
- ☑ Communication for EMS
- ☑ Dive Gear Inspected
- ☑ Air Source Checked
- ☑ Pre-Activity Safety Plan Reviewed
- ☐ ______
- ☑ Physical Condition of Diver(s) Checked
- ☑ Communications for Diver(s) Checked
- ☑ Team Briefed and Understands Dive Plan
- ☑ Special Site Hazards Noted
- ☑ Line-Tending Procedures Reviewed
- ☐ ______

Dive Plan and Dive Team Procedures

Assess site conditions and determine type of dive operation. Hold on-site pre-dive safety meeting to discuss and plan dive operation, determine roles and responsibilities, review emergency procedures, and check physical condition of diver(s). Assemble and check dive gear. Check communication for diver(s). After completion of dive, review notes, check condition of diver(s), take soundings and photos as required.

Washington State Department of Transportation

Daily Site Dive Log

Status: Released | Printed On: 10/31/201 | Agency: Washington State

CD Guid: 6f478b25-5ae5-46d6-80bf-4bb1767723da | CD Date: 10/31/2017 | Program Mgr: Harvey L. Coffman

Dive Schedule

Dive No.	Entry Time	Exit Time	Total Time in Water	Maximum Depth	Remarks
1	09:39:00	10:03:00	00:24:00	11 ffw*	David dove Pier 4.

Dive Narrative

Site was accessed by a 24 ft. Duckworth boat, launched via a primitive launch at the NW shoreline of the bridge. After the pre-dive safety meeting and site assessment, a single diver, surface supplied air operation was decided upon. David, Richard, James, and Michael prepared for a surface supplied air operation. Michael provided the back up support as the stand-by diver and James performed line tending duties. Richard supervised the dive operation as the DPIC. David was chosen to perform the underwater inspection as the diver. After taking a water surface elevation measurement, David was splashed at Pier 3 and proceeded to inspecting the pier in a 'U' shaped pattern. The 'U' shaped pattern allowed the diver to inspect the east side first, then swinging back around to the west side allowing for good line management.

	Rack Box Air In / Out (psig)
1 DRB	2600/2000

Photos and spot soundings were taken as deemed necessary. After the end of the dive, notes were reviewed for completeness and the physical condition of the diver was checked.

*ffw-feet fresh water

Dive Team Members

(Name)	(Role)
Michael B. Smith, P.E.	Notes/Standby diver
Richard M. Pawelka, P.E.	DPIC
David R. Bruce, P.E.	Diver
James R.W. Harding, P.E.	Tender/other

Washington State Department of Transportation

Underwater Inspection Report

Status: Released   Printed On: 10/31/201   Agency: Washington State

CD Guid: 6f478b25-5ae5-46d6-80bf-4bb1767723da   CD Date: 10/31/2017 Program Mgr: Harvey L. Coffman

Inspector	Michael B. Smith	**Agency/Owner**	WSDOT	**Date**	8/24/2017
Bridge No.	241/5	**Bridge Name**	MABTON-SUNNYSIDE #650		
Bridge Type	Box beam/box girder - multiple	**Waterway Name**	YAKIMA RIVER		
Substructure	Reinforced Concrete Pier Wall	**Foundation**	Pile-supported Spread Footing w/ Seal		
No. Spans	7	**No. Piers Dived**	4	**Inspection Hours**	1.0

6 Substructure Condition (1676)   8 Chan/Protection (1677)   5 Scour Code (1680)

BMS Elements

Element	Element Description	Total	Units	State 1	State 2	State 3	State 4
225	Steel Submerged Pile/Column	16	EA	16	0	0	0
361	Scour	4	EA	3	0	1	0

Notes

0	The bridge is oriented from south to north. Spans 1 and 7 are concealed, see the element 38 note. Piers 2 and 7 the first ones visible on either end and are referred to as the abutments in the plan sheets. There is a tree growing on the north side of Pier 6 that restricts UBIT access, see photo #32. REPAIR #14084.
225	Underwater Inspection Findings: A total of 16 submerged steel H-piles support Pier 4 as shown in the plans. These 16 piles have been added as a BMS element for tracking purposes. Five steel piles below the Pier 4 footing/seal are exposed due to scour (Photo UW-7). Original construction plans show 16" octagonal piles supporting the footing. Construction notes from 1953-1954 show octagonal piles were "cripped" for 12" steel H-piles. Pile tip elevations were also found from the 1953-1954 construction notes. Refer to attached underwater inspection drawings for further details.
361	The Yakima River flows from west to east flowing under Spans 2, 3, 4 and 5. Underwater Inspection Findings: Submerged timber debris at the upstream noses of Piers 3, 4, and 5 promotes local scour conditions at each pier (Photo UW-12). Debris deflector are in place but are not working as intended, as there is debris caught on each of these piers. REPAIR #14087. Local scour at the NE quadrant of Pier 4 has undermined the seal up to 19" vertically along the east half of the pier, exposing five steel H-piles. REPAIR #14086. Previous underwater inspections have revealed varying degrees of undermining and pile exposure. This is due to the transient nature of the channel materiel (fine silty clay) and local scour due to timber debris. Calculated maximum scour depth of 626.5 is well above the deep pile tip elevations of 589.25. Refer to attached underwater inspection drawings for further details.
1680	The bridge is founded on a very deep pile foundation.
2693	Soundings taken by WSDOT Dive Team in 2017. See "2017 Underwater Inspection Drawings" for further details.

Repairs

Inspector	Michael B. Smith	**Agency/Owner**	WSDOT	**Date**	8/24/2017
Bridge No.	241/5	**Bridge Name**	MABTON-SUNNYSIDE #650		
Bridge Type	Box beam/box girder - multiple	**Waterway Name**	YAKIMA RIVER		
Substructure	Reinforced Concrete Pier Wall	**Foundation**	Pile-supported Spread Footing w/ Seal		
No. Spans	7	**No. Piers Dived**	4	**Inspection Hours**	1.0

Repair No	Pr	R	Repair Description	BMS	Noted	Maint	Verified
14086	1	S	Pier 4 seal north face east half is undermined with five exposed 12" steel H-pile. Needs scour mitigation for the undermined seal and exposed H-piling at Pier 4 north face east end. See Bridge Preservation Office for design details. 2014 - CRT/ABK - Revised pier numbering to reflect the approach spans. 2015 - DON/MBS - Revised number of current exposed steel H-piles and updated photos 2017 - MBS/DRB - Revised number of current exposed steel H-piles. BMS/NBI Element(s) Affected: 9.	9	9/19/2011		
14087	2	S	Remove timber debris at Piers 3 thru 5. 2014 - CRT/ABK - Revised pier numbering to reflect the approach spans. 2015 - DON/MBS -Updated photos 2017 - MBS/DRB - Updated photos BMS/NBI Element(s) Affected: 361, 9.	361	9/19/2011		

Inspections Performed and Resources Required

Report Type	Date	Freq	Hrs	Insp	CertNo	Coinsp	Note
Routine	6/16/2016	24	1.0	WDS	G0910	SRD	

Resources	Hours	Min	Pref	Max	Freq	Date	Need Date	Override	Notes
UBIT	1.00	30	30	30	24	6/16/2016	6/16/2018		The bridge is posted for weight restrictions and the UB30 is the maximum UBIT.
Flagging	2.00	ST	ST	ST					Contact South Central Region at 509-865-2437 to arrange for flagging.
Scheduling Restrictions									2016- Inspection Work Window: No Restrictions
Animals									Heavy bat presence at the south end of the drop-in span. None noted in 2016.

Report Type	Date	Freq	Hrs	Insp	CertNo	Coinsp	Note
Underwater	9/28/2015	48	3.0	DON	G0314	MBS	UW Interim obsoleted in 2017. Update Full underwater frequency to 60 months in 2019.

Resources	Hours	Min	Pref	Max	Freq	Date	Need Date	Override	Notes
SNDG					48	9/28/2015	9/28/2019		Underwater inspectors provide groundlines. Regional inspectors do not need to take soundings.
Boat	3.00								Used 24' Duckworth Magnum.
Access Issues									Used WDFW boat launch adjacent to bridge at the NW corner.

Inspector	Michael B. Smith	**Agency/Owner**	WSDOT	**Date**	8/24/2017
Bridge No.	241/5	**Bridge Name**	MABTON-SUNNYSIDE #650		
Bridge Type	Box beam/box girder - multiple	**Waterway Name**	YAKIMA RIVER		
Substructure	Reinforced Concrete Pier Wall	**Foundation**	Pile-supported Spread Footing w/ Seal		
No. Spans	7	**No. Piers Dived**	4	**Inspection Hours**	1.0

Special Feature	6/16/2016	24	1.0	WDS	G0910	SRD	Special inspection for the catcher block tension rods. UT testing of all tension rods are on a 48 month frequency, next due in 2018.

Resources	Hours	Min	Pref	Max	Freq Date	Need Date	Override	Notes
Special Equipment	1.00							UT machine is needed for the tension rods at the catcher blocks.

UW Interim	8/24/2017	48	1.0	MBS	G1623	DRB	No further in depth underwater inspection is needed at this time due to the calculated maximum scour depth of 626.5 is well above the deep pile tip elevations of 589.25. UW Interim obsoleted in 2017.

Resources	Hours	Min	Pref	Max	Freq Date	Need Date	Override	Notes
Boat								Used 24' Duckworth Magnum.
Access Issues								Use WDFW boat launch adjacent to bridge at the NW corner.

BRIDGE INSPECTION REPORT

Status: Released

CD Guid: 6f478b25-5ae5-46d6-80bf-4bb1767723da

Printed On: 10/31/2017

CD Date: 10/31/2017

Agency: Washington State

Program Mgr: Harvey L. Coffman

Br. No. 241/5 **SID** 08336200 **Br. Name** MABTON-SUNNYSIDE #650

Carrying SR 241

Route On 00241 **Mile Post** 1.34

Intersecting YAKIMA RIVER

Route Under **Mile Post**

UW-7

225 Steel Submerged Pile/Column

Photo Type: I - In Depth

Orientation: S

Date: 9/28/2015

Repairs: 14086

Pier 4 north face east end undermined seal showing exposed H-pile.

UW-12

361 Scour

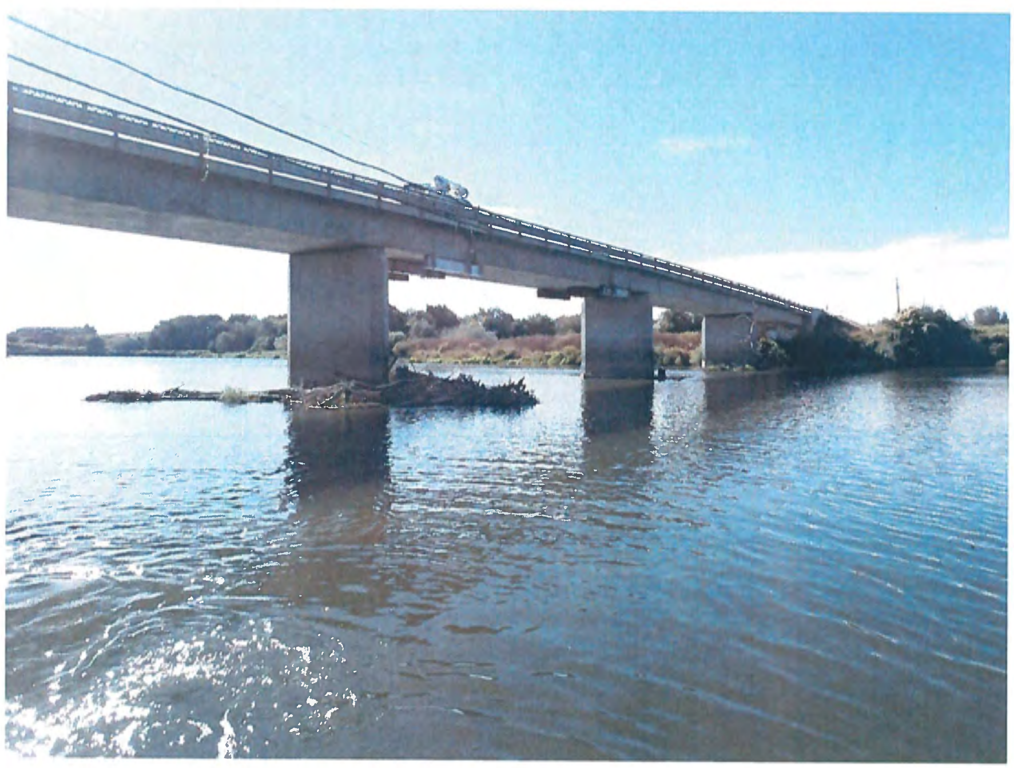
Photo Type: S - Scour

Orientation: SE

Date: 8/24/2017

Repairs: 14087

Submerged timber debris at the upstream noses of Piers 3, 4, and 5.



WASHINGTON STATE DEPARTMENT OF TRANSPORTATION
NBI STRUCTURE INVENTORY AND APPRAISAL REPORT
(ENGLISH UNITS)

CD Date: 10/31/2017 Printed on: 11/1/2017
CD Guid: 6f478b25-5ae5-46d6-80bf-4bb1767723da

IDENTIFICATION

(1) STATE NAME - WASHINGTON	530
(8) STRUCTURE NUMBER	# 083362000000000
(5) INVENTORY ROUTE (ON/UNDER) - On	1 3 1 00241
STATE ROUTE MILEPOST	1.34
(2) HIGHWAY AGENCY DISTRICT - SC Region	05
(3) COUNTY CODE 77 - Yakima County	(4) PLACE CODE 00000
(6) FEATURES INTERSECTED	YAKIMA RIVER
(7) FACILITY CARRIED	SR 241
(9) LOCATION	1.3 N SR 22
(12) BASE HIGHWAY NETWORK - Not part of network	0
(13) LRS INV ROUTE AND SUB ROUTE	
(11) LRS MILEPOST	
(16) LATITUDE	46 Deg 13 Min 51.00 Sec
(17) LONGITUDE	119 Deg 59 Min 58.10 Sec
(98A) BORDER BR. - Not a border bridge (98B) (99) BORDER BR. SID - Not a border bridge	

STRUCTURE TYPE AND MATERIAL

(43) STRUCTURE TYPE MAIN: MATERIAL - Concrete continuous DESIGN - Box beam/girder - multiple	205
(44) STRUCTURE TYPE APPR: MATERIAL - Concrete DESIGN - Slab	101
(45) NO. OF SPANS IN MAIN UNIT	5
(46) NO. OF APPROACH SPANS	2
(107) DECK STRUCTURE TYPE - Conc. CIP	1
(108) WEARING SURFACE / PROTECTIVE SYSTEM:	
(A) TYPE OF WEARING SURFACE - Bituminous	6
(B) TYPE OF MEMBRANE - None	0
(C) TYPE OF DECK PROTECTION - None	0

AGE AND SERVICE

(27) YEAR BUILT	1954
(106) YEAR RECONSTRUCTED	0000
(42) TYPE OF SERVICE ON - Highway	1
UNDER - Waterway	5
(28) LANES: ON STRUCTURE 2	UNDER STRUCTURE 0
(29) AVERAGE DAILY TRAFFIC	4421
(30) YEAR OF ADT 2012	(109) TRUCK ADT 7%
(19) BYPASS, DETOUR LENGTH	12 mi

GEOMETRIC DATA

(48) LENGTH OF MAXIMUM SPAN	110 ft
(49) STRUCTURE LENGTH	550 ft
(50) CURB OR SIDEWALK: LEFT 1.7 ft	RIGHT 1.7 ft
(51) BRIDGE ROADWAY WIDTH CURB TO CURB	24.0 ft
(52) DECK WIDTH OUT TO OUT	28.0 ft
(32) APPROACH ROADWAY WIDTH (W/SHOULDERS)	32 ft
(33) BRIDGE MEDIAN - No median	0
(34) SKEW 0 Deg	(35) STRUCTURE FLARED No 0
(10) INVENTORY ROUTE MIN VERT CLEAR	99 ft 99 in
(47) INVENTORY ROUTE TOTAL HORIZ CLEAR	24 ft 00 in
(53) MIN VERT CLEAR OVER BRIDGE RDW	99 ft 99 in
(54) MIN VERT UNDERCLEAR	0 ft 00 in N
(55) MIN LAT UNDERCLEAR RT	0.0 ft N
(56) MIN LAT UNDERCLEAR LT	0.0 ft

NAVIGATION DATA

(38) NAVIGATION CONTROL - No nav control	0
(111) PIER PROTECTION - Not Applicable	
(39) NAVIGATION VERTICAL CLEARANCE	000 ft
(116) VERT-LIFT BRIDGE NAV MIN VERT CLR	
(40) NAVIGATION HORIZONTAL CLR	0000 ft

WSBIS DATA

BRIDGE NUMBER	241/5
BRIDGE NAME	MABTON-SUNNYSIDE #650
CUSTODIAN	Washington State
CROSSING DESC	MABTON-SUNNYSIDE #650
MAIN LISTING FLAG	M
SUFFICIENCY RATING	11.06 FO

CLASSIFICATION

(112) NBIS BRIDGE LENGTH	Y
(104) HIGHWAY SYSTEM - Not on the NHS	0
(26) FUNCTIONAL CLASS - Major Collector (Fed Aid Secondary)	07
(100) DEFENSE HIGHWAY - Not a STRAHNET route	0
(101) PARALLEL STRUCTURE - Not a parallel bridge	N
(102) DIRECTION OF TRAFFIC - 2-way traffic	2
(103) TEMPORARY STRUCTURE - Not Applicable	
(105) FEDERAL LANDS HIGHWAY - Not Applicable	0
(110) DESIGNATED NATIONAL NETWORK - Not part of network	0
(20) TOLL - Non-toll structure	3
(21) MAINTENANCE - State Highway Agency	1
(22) OWNER - Washington State	1
(37) HISTORICAL SIGNIFICANCE - Not determined	4

CONDITION

(58) DECK	7
(59) SUPERSTRUCTURE	5
(60) SUBSTRUCTURE	6
(61) CHANNEL AND CHANNEL PROTECTION	8
(62) CULVERTS	N

LOAD RATING AND POSTING

(31) DESIGN LOAD - HS 15	3
(63) OPER RATING METHOD - Ld Factor (LFR) tons HS20	1
(64) OPERATING RATING	13 T
(65) INV RATING METHOD - Ld Factor (LFR) tons HS20	1
(66) INVENTORY RATING	8 T
(70) BRIDGE POSTING - 30.0 - 39.9% below legal load	1
(41) STRUCT OPEN, POSTED, CLOSED - Posted for load restrictions	P

APPRAISAL

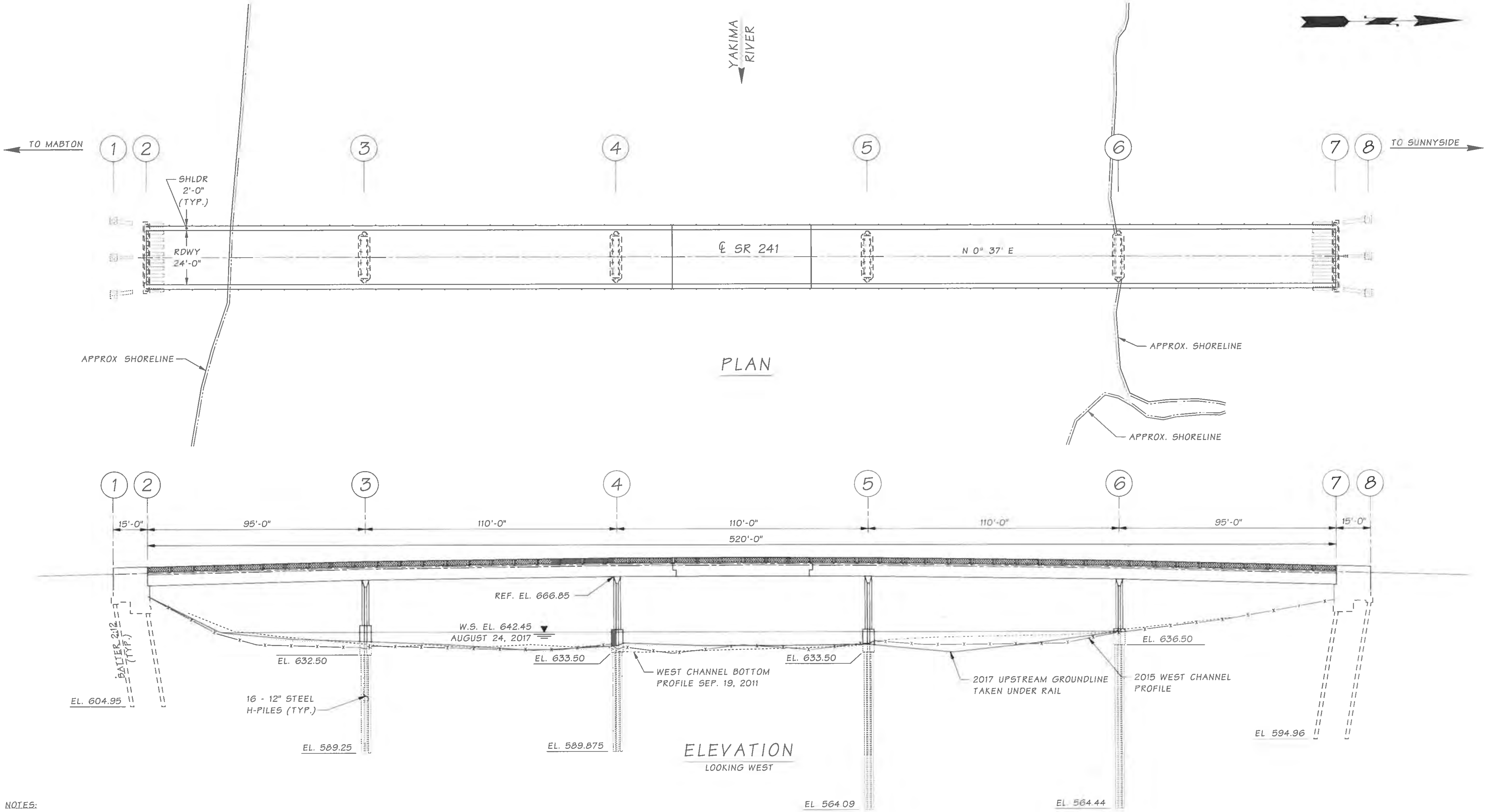
(67) STRUCTURAL EVALUATION	3
(68) DECK GEOMETRY	2
(69) UNDERCLEARANCES, VERTICAL & HORIZONTAL	N
(71) WATERWAY ADEQUACY	8
(72) APPROACH ROADWAY ALIGNMENT	8
(36) TRAFFIC SAFETY FEATURES	0110
(113) SCOUR CRITICAL BRIDGE	5

PROPOSED IMPROVEMENTS

(75) TYPE OF WORK -	351
(76) LENGTH OF STRUCTURE IMPROVEMENT	550 ft
(94) BRIDGE IMPROVEMENT COST	$3,740,000
(95) ROADWAY IMPROVEMENT COST	$748,000
(96) TOTAL PROJECT COST	$7,480,000
(97) YEAR OF IMPROVEMENT COST ESTIMATE	2014
(114) FUTURE ADT	6119
(115) YEAR OF FUTURE ADT	2036

INSPECTIONS

(90) INSPECTION DATE 06/16		(91) FREQUENCY 24 MO
(92) CRITICAL FEATURE INSPECTION:		(93) CFI DATE
(A) FRACTURE CRIT DETAIL - NO -	Month	(A) __/__
(B) UNDERWATER INSP - YES -	48 Month	(B) 09/15
(C) OTHER SPECIAL INSP - YES -	24 Month	(C) 06/16



NOTES:

1. BRIDGE LAYOUT PER ORIGINAL CONSTRUCTION PLANS, YAKIMA COUNTY, DATED CIRCA DEC. 22, 1953.
2. REFERENCE ELEVATION TOP OF PIER 4 = 666.85.
3. 12" H-PILES WERE USED INSTEAD OF 16" OCTOGONAL PILES CALLED OUT IN THE CONSTRUCTION PLANS. PILE TYPES AND PILE TIP ELEVATIONS ARE PER 1953-54 CONSTRUCTION NOTES IN WSDOT #241/5 FOUNDATION FILE.
4. PIER NUMBERING VARIES FROM ORIGINAL CONSTRUCTION PLANS. PREVIOUSLY LABELED SOUTH ABUTMENT AND NORTH ABUTMENT WERE DIVIDED INTO TWO PIERS A PIECE TO ACCOUNT FOR THE ROADWAY APPROACH SLABS.

Date:	AUGUST 24, 2017
Scale:	MGDS SCALE 1:250
Drawn By:	MBS
Reviewed By:	DRB/RMP

WSDOT Dive Team

Washington State Department of Transportation
Bridge and Structures Office

241/5 MABTON-SUNNYSIDE #650
WSDOT SID #08336200
UNDERWATER INSPECTION

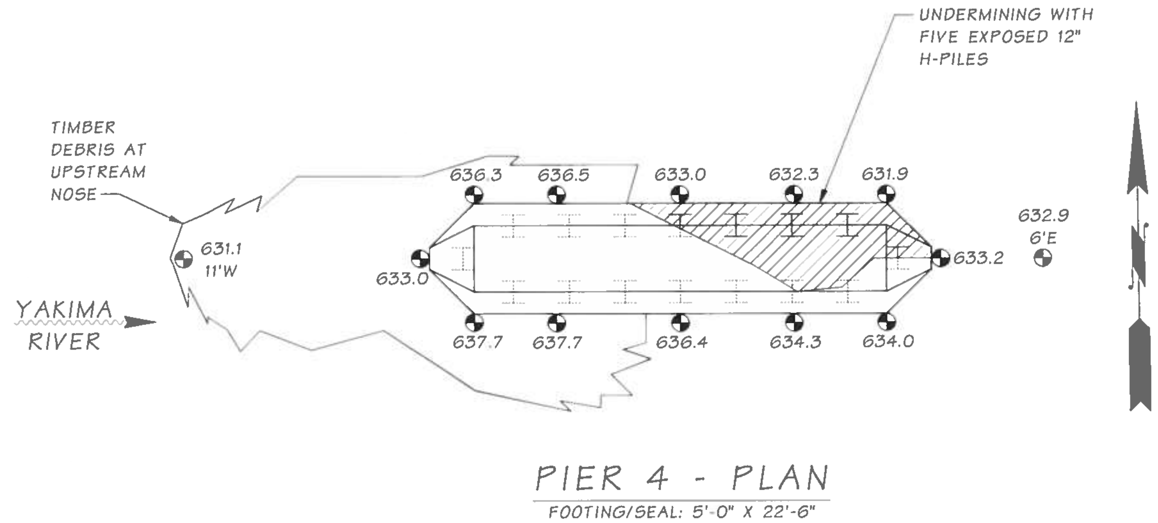
LAYOUT

SHEET NO. 1

SHEET 1 OF 3 SHEETS

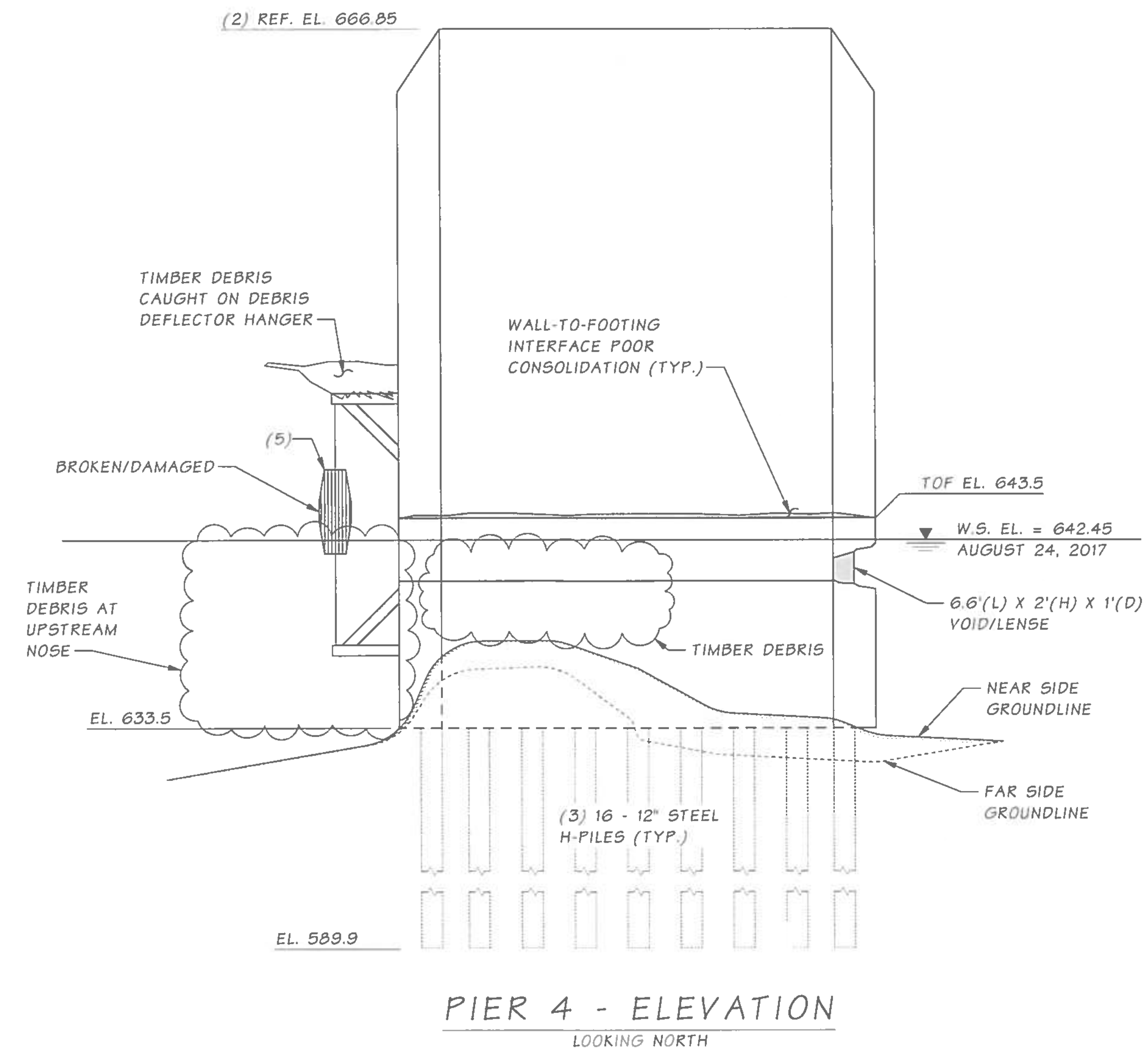
C:\Users\SmithMc\Documents\2017 UW Inspections\241_5\2017\2017 Sun-Mab241_5_UW.MAN

Mon Oct 30 13:06:52 2017



PIER 4 - PLAN

FOOTING/SEAL: 5'-0" X 22'-6"



PIER 4 - ELEVATION

LOOKING NORTH

NOTES:

1. BRIDGE LAYOUT PER ORIGINAL CONSTRUCTION PLANS, YAKIMA COUNTY, DATED CIRCA DEC. 22, 1953.
2. REFERENCE ELEVATION TOP OF PIER 4 EL. 666.85.
3. 12" H-PILES WERE USED INSTEAD OF 16" OCTOGONAL PILES CALLED OUT IN THE CONSTRUCTION PLANS. PILE TYPES AND PILE TIP ELEVATIONS ARE PER 1953-54 CONSTRUCTION NOTES IN WSDOT #241/5 FOUNDATION FILE.
4. PIER 3 OFFSET 1½" TO THE EAST ON TOF FIELD MEASURED AT EL. 645.7. TOS EL. 643.7.
5. BRIDGESHARK TIMBER DEBRIS DEFLECTOR AT UPSTEAM NOSE. NOT SHOWN IN PLAN VIEW FOR CLARITY.

LEGEND:

⊕	CHANNEL ELEVATION
(hatch)	EXTENTS OF UNDERMINING
(shade)	POOR CONSOLIDATION OR EXFOLIATION
TOD	TOP OF DEBRIS
TOF	TOP OF FOOTING
TOS	TOP OF SEAL

Date:	AUGUST 24, 2017
Scale:	MGDS SCALE 1:50
Drawn By:	MBS
Reviewed By:	DRB/RMP

WSDOT Dive Team

Washington State Department of Transportation
Bridge and Structures Office

241/5 MABTON-SUNNYSIDE #650
WSDOT, SID #08336200
UNDERWATER INSPECTION

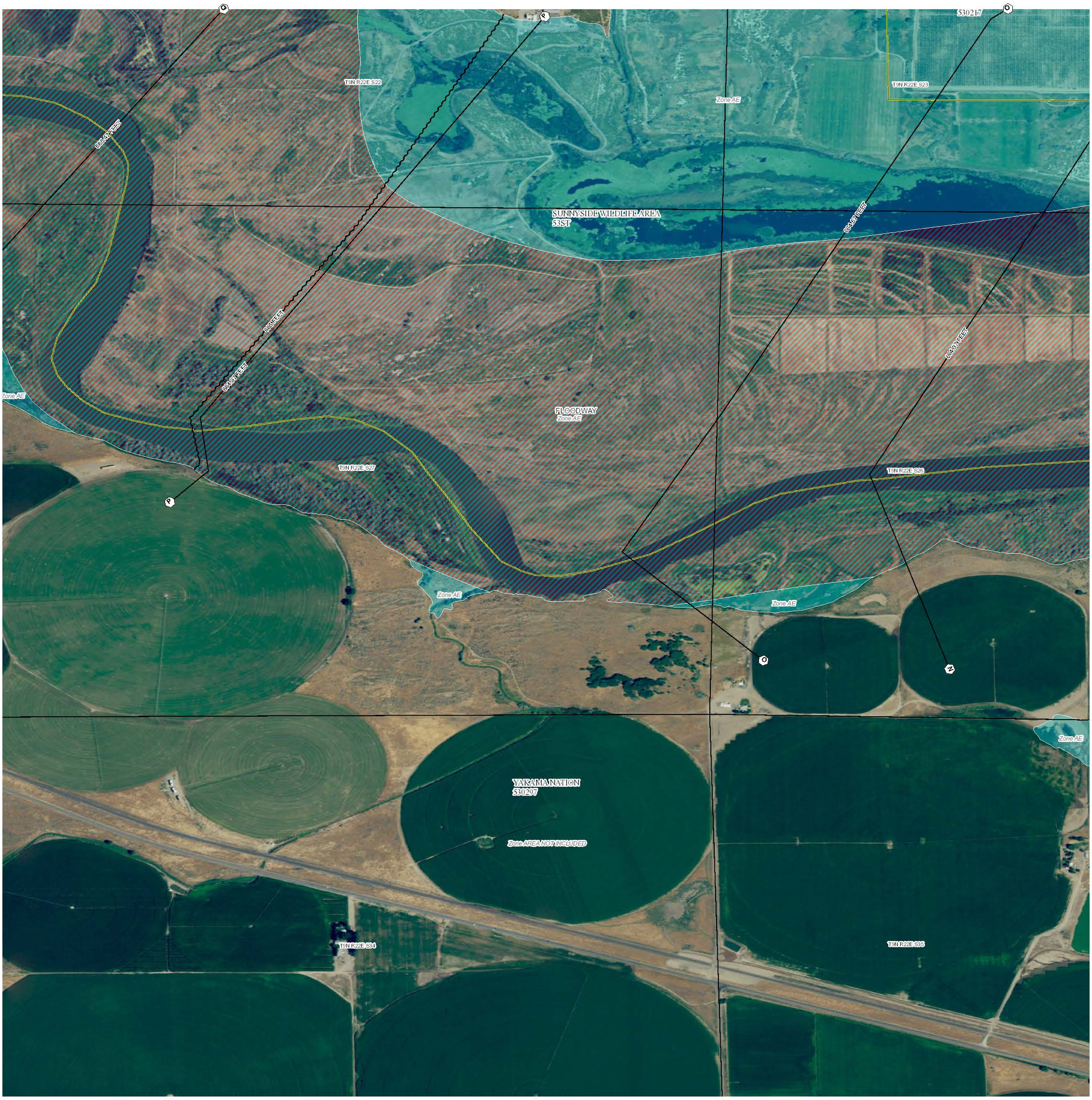
PIER 3 AND PIER 4

SHEET NO. 2

SHEET 2 OF 3 SHEETS

Appendix C – FEMA Floodplain Map

46°15'6.68"N
120°3'45.54"W



USGS The National Map: Orthoimagery. Data refreshed April, 2019.
120°1'52.06"W
46°13'0.86"N

FLOOD HAZARD INFORMATION

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS	Without Base Flood Elevation (BFE) *Zone A, V, A99* With BFE or Depth *Zone AE, AO, AH, VE, AR* Regulatory Floodway
OTHER AREAS OF FLOOD HAZARD	0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X* Future Conditions 1% Annual Chance Flood Hazard *Zone X* Area with Reduced Flood Risk due to Levee See Notes. *Zone X* Area with Flood Risk due to Levee *Zone D*
OTHER AREAS	NO SCREEN Area of Minimal Flood Hazard *Zone X* Effective LOMRs Area of Undetermined Flood Hazard *Zone D*
GENERAL STRUCTURES	Channel, Culvert, or Storm Sewer Levee, Dike, or Floodwall
OTHER FEATURES	20.2 Cross Sections with 1% Annual Chance 17.5 Water Surface Elevation Coastal Transect Coastal Transect Baseline Profile Baseline Hydrographic Feature 513 Base Flood Elevation Line (BFE) Limit of Study Jurisdiction Boundary

NOTES TO USERS

For information and questions about this Flood Insurance Rate Map (FIRM), available products associated with this FIRM, including historic versions, the current map date for each FIRM panel, how to order products, or the National Flood Insurance Program (NFIP) in general, please call the FEMA Map Information eXchange at 1-877-FEMA-MAP (1-877-336-2627) or visit the FEMA Flood Map Service Center website at http://msc.fema.gov. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. Many of these products can be ordered or obtained directly from the website.

Communities annexing land on adjacent FIRM panels must obtain a current copy of the adjacent panel as well as the current FIRM Index. These may be ordered directly from the Flood Map Service Center at the number listed above.

For community and countywide map dates refer to the Flood Insurance Study Report for this jurisdiction.

To determine if flood insurance is available in this community, contact your Insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

Basemap information shown on this FIRM was provided in digital format by USDA, Farm Service Agency (FSA). This information was derived from NAIP, dated April 11, 2018.

This map was exported from FEMA's National Flood Hazard Layer (NFHL) on **1/13/2020 3:10:44 PM** and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time. For additional information, please see the Flood Hazard Mapping Updates Overview Fact Sheet at https://www.fema.gov/media-library/assets/documents/118418

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date.

SCALE

N

Map Projection:
GCS, Geodetic Reference System 1980;
Vertical Datum: NAVD88
For information about the specific vertical datum for elevation features, datum conversions, or vertical monuments used to create this map please see the Flood Insurance Study(FIS) Report for your community at https://msc.fema.gov

1 inch = 500 feet 1:6,000

0 250 500 1,000 1,500 2,000 Feet

0 50 100 200 300 400 Meters

FEMA

National Flood Insurance Program

NATIONAL FLOOD INSURANCE PROGRAM

FLOOD INSURANCE RATE MAP

YAKIMA COUNTY, WASHINGTON AND INCORPORATED AREAS

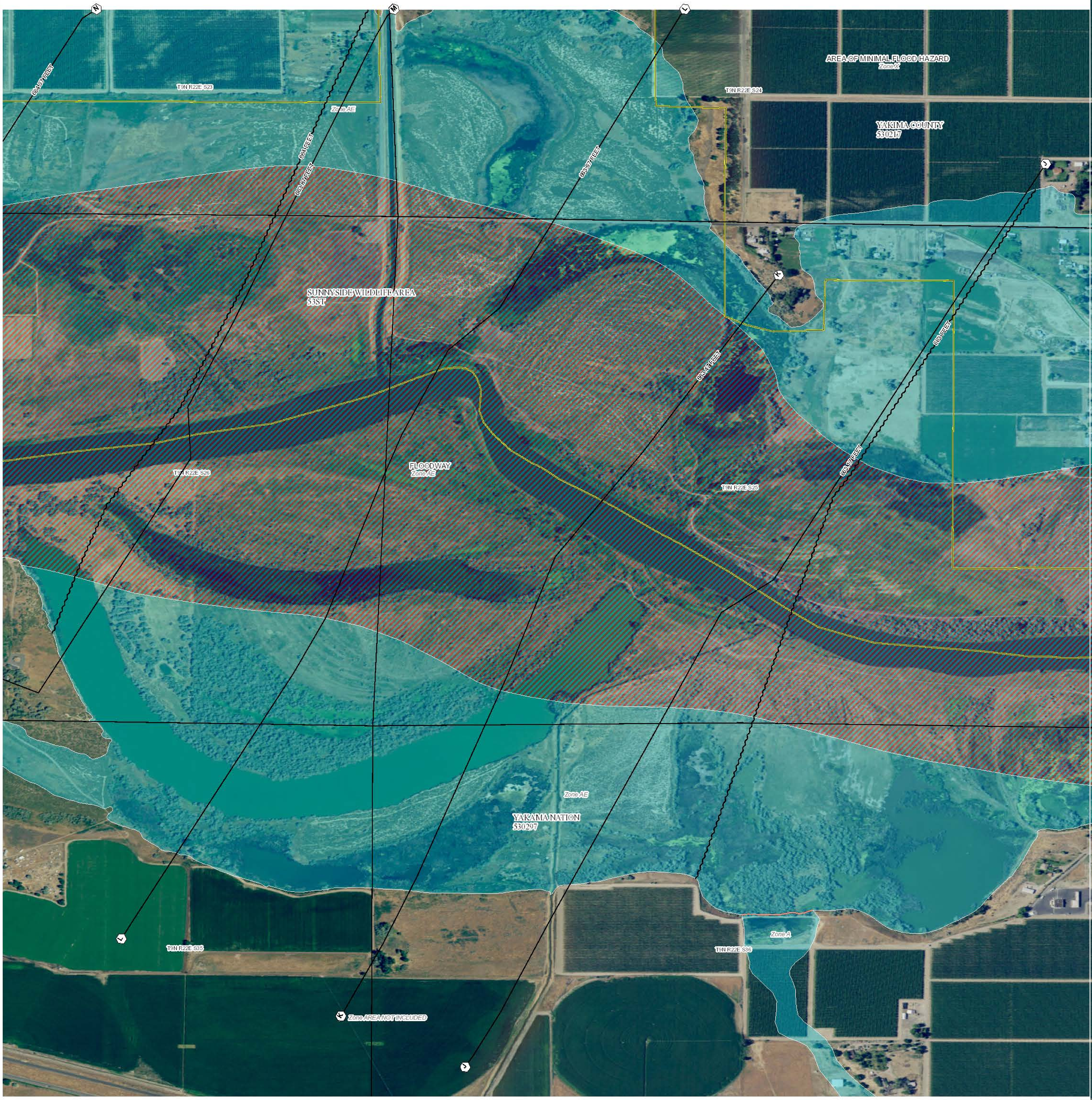
PANEL **2256** OF **2325**

Panel Contains:

COMMUNITY	NUMBER	PANEL
SUNNYSIDE WILDLIFE AREA WASHINGTON	53ST	2256
YAKIMA COUNTY WASHINGTON	530217	2256
YAKAMA NATION WASHINGTON	530297	2256

MAP NUMBER
53077C2256D
EFFECTIVE DATE
11/18/2009

46°15'6.68"N
120°1'53.04"W



USGS The National Map: Orthoimagery. Data refreshed April, 2019
46°13'0.86"N
119°59'59.56"W

FLOOD HAZARD INFORMATION

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS	Without Base Flood Elevation (BFE) *Zone A, V, A99*
	With BFE or Depth *Zone AE, AO, AH, VE, AR*
	Regulatory Floodway
OTHER AREAS OF FLOOD HAZARD	0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
	Future Conditions 1% Annual Chance Flood Hazard *Zone X*
	Area with Reduced Flood Risk due to Levee See Notes. *Zone X*
	Area with Flood Risk due to Levee *Zone D*
OTHER AREAS	NO SCREEN Area of Minimal Flood Hazard *Zone X*
	Effective LOMRs
	Area of Undetermined Flood Hazard *Zone D*
GENERAL STRUCTURES	Channel, Culvert, or Storm Sewer
	Levee, Dike, or Floodwall
OTHER FEATURES	(B) 20.2 / 17.5 Cross Sections with 1% Annual Chance Water Surface Elevation
	(8) Coastal Transect
	Coastal Transect Baseline
	Profile Baseline
	Hydrographic Feature
	513 Base Flood Elevation Line (BFE)
	Limit of Study
	Jurisdiction Boundary

NOTES TO USERS

For information and questions about this Flood Insurance Rate Map (FIRM), available products associated with this FIRM, including historic versions, the current map date for each FIRM panel, how to order products, or the National Flood Insurance Program (NFIP) in general, please call the FEMA Map Information eXchange at 1-877-FEMA-MAP (1-877-336-2627) or visit the FEMA Flood Map Service Center website at http://msc.fema.gov. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. Many of these products can be ordered or obtained directly from the website.

Communities annexing land on adjacent FIRM panels must obtain a current copy of the adjacent panel as well as the current FIRM Index. These may be ordered directly from the Flood Map Service Center at the number listed above.

For community and countywide map dates refer to the Flood Insurance Study Report for this jurisdiction.

To determine if flood insurance is available in this community, contact your Insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

Basemap information shown on this FIRM was provided in digital format by USDA, Farm Service Agency (FSA). This information was derived from NAIP, dated April 11, 2018.

This map was exported from FEMA's National Flood Hazard Layer (NFHL) on **1/13/2020 1:10:34 PM** and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time. For additional information, please see the Flood Hazard Mapping Updates Overview Fact Sheet at https://www.fema.gov/media-library/assets/documents/118418

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

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SCALE

N

Map Projection:
GCS, Geodetic Reference System 1980;
Vertical Datum: NAVD88
For information about the specific vertical datum for elevation features, datum conversions, or vertical monuments used to create this map please see the Flood Insurance Study(FIS) Report for your community at https://msc.fema.gov

1 inch = 500 feet 1:6,000

0 250 500 1,000 1,500 2,000 Feet

Meters 0 50 100 200 300 400

FEMA
National Flood Insurance Program

NATIONAL FLOOD INSURANCE PROGRAM
FLOOD INSURANCE RATE MAP

YAKIMA COUNTY, WASHINGTON AND INCORPORATED AREAS

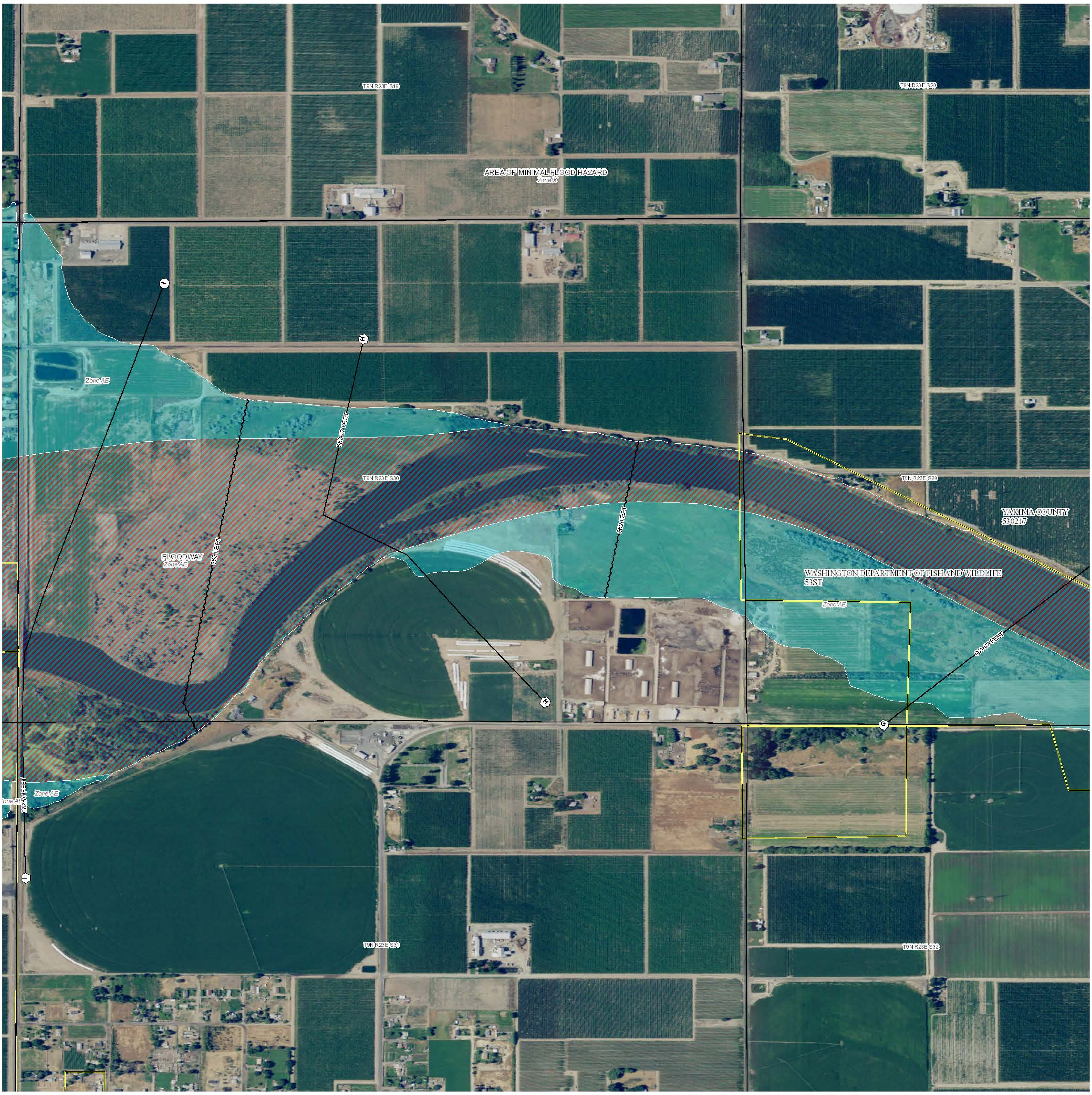
PANEL **2257** OF **2325**

Panel Contains:

COMMUNITY	NUMBER	PANEL
SUNNYSIDE WILDLIFE AREA WASHINGTON	53ST	2257
YAKIMA COUNTY WASHINGTON	530217	2257
YAKAMA NATION WASHINGTON	530297	2257

MAP NUMBER
53077C2257D
EFFECTIVE DATE
11/18/2009

46°15'6.68"N
120°0'0.54"W



USGS The National Map: Orthoimagery. Data refreshed April, 2019.
46°13'0.86"N
119°58'7.06"W

FLOOD HAZARD INFORMATION

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS	Without Base Flood Elevation (BFE) *Zone A, V, A99*
	With BFE or Depth *Zone AE, AO, AH, VE, AR*
	Regulatory Floodway
OTHER AREAS OF FLOOD HAZARD	0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
	Future Conditions 1% Annual Chance Flood Hazard *Zone X*
	Area with Reduced Flood Risk due to Levee See Notes. *Zone X*
	Area with Flood Risk due to Levee *Zone D*
OTHER AREAS	NO SCREEN Area of Minimal Flood Hazard *Zone X*
	Effective LOMRs
	Area of Undetermined Flood Hazard *Zone D*
GENERAL STRUCTURES	Channel, Culvert, or Storm Sewer
	Levee, Dike, or Floodwall
OTHER FEATURES	(B) 20.2 Cross Sections with 1% Annual Chance
	17.5 Water Surface Elevation
	(8) Coastal Transect
	Coastal Transect Baseline
	Profile Baseline
	Hydrographic Feature
	513 Base Flood Elevation Line (BFE)
	Limit of Study
	Jurisdiction Boundary

NOTES TO USERS

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For community and countywide map dates refer to the Flood Insurance Study Report for this jurisdiction.

To determine if flood insurance is available in this community, contact your Insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

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SCALE

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1 inch = 500 feet 1:6,000

0 250 500 1,000 1,500 2,000 Feet

Meters 0 50 100 200 300 400

FEMA

National Flood Insurance Program

NATIONAL FLOOD INSURANCE PROGRAM

FLOOD INSURANCE RATE MAP

YAKIMA COUNTY, WASHINGTON AND INCORPORATED AREAS

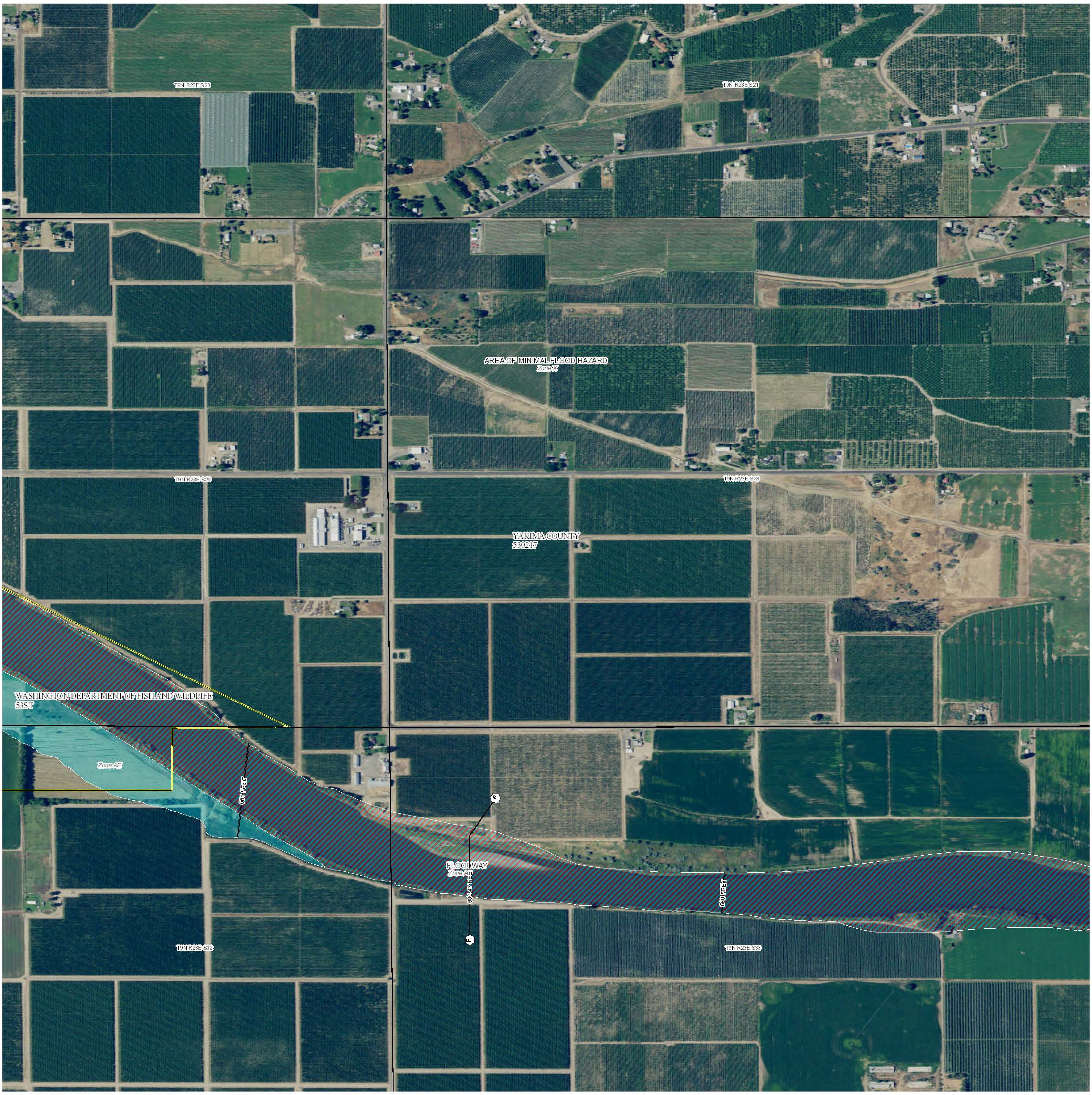
PANEL **2276** OF **2325**

Panel Contains:

COMMUNITY	NUMBER	PANEL
WASHINGTON DEPARTMENT OF FISH AND WILDLIFE WASHINGTON	53ST	2276
SUNNYSIDE WILDLIFE AREA WASHINGTON	53ST	2276
YAKIMA COUNTY WASHINGTON	530217	2276
CITY OF MABTON WASHINGTON	530221	2276
YAKAMA NATION WASHINGTON	530297	2276

MAP NUMBER
53077C2276D
EFFECTIVE DATE
11/18/2009

46°15'6.68"N
119°58'8.04"W



USGS The National Map: Orthoimagery. Data refreshed April, 2019.
119°56'14.56"W
46°13'0.86"N

FLOOD HAZARD INFORMATION

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS		Without Base Flood Elevation (BFE) *Zone A, V, A99* With BFE or Depth *Zone AE, AO, AH, VE, AR*
		Regulatory Floodway
OTHER AREAS OF FLOOD HAZARD		0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
		Future Conditions 1% Annual Chance Flood Hazard *Zone X*
		Area with Reduced Flood Risk due to Levee See Notes. *Zone X*
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		Effective LOMRs
		Area of Undetermined Flood Hazard *Zone D*
GENERAL STRUCTURES		Channel, Culvert, or Storm Sewer
		Levee, Dike, or Floodwall
OTHER FEATURES	(B) 20.2	Cross Sections with 1% Annual Chance
	17.5	Water Surface Elevation
	(8)	Coastal Transect
		Coastal Transect Baseline
		Profile Baseline
		Hydrographic Feature
	513	Base Flood Elevation Line (BFE)
		Limit of Study
		Jurisdiction Boundary

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SCALE

N

Map Projection:
GCS, Geodetic Reference System 1980;
Vertical Datum: NAVD88
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1 inch = 500 feet 1:6,000

0 250 500 1,000 1,500 2,000 Feet

Meters
0 50 100 200 300 400

FEMA
National Flood Insurance Program

NATIONAL FLOOD INSURANCE PROGRAM
FLOOD INSURANCE RATE MAP

YAKIMA COUNTY, WASHINGTON AND INCORPORATED AREAS

PANEL **2277** OF **2325**

Panel Contains:

COMMUNITY	NUMBER	PANEL
WASHINGTON DEPARTMENT OF FISH AND WILDLIFE WASHINGTON	53ST	2277
YAKIMA COUNTY WASHINGTON	530217	2277

MAP NUMBER
53077C2277D
EFFECTIVE DATE
11/18/2009

Appendix D – WSDOT Scour Inspections of Bridge 241/2

BRIDGE NUMBER	SPAN LENGTH FROM PLANS	SCALE SPAN LENGTH	SCALE RATIO	SCALE USED	RAIL HEIGHT	IST DECK ELEV.	2ND DECK ELEV.	1993 RAIL TO G/L DIST	2010 RAIL TO G/L DIST	2016 RAIL TO G/L DIST	SCALE; RAIL TO G/L DIST.	PIER LOC.	SOUNDING LOC. DIST.	1993 G/L ELEV.	2010 G/L ELEV.	2016 G/L ELEV.	1962 AS-BUILT G/L ELEV.	RAIL ELEV.	EST. PILE TIP ELEV.	COMMENTS
241/2	360.0	360.0	1.0	ACH 3/64	3.8	676.51	668.23	13.4	11.5	11.5	15.0	P1	0.0	666.91	669.61	669.61	665.31	680.31	644.09	12-20-94 PDE
SID 842090	360.0	360.0	1.0	ACH 3/64	3.8	676.51	668.23	27.0	21.5	21.5	31.0	MS1	29.5	652.63	658.93	658.93	648.63	679.63		Total length bridge: 550'-0"
	360.0	360.0	1.0	ACH 3/64	3.8	676.51	668.23	33.5	31.5	31.0	34.0	P2	59.0	645.45	648.25	648.75	644.95	678.95	630.71	bk to bk pav't seats.
	360.0	360.0	1.0	ACH 3/64	3.8	676.51	668.23	33.0	31.0	31.5	32.0	MS2	89.0	645.26	648.06	647.56	646.26	678.26		USED ACHITECTURAL
	360.0	360.0	1.0	ACH 3/64	3.8	676.51	668.23	32.3	30.5	31.0	29.0	P3	119.0	645.27	647.87	647.37	648.57	677.57	633.33	SCALE AS PER PLAN
	360.0	360.0	1.0	ACH 3/64	3.8	676.51	668.23	31.7	28.8	30.0	26.5	MS3	149.0	645.18	648.88	647.68	650.38	676.88		Rail ht. = 3.0' 2010 &2016
	360.0	360.0	1.0	ACH 3/64	3.8	676.51	668.23	28.1	25.3	27.5	25.5	P4	179.0	648.09	651.69	649.49	650.69	676.19	638.95	
	360.0	360.0	1.0	ACH 3/64	3.8	676.51	668.23	28.6	26.8	27.5	23.33	MS4	209.0	646.9	649.5	648.80	652.17	675.5		
	360.0	360.0	1.0	ACH 3/64	3.8	676.51	668.23	27.5	25.8	26.5	21.5	P5	239.0	647.31	649.81	649.11	653.31	674.81	639.57	
	360.0	360.0	1.0	ACH 3/64	3.8	676.51	668.23	26.9	24.2	25.5	21.0	MS5	269.0	647.22	650.72	649.42	653.12	674.12		
	360.0	360.0	1.0	ACH 3/64	3.8	676.51	668.23	25.3	23.0	25.7	19.5	P6	299.0	648.13	651.23	648.53	653.93	673.43	639.19	
	360.0	360.0	1.0	ACH 3/64	3.8	676.51	668.23	#N/A	#N/A	28.3	#N/A	2016 thalweg	311.0	#N/A	#N/A	645.66	#N/A	673.16		
	360.0	360.0	1.0	ACH 3/64	3.8	676.51	668.23	#N/A	27.5	#N/A	#N/A	2010 thalweg	316.5	#N/A	646.33	#N/A	#N/A	673.03		
	360.0	360.0	1.0	ACH 3/64	3.8	676.51	668.23	28.0	25.2	27.5	18.0	MS6	328.5	644.75	648.35	646.05	654.75	672.75		
	360.0	360.0	1.0	ACH 3/64	3.8	676.51	668.23	12.9	10.3	10.3	15.0	P7	358.0	659.18	662.58	662.58	657.08	672.08	640.81	

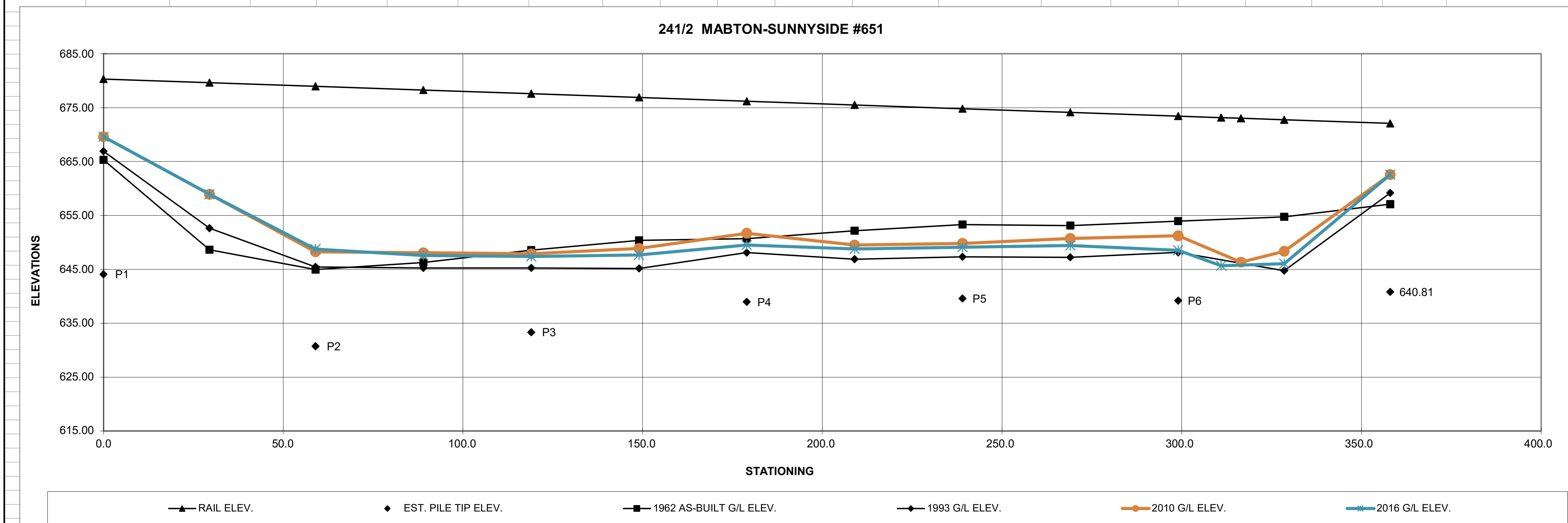


Figure D-1. Historic WSDOT Groundline Surveys of Bridge 241/5

BRIDGE INSPECTION REPORT

Status: Released | Printed On: 4/24/2018 | Agency: Washington State

CD Guid: d63a07aa-006f-482a-8e92-8cc9c7219cff | CD Date: 3/26/2018 | Program Mgr: Harvey L. Coffman

Br. No. 241/2 **SID** 08420900 **Br. Name** MABTON-SUNNYSIDE #651

Carrying SR 241 **Route On** 00241 **Mile Post** 1.12

Intersecting SLOUGH **Route Under** **Mile Post**

SIGNATURE ON FILE

Inspector's Signature JPP Cert # G1603 Cert Exp Date 1/12/2022 Co-Inspector's Signature TJN

Value	Item	Code	Value	Item	Code	Value	Item	Code
4	Structural Eval	(1657)	44	Operating Tons	(1552)	0	No Utilities	(2675)
2	Deck Geometry	(1658)		Op RF	(1553)	1	Bridge Rails	(1684)
9	Underclearance	(1659)	18	Inventory Tons	(1555)	1	Transition	(1685)
8	Alignment	(1661)		Inv RF	(1556)	0	Guardrails	(1686)
4	Deck Overall	(1663)	5	Operating Level	(1660)	N	Terminals	(1687)
4	Superstructure	(1671)	P	Open/Closed	(1293)	3.00	Asphalt Depth	(2610)
7	Substructure	(1676)	8	Waterway	(1662)	15.0	Design Curb Ht	(2611)
9	Culvert	(1678)	5	Scour	(1680)	35.5	Bridge Rail Ht	(2612)
8	Chan/Protection	(1677)				1962	Year Built	(1332)
N	Pier/Abut/Prot	(1679)				0	Year Rebuilt	(1336)

Soundings Flag	(2693)	*	Revise Rating	(2688)	Sufficiency Rating 14.98 SD
Measure Clrnc	(2694)		Photos Flag	(2691)	High Risk
			QA Flag	(2695)	

Inspections Performed:

Freq	Hrs	Date	Rep Type
24	**4.0**	**3/26/2018**	**Routine**
			Fract Crit
			UW
			Special
			Interim
			UWI
			Damage
			PRM Safety
			SEC Safety
			Condition
			Short Span
	8.0	7/30/2014	In Depth
			Geometric

BMS Elements

Element	Element Description	Total	Units	CS 1	CS 2	CS 3	CS 4
13	Bridge Deck Surface	8,640	SF	8,437	203	0	0
108	Prestressed Concrete Bulb-T Girder	2,520	LF	501	346	836	837
200	Abutment Fill	2	EA	2	0	0	0
205	Concrete Pile/Column	7	EA	7	0	0	0
215	Concrete Abutment	96	LF	92	0	4	0
227	Concrete Submerged Pile/Column	35	EA	35	0	0	0
234	Concrete Pier Cap/Crossbeam	140	LF	140	0	0	0
310	Elastomeric Bearing	84	EA	75	0	9	0
322	Bridge Impact	2	EA	2	0	0	0
330	Metal Bridge Railing	720	LF	702	0	0	18
361	Scour	5	EA	5	0	0	0
401	Asphalt Open Joint Seal	168	LF	168	0	0	0
801	AC Overlay with Waterproofing Membrane	8,640	SF	8,640	0	0	0

Notes

0 Bridge is orientated south to north.
At the NW corner there is an electric fence attached to the bridge. See photo #61. REPAIR #14554.
Brush in Span 6 needs to be cut back before the next scheduled inspection. See photo #62. REPAIR #14555.

Status: Released | Printed On: 4/24/2018 | Agency: Washington State

CD Guid: d63a07aa-006f-482a-8e92-8cc9c7219cff | CD Date: 3/26/2018 | Program Mgr: Harvey L. Coffman

Br. No. 241/2 **SID** 08420900 **Br. Name** MABTON-SUNNYSIDE #651

Carrying SR 241 **Route On** 00241 **Mile Post** 1.12

Intersecting SLOUGH **Route Under** **Mile Post**

Notes (Continued)

11	Bridge is posted for 14, 18, and 22 tons for the AASHTO legal trucks type 3, 3S2 and 3-3 respectively. Posting recommended for low service ratings and bridge condition. Posting tonnage is to match Bridge 241/5. Safe Load Operating Level is coded "5" to reflect the operating load factors. See photo #29.
13	Deck surface is covered with an ACP overlay. See the element 801 note. Patching quantity is based on forms in the girder flanges. Patching is assumed to be full depth in all cases. The letter file for this bridge justifies this assumption, with a history of full depth spalling along the girder longitudinal joints noted. See the element 108 note for patch location details.
108	Girder webs have hairline shear cracks near the piers. Girder webs have small spalls and delaminations in the bottom and faces, primarily near the diaphragms. The worst case of web spalling is Girder 1A, which has 18 ft. of delaminations and spalls in the east face of the web. See photos #40, #63, and #50. REPAIR #14546. Girder 1A west web face has several patches and epoxy sealed cracks. See photo #41. Girder diaphragms have scattered spalls, some of which expose the connecting pins between girders. See photo #64. REPAIR #14546. Girder flanges have extensive delaminations and spalls with exposed rebar. Plans indicate the rebar cover should be 1" minimum in the flange soffit, however 1/4" to 1/2" seems more likely based on observations. In locations of spalling, several of the welded connection tabs between girders have corroded completely through, allowing the girders to have up to 1" of separation between the top flanges. Many rebar have become detached from the girder flanges. See photos #14, #51, #52, #65, #66, and #48. REPAIR #14546. For full extent of girder flange defects and BMS quantities, see the "Top Flange Defects", "Girder Defect Map" and "Condition State Spreadsheet" files. The CAD base file for the defect map can be found under -- M:/M-team/GIR MAP BR 241-2.cpj
205	Piles at the south abutment are visible. See photo #8.
215	Abutments have a few vertical and diagonal hairline cracks. North abutment has a 10" x 6" x 2" deep spall at the top east corner. North abutment has a 3 ft. long delamination in the northeast wing wall.
227	Submerged piles have scattered locations of transverse reinforcement exposed.
310	Bearings are slightly curled and lifted at the corners. Many of the bearings are off-center from the girders, up to 1" in either direction. In many cases bearings overhang the pier cap 1/4" to 1/2". Bearing 3A north overhangs 3" on the west and 1-1/4" on the east. This is approximately a 20% reduction in bearing area. Bearing 5A south is shifted out from below the girder and transfers load from under the diaphragm. Bearings 6A through 6G north overhang, the worst is 2" at 6G. Reduction in bearing area at 6G is approximately 20%. No significant change has been noted since 2000.
330	West rail near Midspan 2 has two damaged posts in an 18 ft. section bent out 6" by traffic impact. Posts have been bent and partly torn off. See photos #58 and #59. REPAIR #14552.
361	Bridge spans an overflow channel.
401	Joints are saw cut and rubber filled. The paving contract of 2015 removed the raised portion of the steel headers. Joints still have steel bars embeded in the deck, however these are not coded in the 420 flag, as they are not a problem for paving per BBT.
801	ACP Overlay is new as of the 2016 inspection, is a uniform 3" depth, and now includes a membrane.
1660	Safe Load Operating Level is coded "5" for this structure. See note 11.
1663	Deck is coded '4' due to 2.34 % of the area having full depth patches. See the elements 13 and 108 notes.
1671	Superstructure coded a '4' due to deterioration of girder top flanges. See the element 108 note.
1680	Overflow channel with a pile foundation.

Status: Released | Printed On: 4/24/2018 | Agency: Washington State

CD Guid: d63a07aa-006f-482a-8e92-8cc9c7219cff | CD Date: 3/26/2018 | Program Mgr: Harvey L. Coffman

Br. No. 241/2 **SID** 08420900 **Br. Name** MABTON-SUNNYSIDE #651

Carrying SR 241 **Route On** 00241 **Mile Post** 1.12

Intersecting SLOUGH **Route Under** **Mile Post**

Notes (Continued)

1686 Guardrail at the SW corner has impact damage and a missing spacer block. See photo #60. REPAIR #14553. Guardrails are too low for current standards.

Repairs

Repair No	Pr	R	Repair Descriptions	BMS	Noted	Maint	Verified
14546	1	B	Girders have extensive spalling with exposed rebar in flanges, webs, and diaphragms. Remove loose and delaminated concrete, clean exposed reinforcement, and coat with rust inhibitor. In areas where old formwork was left in place, remove formwork and repair as necessary. Contact BPO repair specialist before performing this repair.	108	4/9/2008		
14552	1	B	Repair/replace the damaged west bridge rail near Midspan 2. Two rail posts are bent and partially torn off and about 18 ft. of thrie beam railing is bent out.	330	3/10/2016		
14553	0	J	Repair/replace the damaged section of guardrail at the SW corner of the bridge.	1686	3/10/2016		
14554	1	B	At the NW corner of the bridge, remove the electric fence. Contact property owner.	0	3/26/2018		
14555	2	B	In Span 6, cut back brush before the next scheduled inspection.	0	3/26/2018		

Inspections Performed and Resources Required

Report Type	Date	Freq	Hrs	Insp	CertNo	Coinsp	Note
Routine	3/26/2018	24	4.0	JPP	G1603	TJN	

Resources	Hours	Min	Pref	Max	Freq	Date	Need Date	Override	Notes
SNDG					72	3/10/2016	3/10/2022		
UBIT	3.00				24	3/26/2018	3/26/2020		Bridge 241/5 is a load posted bridge. UBIT should travel to bridge from the south. Schedule inspection for last week of the month to avoid inclement weather.
Flagging	4.00								Contact SCR for flagging. 2018 contact was Keith Maybee at 509-865-2437.
Scheduling Restrictions									2018 Inspection Work Window: No Restrictions.

Report Type	Date	Freq	Hrs	Insp	CertNo	Coinsp	Note
In Depth	7/30/2014		8.0	ABK	G1220	SMT	In Depth inspection was done to map out the defects in the flanges of the T beam girders. Drawings of the defects were not completed in 2014 and will be added when completed.

WASHINGTON STATE DEPARTMENT OF TRANSPORTATION
NBI STRUCTURE INVENTORY AND APPRAISAL REPORT
(ENGLISH UNITS)

CD Date: 3/26/2018 Printed on: 4/24/2018
CD Guid: d63a07aa-006f-482a-8e92-8cc9c7219cff

IDENTIFICATION	
(1) STATE NAME - WASHINGTON	530
(8) STRUCTURE NUMBER	# 084209000000000
(5) INVENTORY ROUTE (ON/UNDER) - On	1 3 1 00241
STATE ROUTE MILEPOST	1.12
(2) HIGHWAY AGENCY DISTRICT - SC Region	05
(3) COUNTY CODE 77 - Yakima County	(4) PLACE CODE 00000
(6) FEATURES INTERSECTED	SLOUGH
(7) FACILITY CARRIED	SR 241
(9) LOCATION	1.1 N SR 22
(12) BASE HIGHWAY NETWORK - Not part of network	0
(13) LRS INV ROUTE AND SUB ROUTE	
(11) LRS MILEPOST	
(16) LATITUDE	46 Deg 13 Min 39.50 Sec
(17) LONGITUDE	119 Deg 59 Min 58.50 Sec
(98A) BORDER BR. - Not a border bridge (98B)	(99) BORDER BR. SID - Not a border bridge

STRUCTURE TYPE AND MATERIAL	
(43) STRUCTURE TYPE MAIN: MATERIAL - Prestressed concrete DESIGN - Tee beam	504
(44) STRUCTURE TYPE APPR: MATERIAL - Other DESIGN - Other	000
(45) NO. OF SPANS IN MAIN UNIT	6
(46) NO. OF APPROACH SPANS	0
(107) DECK STRUCTURE TYPE - Wood or Ti	9
(108) WEARING SURFACE / PROTECTIVE SYSTEM:	
(A) TYPE OF WEARING SURFACE - Bituminous	6
(B) TYPE OF MEMBRANE - Preformed fabric	2
(C) TYPE OF DECK PROTECTION - None	0

AGE AND SERVICE	
(27) YEAR BUILT	1962
(106) YEAR RECONSTRUCTED	0000
(42) TYPE OF SERVICE ON - Highway	1
UNDER - Waterway	5
(28) LANES: ON STRUCTURE 2	UNDER STRUCTURE 0
(29) AVERAGE DAILY TRAFFIC	4800
(30) YEAR OF ADT 2014	(109) TRUCK ADT 4%
(19) BYPASS, DETOUR LENGTH	12 mi

GEOMETRIC DATA		
(48) LENGTH OF MAXIMUM SPAN		60 ft
(49) STRUCTURE LENGTH		360 ft
(50) CURB OR SIDEWALK: LEFT 1.7 ft	RIGHT	1.7 ft
(51) BRIDGE ROADWAY WIDTH CURB TO CURB		24.0 ft
(52) DECK WIDTH OUT TO OUT		28.0 ft
(32) APPROACH ROADWAY WIDTH (W/SHOULDERS)		34 ft
(33) BRIDGE MEDIAN - No median		0
(34) SKEW 0 Deg	(35) STRUCTURE FLARED No	0
(10) INVENTORY ROUTE MIN VERT CLEAR		99 ft 99 in
(47) INVENTORY ROUTE TOTAL HORIZ CLEAR		24 ft 00 in
(53) MIN VERT CLEAR OVER BRIDGE RDW		99 ft 99 in
(54) MIN VERT UNDERCLEAR		0 ft 00 in N
(55) MIN LAT UNDERCLEAR RT		0.0 ft N
(56) MIN LAT UNDERCLEAR LT		0.0 ft

NAVIGATION DATA	
(38) NAVIGATION CONTROL - No nav control	0
(111) PIER PROTECTION - Not Applicable	
(39) NAVIGATION VERTICAL CLEARANCE	000 ft
(116) VERT-LIFT BRIDGE NAV MIN VERT CLR	
(40) NAVIGATION HORIZONTAL CLR	0000 ft

WSBIS DATA	
BRIDGE NUMBER	241/2
BRIDGE NAME	MABTON-SUNNYSIDE #651
CUSTODIAN	Washington State
CROSSING DESC	MABTON-SUNNYSIDE #651
MAIN LISTING FLAG	M
SUFFICIENCY RATING	14.98 SD

CLASSIFICATION	
(112) NBIS BRIDGE LENGTH	Y
(104) HIGHWAY SYSTEM - Not on the NHS	0
(26) FUNCTIONAL CLASS - Major Collector (Fed Aid Secondary)	07
(100) DEFENSE HIGHWAY - Not a STRAHNET route	0
(101) PARALLEL STRUCTURE - Not a parallel bridge	N
(102) DIRECTION OF TRAFFIC - 2-way traffic	2
(103) TEMPORARY STRUCTURE - Not Applicable	
(105) FEDERAL LANDS HIGHWAY - Not Applicable	0
(110) DESIGNATED NATIONAL NETWORK - Not part of network	0
(20) TOLL - Non-toll structure	3
(21) MAINTENANCE - State Highway Agency	01
(22) OWNER - Washington State	1
(37) HISTORICAL SIGNIFICANCE - Not determined	4

CONDITION	
(58) DECK	4
(59) SUPERSTRUCTURE	4
(60) SUBSTRUCTURE	7
(61) CHANNEL AND CHANNEL PROTECTION	8
(62) CULVERTS	N

LOAD RATING AND POSTING	
(31) DESIGN LOAD - HS 20	5
(63) OPER RATING METHOD - Ld Factor (LFR) tons HS20	1
(64) OPERATING RATING	44 T
(65) INV RATING METHOD - Ld Factor (LFR) tons HS20	1
(66) INVENTORY RATING	18 T
(70) BRIDGE POSTING - Equal or above legal loads	5
(41) STRUCT OPEN, POSTED, CLOSED - Posted for load restrictions	P

APPRAISAL	
(67) STRUCTURAL EVALUATION	4
(68) DECK GEOMETRY	2
(69) UNDERCLEARANCES, VERTICAL & HORIZONTAL	N
(71) WATERWAY ADEQUACY	8
(72) APPROACH ROADWAY ALIGNMENT	8
(36) TRAFFIC SAFETY FEATURES	110N
(113) SCOUR CRITICAL BRIDGE	5

PROPOSED IMPROVEMENTS	
(75) TYPE OF WORK -	351
(76) LENGTH OF STRUCTURE IMPROVEMENT	360 ft
(94) BRIDGE IMPROVEMENT COST	$2,592,000
(95) ROADWAY IMPROVEMENT COST	$518,000
(96) TOTAL PROJECT COST	$5,184,000
(97) YEAR OF IMPROVEMENT COST ESTIMATE	2014
(114) FUTURE ADT	6490
(115) YEAR OF FUTURE ADT	2036

INSPECTIONS		
(90) INSPECTION DATE 03/18		(91) FREQUENCY 24 MO
(92) CRITICAL FEATURE INSPECTION:		(93) CFI DATE
(A) FRACTURE CRIT DETAIL - NO -	Month	(A) __/__
(B) UNDERWATER INSP - NO -	Month	(B) __/__
(C) OTHER SPECIAL INSP - NO -	Month	(C) __/__

Appendix E – WSDOT Geotechnical Borings

July 25, 2019

TO: Julie A. Heilman
Hydraulics Office

FROM: Tony M. Allen/ David I. Johnson
Geotechnical Office

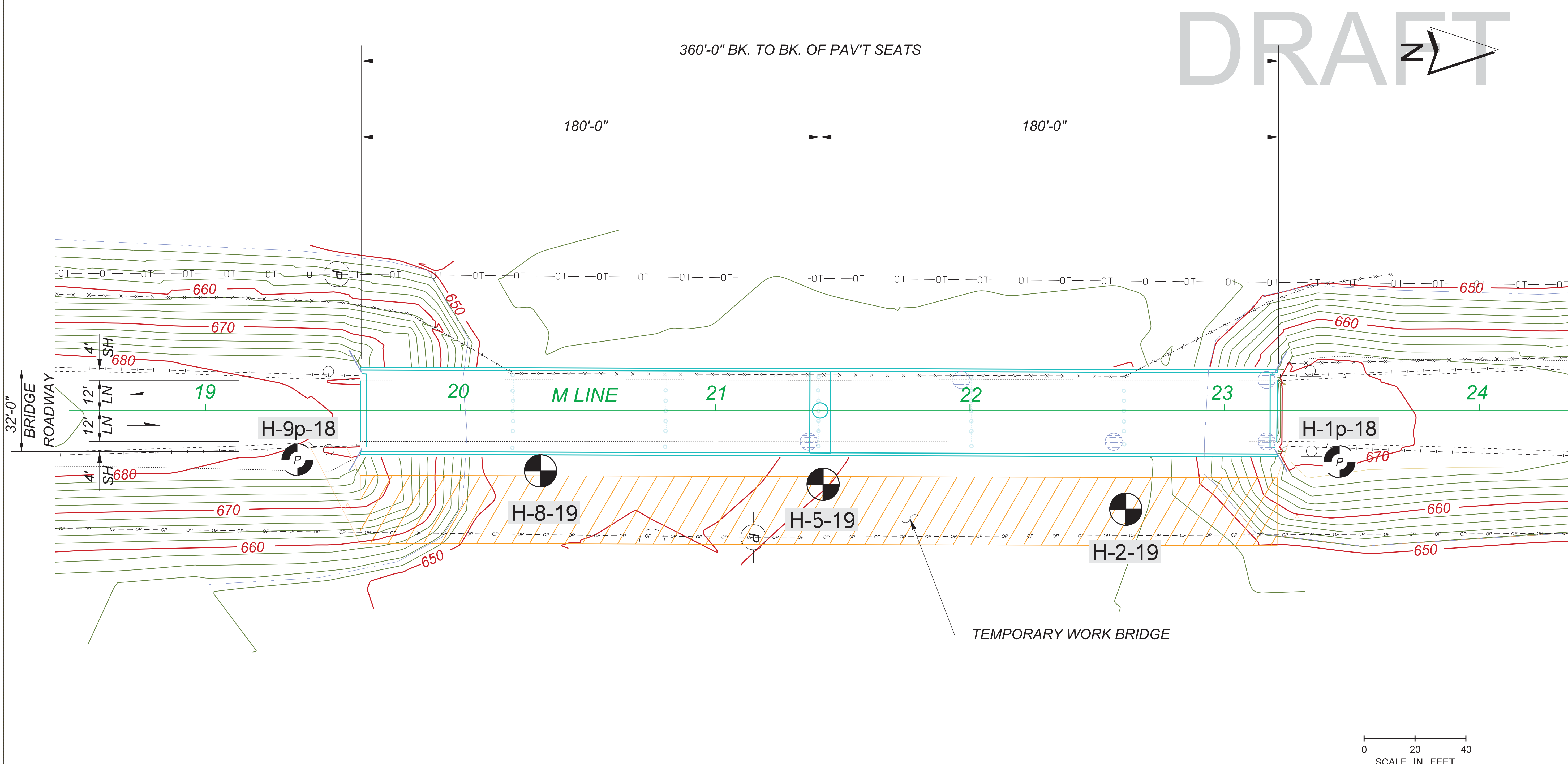
SUBJECT: SR 241, MP 1.06 – 1.50, XL-5661
Mabton Vicinity – Retrofit Bridges
DRAFT Boring Logs and Laboratory Test Results

Attached, please find the DRAFT boring logs and DRAFT laboratory test results for the subject project. If you have any questions about this information, please contact David Johnson at (360) 709-5462.

TMA: dij

cc: Alejandro Sanguino, South Central Region
Michael Adams, South Central Region
Owen Sabong, South Central Region
Mark Melton, South Central Region
Bethany Jackson, Geotechnical Office

Attachments:
Figure 1 – Site and Exploration Plan for Bridge 241/2
Figure 2 – Site and Exploration Plan for Bridge 241/5
DRAFT Boring Logs
DRAFT Laboratory Test Results



H-1-19 SURVEYED TEST BORING LOCATION

H-1p-18 SURVEYED TEST BORING AND PIEZOMETER LOCATION

JOB# XL-5661 **STATE ROUTE** 241 **MILEPOST(S)** 01.06 - 01.50

FIGURE 1: SITE AND EXPLORATION PLAN FOR BRIDGE 241/2

SR241 MABTON VICINITY - RETROFIT BRIDGES

WSDOT GEOTECHNICAL OFFICE

PREPARED BY William Montgomery **DATE** July, 2019

File Location: I:\XL-5661 SR241 Mabton Bridge\Mabton Bridge State Plane Coordinates.dgn

WSDOT

LOG OF TEST BORING

Job No.	XL-5661	SR	241	Elevation	670.0 ft
Start Card	RE-16099	HOLE No.	H-1p-18	Sheet	1 of 5
Project	SR-241 Mabton Vicinity - Retrofit Bridges	Driller	Henderson, Ted	Lic#	2902
Component	Bridge 241/2	Inspector	Shepherd, Robert #2710		
Start	November 5, 2018	Completion	November 7, 2018	Well ID#	BLA-678
Equipment	CME 45 (9C4-4)				
Station	M 23+45.06	Offset	20.0 feet right	Hole Dia (inches)	6
Historical SPT Efficiency	88.3%				
Northing	326890.589	Easting	1767083.517	Collected by	Region Survey Crew
Method	Casing Advancer				
Lat	46.2286522	Long	-119.9994897	Datum	NAD 83/91 HARN, NAVD88, SPS (ft)
Drill Fluid	Bentonite				

Legend: SPT Efficiency; Field SPT (N); Moisture Content; RQD (scale 20, 40, 60, 80)

Depth (ft)	Elevation (ft)	Blows/6" (N) and/or RQD FF	Sample No. (Tube No.)	Lab Tests	Description of Material
1		6, 10, 5, 4 (15)	D-1		Silty SAND with gravel, sub-angular, medium dense, light brown, dry, homogeneous. HCl not tested. Recovered: 1.2 ft Retained: 1.2 ft
5	665.0				NOTE: From 5.0 to 5.5 ft, drilling indicates gravel.
5.5		5, 4, 3 (7)	D-2	MC GS AL	SM, MC=16%, LL=NA, PL=NP Silty SAND with organics including roots, sub-rounded, loose, brown, moist, homogeneous. HCl not tested. Recovered: 1.1 ft Retained: 1.1 ft
8		6, 5, 7 (12)	D-3		Silty SAND, medium dense, light brown, moist, homogeneous. HCl not tested. Recovered: 1.1 ft Retained: 1.1 ft
10	660.0				
10.5		4, 5, 5 (10)	D-4		Silty SAND, sub-rounded, loose, light brown, moist, homogeneous. HCl not tested. Recovered: 1.4 ft Retained: 1.4 ft
13.5		4, 4, 3 (7)	D-5		Silty SAND, loose, light brown, moist, homogeneous. HCl not tested. Recovered: 1.1 ft Retained: 1.1 ft
15	655.0				
15.5		2, 2, 5 (7)	D-6	MC GS AL	SM, MC=17%, LL=NA, PL=NP Silty SAND, loose, light brown, moist, homogeneous. HCl not tested. Recovered: 1.0 ft Retained: 1.0 ft
18.5		4, 4, 6 (10)	D-7		Silty SAND, loose, light brown, wet, homogeneous. HCl not tested. Recovered: 0.9 ft Retained: 0.9 ft
20					

Groundwater: Groundwater readings were taken from 11-06-2018 to 06-20-2019

11-06-2018

Instrument

Depth (ft)	Elevation (ft)	Blows/6" (N) and/or RQD FF	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater
		5 6 7 (13)	D-8		Silty SAND, medium dense, light brown, wet, homogeneous. HCl not tested. Recovered: 1.0 ft Retained: 1.0 ft	03-10-2019
		2 2 1 (3)	D-9	MC GS AL	SM, MC=23%, LL=NA, PL=NP Silty SAND, very loose, light gray, wet, homogeneous. HCl not tested. Recovered: 1.0 ft Retained: 1.0 ft	
25	645	1 2 5 (7)	PS-10 D-11	MC GS AL HT SG	NOTE: From 25.0 to 28.5 ft, drilling indicates gravel. NOTE: At 25.1 ft, lost drilling fluid. NO RECOVERY (bent Shelby tube). ML, MC=38%, LL=27, PL=NP Sandy SILT with organics, loose, gray, wet, homogeneous. HCl not tested. Recovered: 0.9 ft Retained: 0.9 ft	
30	640	10 6 4 (10)	PS-12 D-13		NO RECOVERY (bent Shelby tube). NO RECOVERY (2-in I.D. oversize sampler used to recover sample).	
		5 2 2 (4)	D-14	MC GS AL	SM, MC=39%, LL=25, PL=NP Silty SAND, very loose, gray, wet, homogeneous. HCl not tested. Recovered: 1.1 ft Retained: 1.1 ft	
35	635	1 1 1 (2)	D-15	MC GS AL	SM, MC=29%, LL=NA, PL=NP Silty SAND, very loose, gray, wet, homogeneous. HCl not tested. Recovered: 1.5 ft Retained: 1.5 ft	
40	630	3 3 2 (5)	D-16		Silty SAND, loose, gray, wet, homogeneous. HCl not tested. Recovered: 0.1 ft Retained: 0.1 ft	
45						

Legend: SPT Efficiency; Field SPT (N); Moisture Content; RQD (scale 20, 40, 60, 80)

LOG OF TEST BORING

WSDOT

Job No. XL-5661 SR 241 Elevation 670.0 ft

HOLE No. H-1p-18

Sheet 3 of 5

Project SR-241 Mabton Vicinity - Retrofit Bridges

Driller Henderson, Ted

Depth (ft)	Elevation (ft)	Blows/6" (N) and/or RQD FF	Sample No. (Tube No.)	Lab Tests	Description of Material
		7 6 6 (12)	D-17	MC GS AL	SP-SM, MC=22%, LL=NA, PL=NP Poorly graded SAND with silt, medium dense, gray, wet, homogeneous. HCl not tested. Recovered: 0.9 ft Retained: 0.9 ft
50	620	31 22 20 (42)	D-18		Poorly graded SAND with silt, sub-angular, dense, gray, wet, homogeneous. HCl not tested. Recovered: 0.9 ft Retained: 0.9 ft
55	615	18 22 22 (44)	D-19	MC GS AL	SP-SM, MC=19%, LL=NA, PL=NP Poorly graded SAND with silt, sub-rounded, dense, light brownish gray, wet, homogeneous. HCl not tested. Recovered: 1.2 ft Retained: 1.2 ft
60	610	15 14 22 (36)	D-20		Poorly graded SAND with silt, sub-angular, dense, light brownish gray, wet, homogeneous. HCl not tested. Recovered: 1.3 ft Retained: 1.3 ft
65	605	5 6 6 (12)	D-21	MC GS AL HT SG	ML, MC=33%, PI=5 SILT, medium dense, light gray, moist, homogeneous. HCl not tested. Recovered: 1.2 ft Retained: 1.2 ft
			PS-22	MC GS AL HT SG	ML, MC=29%, LL=26 SILT, gray. HCl not tested. Recovered: 1.5 ft Retained: 1.5 ft
		4 5 11	D-23	MC	SM, MC=25%, LL=NA, PL=NP Silty SAND, medium dense, light gray, wet,
70					

Legend: SPT Efficiency; Field SPT (N); Moisture Content; RQD. Scale: 20 40 60 80

LOG OF TEST BORING

WSDOT

Job No. XL-5661 | SR 241 | Elevation 670.0 ft | HOLE No. H-1p-18

Project SR-241 Mabton Vicinity - Retrofit Bridges | Driller Henderson, Ted

Depth (ft)	Elevation (ft)	Blows/6" (N) and/or RQD FF	Sample No. (Tube No.)	Lab Tests	Description of Material
		(16)		GS AL	homogeneous. HCl not tested. Recovered: 1.2 ft Retained: 1.2 ft
75	595	23 37 42 (79)	D-24		Poorly graded SAND with silt, sub-rounded, very dense, light gray, wet, homogeneous. HCl not tested. Recovered: 1.5 ft Retained: 1.5 ft
80	590	15 20 24 (44)	D-25	MC GS AL	SP-SM, MC=23%, LL=NA, PL=NP Poorly graded SAND with silt, dense, light gray, wet, homogeneous. HCl not tested. Recovered: 1.5 ft Retained: 1.5 ft
85	585	9 26 34 (60)	D-26		Poorly graded SAND with silt, very dense, light gray, wet, stratified. HCl not tested. Recovered: 1.5 ft Retained: 1.5 ft
90	580	7 40 50/6" (REF)	D-27		Poorly graded SAND with silt, very dense, light gray, wet, homogeneous. HCl not tested. Recovered: 1.5 ft Retained: 1.5 ft
					NOTE: At 93.0 ft, drilling indicates gravel.
95					

Legend: SPT Efficiency; Field SPT (N); Moisture Content; RQD (scale 20, 40, 60, 80)

LOG OF TEST BORING

WSDOT

Job No. XL-5661 | SR 241 | Elevation 670.0 ft | HOLE No. H-1p-18

Project SR-241 Mabton Vicinity - Retrofit Bridges | Driller Henderson, Ted

Depth (ft)	Elevation (ft)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material
		32 45 50/6" (REF)		D-28	MC GS AL	GP-GM, MC=10%, LL=NA, PL=NP Well graded GRAVEL with silt and sand, sub-rounded, very dense, light brownish gray, wet, homogeneous. HCl not tested. Recovered: 0.9 ft Retained: 0.9 ft
						NOTE: From 99.0 to 99.5 ft, drilling indicates cobble or coarse gravel.
100	570	50/3" (REF)		D-29		Well graded GRAVEL with sand, sub-rounded, very dense, light brownish gray, wet, homogeneous. HCl not tested. Recovered: 0.1 ft Retained: 0.1 ft NOTE: At 101.0 ft, drilling indicates finer sized gravel.
105	565	4 8 17 (25)		D-30	MC GS AL	SP-SM, MC=21%, LL=NA, PL=NP Poorly graded SAND with silt, dense, light brownish gray, wet, homogeneous. HCl not tested. Recovered: 1.3 ft Retained: 1.3 ft
						NOTE: At 107.5 ft, drilling indicates gravel.
110	560	50/3" (REF)		D-31		Well graded GRAVEL with sand, sub-rounded, very dense, dark gray, wet, homogeneous. HCl not tested. Recovered: 0.3 ft Retained: 0.3 ft
115	555					
120						

A standpipe monument was installed on this boring.

The implied accuracy of the borehole location information displayed on this boring log is typically sub-meter in (X,Y) when collected by the HQ Geotech Office and sub-centimeter in (X,Y,Z) when collected by the Region Survey Crew.

End of test hole boring at 110.8 ft below ground surface.
This is a summary Log of Test Boring.
Soil/Rock descriptions are derived from visual field identifications and laboratory test data.
Note: REF = SPT Refusal

Bail/Recharge test: Test was not conducted due to heaving sands.

Water Levels at the Time of and After Drilling:
11-6-2018: 12.8 ft
11-8-2018, 9:45am: 19.5 ft
11-9-2018, 3:30pm: 19.5 ft

WSDOT

LOG OF TEST BORING

Start Card SE70126 / AE54995
HOLE No. H-2-19
Sheet 1 of 5

Job No. XL-5661 SR 241 Elevation 649.2 ft

Project SR-241 Mabton Vicinity - Retrofit Bridges

Driller Henderson, Danny Lic# 2742

Component Bridge 241/2

Inspector Cooper, Kerry #2552

Start June 11, 2019 Completion June 12, 2019 Well ID# N/A Equipment CME 45 (9C4-4)

Station M 22+61.13 Offset 38.6 feet right Hole Dia (inches) 4 Historical SPT Efficiency 88.3%

Northing 326806.728 Easting 1767102.362 Collected by Region Survey Crew Method Casing Advancer

Lat 46.2284219 Long -119.9994174 Datum NAD 83/91 HARN, NAVD88, SPS (ft) Drill Fluid Bentonite and Polymer

Legend: SPT Efficiency; Field SPT (N); Moisture Content; RQD (scale 20, 40, 60, 80)

Depth (ft)	Elevation (ft)	Blows/6" (N) and/or RQD FF	Sample No. (Tube No.)	Lab Tests	Description of Material
0	649.2	1 1 1 (2)	D-1	MC GS AL HT SG	ML, MC=41%, LL=27, PL=NP Sandy SILT with organics including roots, very loose, dark gray, wet, homogeneous. Recovered: 1.5 ft Retained: 1.5 ft
5	645.0	0 1 1 (2)	D-2		Sandy SILT with organics including roots, very loose, dark gray, wet, homogeneous. Recovered: 1.2 ft Retained: 1.2 ft
		0 1 1 (2)	D-3		Silty SAND with organics including roots, sub-angular, very loose, dark gray, wet, homogeneous. Recovered: 1.3 ft Retained: 1.3 ft
10	640.0	1 1 1 (2)	D-4	MC GS AL HT SG	SM, MC=33%, LL=NA, PL=NP Silty SAND, sub-angular, very loose, dark gray, wet, homogeneous. Recovered: 1.5 ft Retained: 1.5 ft
			PS-5		Poorly graded SAND with organics, sub-angular, dark gray, wet. Recovered: 2.0 ft Retained: 2.0 ft
15	635.0	0 1 1 (2)	D-6		Sandy SILT, very loose, dark gray, wet, homogeneous. Recovered: 1.2 ft Retained: 1.2 ft
	630.0	1 1 1 (2)	D-7	MC GS AL HT SG	ML, MC=45%, LL=27, PL=NP Sandy SILT, very loose, dark gray, wet, homogeneous. Recovered: 1.1 ft Retained: 1.1 ft
20					

WSDOT

LOG OF TEST BORING

Job No. XL-5661 SR 241 Elevation 649.2 ft

HOLE No. H-2-19

Project SR-241 Mabton Vicinity - Retrofit Bridges

Driller Henderson, Danny

Legend: SPT Efficiency; Field SPT (N); Moisture Content; RQD (scale 20, 40, 60, 80)

Depth (ft)	Elevation (ft)	Blows/6" (N) and/or RQD FF	Sample No. (Tube No.)	Lab Tests	Description of Material
20		8, 16, 24 (40)	D-8	MC, GS, AL	ML, MC=48%, LL=27, PL=NP Sandy SILT, dense, dark gray, wet, homogeneous. Recovered: 1.2 ft Retained: 1.2 ft
	625	13, 12, 10 (22)	D-9		Silty GRAVEL with sand, sub-rounded, medium dense, dark gray, wet, homogeneous. Recovered: 0.3 ft Retained: 0.3 ft
25		5, 9, 11 (20)	D-10	MC, GS, AL, HT	ML, MC=25%, LL=23, PL=NP SILT with sand, medium dense, gray, wet, homogeneous. Recovered: 1.5 ft Retained: 1.5 ft
			PS-11	SG	Sandy SILT, gray, wet. Recovered: 2.0 ft Retained: 2.0 ft
30	620	14, 24, 22 (46)	D-12	MC, GS, AL	ML, MC=20%, LL=NA, PL=NP Sandy SILT, dense, gray, wet, homogeneous. Recovered: 1.3 ft Retained: 1.3 ft
35	615	18, 27, 34 (61)	D-13		Sandy SILT, very dense, gray, wet, homogeneous. Recovered: 1.4 ft Retained: 1.4 ft
40	610	15, 20, 28 (48)	D-14		Sandy SILT, dense, gray, wet, homogeneous. Recovered: 1.5 ft Retained: 1.5 ft
45	605				

WSDOT

LOG OF TEST BORING

Job No. XL-5661 SR 241 Elevation 649.2 ft

HOLE No. H-2-19

Sheet 3 of 5

Project SR-241 Mabton Vicinity - Retrofit Bridges

Driller Henderson, Danny

Legend: SPT Efficiency; Field SPT (N); Moisture Content; RQD (scale 20, 40, 60, 80)

Depth (ft)	Elevation (ft)	Blows/6" (N) and/or RQD FF	Sample No. (Tube No.)	Lab Tests	Description of Material
45		5 10 14 (24)	D-15	MC GS AL HT SG	ML, MC=34%, PI=6 SILT, medium dense, gray, wet, homogeneous. Recovered: 1.5 ft Retained: 1.5 ft
			PS-16		SILT, gray, moist. Recovered: 2.0 ft Retained: 2.0 ft
	600		PS-17		SILT, gray, moist. Recovered: 2.0 ft Retained: 2.0 ft
50					
	595				
55		19 25 27 (52)	D-18	MC GS AL	SM, MC=22%, LL=NA, PL=NP Silty SAND, sub-angular, very dense, gray, wet, homogeneous. Recovered: 1.5 ft Retained: 1.5 ft
	590				
60		13 11 12 (23)	D-19	MC GS AL	ML, MC=27%, LL=16, PL=NP Sandy SILT, medium dense, gray, wet, homogeneous. Recovered: 1.2 ft Retained: 1.2 ft
	585				
65		18 20 28 (48)	D-20		Sandy SILT, dense, gray, wet, homogeneous. Recovered: 1.5 ft Retained: 1.5 ft
	580				
70					

WSDOT

LOG OF TEST BORING

Job No. XL-5661 SR 241 Elevation 649.2 ft

HOLE No. H-2-19

Sheet 4 of 5

Project SR-241 Mabton Vicinity - Retrofit Bridges

Driller Henderson, Danny

Legend: SPT Efficiency; Field SPT (N); Moisture Content; RQD (scale 20, 40, 60, 80)

Depth (ft)	Elevation (ft)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material
70		10 15 17 (32)		D-21		Silty SAND, sub-angular, dense, gray, wet, homogeneous. Recovered: 1.5 ft Retained: 1.5 ft
73						NOTE: At 73.0 ft, drilling indicates gravel.
75	575	>> 50/2" (REF)		D-22		Well graded GRAVEL with sand, sub-rounded, very dense, gray, wet, homogeneous. Recovered: 0.2 ft Retained: 0.2 ft
80	570	>> 50/6" (REF)		D-23		Silty GRAVEL with sand, sub-rounded, very dense, grayish brown, wet, homogeneous. Recovered: 0.4 ft Retained: 0.4 ft
85	565	30 43 26 (69)		D-24	MC GS AL	GP, MC=10%, LL=NA, PL=NP Poorly graded GRAVEL with sand, sub-rounded, very dense, gray, wet, homogeneous. Recovered: 1.2 ft Retained: 1.2 ft
90	560	31 37 25 (62)		D-25		Poorly graded GRAVEL with sand, sub-rounded, very dense, gray, wet, homogeneous. Recovered: 1.0 ft Retained: 1.0 ft
95	555					The implied accuracy of the borehole location information displayed on this boring log is typically sub-meter in (X,Y) when collected by the HQ Geotech Office and sub-centimeter in (X,Y,Z) when collected by the Region Survey Crew.

LOG OF TEST BORING

WSDOT

Job No. XL-5661 SR 241 Elevation 649.2 ft

HOLE No. H-2-19

Sheet 5 of 5

Project SR-241 Mabton Vicinity - Retrofit Bridges

Driller Henderson, Danny

Depth (ft)	Elevation (ft)	Profile	SPT Efficiency / Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
								End of test hole boring at 91.5 ft below ground elevation. This is a summary Log of Test Boring. Soil/Rock descriptions are derived from visual field identifications and laboratory test data. Note: REF = SPT Refusal At 6-11-2019, 8:55AM: Depth to mudline = 2.0 ft below water surface.		
	550									
100										
	545									
105										
	540									
110										
	535									
115										
	530									
120										

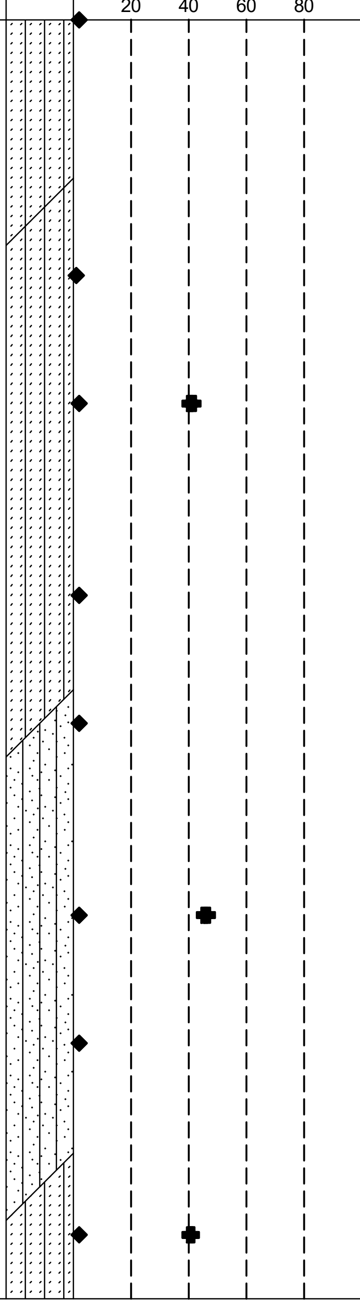
LOG OF TEST BORING

WSDOT

Job No.	XL-5661	SR	241	Elevation	650.4 ft
Project	SR-241 Mabton Vicinity - Retrofit Bridges				
Component	Bridge 241/2				
Start	June 18, 2019	Completion	June 20, 2019	Well ID#	N/A
Station	M 21+42.31	Offset	28.8 feet right	Hole Dia (inches)	4
Northing	326687.886	Easting	1767092.879	Collected by	Region Survey Crew
Lat	46.2280962	Long	-119.9994578	Datum	NAD 83/91 HARN, NAVD88, SPS (ft)

Start Card	SE70126 / AE54995
HOLE No.	H-5-19
Sheet	1 of 6
Driller	Henderson, Danny
Lic#	2742
Inspector	Cooper, Kerry #2552
Equipment	CME 45 (9C4-4)
Historical SPT Efficiency	88.3%
Method	Casing Advancer
Drill Fluid	Bentonite and Polymer

Legend: SPT Efficiency; Field SPT (N); Moisture Content; RQD (scale 20, 40, 60, 80)



Depth (ft)	Elevation (ft)	Blows/6" (N) and/or RQD FF	Sample No. (Tube No.)	Lab Tests	Description of Material
0	650.0	1 1 1 (2)	D-1		Silty SAND with organics including roots, sub-angular, very loose, dark gray, wet, homogeneous. Recovered: 1.5 ft Retained: 1.5 ft
5	645.0	1 0 1 (1)	D-2		Silty SAND, sub-angular, very loose, dark gray, wet, homogeneous. Recovered: 0.5 ft Retained: 0.5 ft
		0 1 1 (2)	D-3	MC GS AL HT SG	SM, MC=41%, LL=NA, PL=NP Silty SAND, sub-angular, very loose, dark gray, wet, homogeneous. Recovered: 1.5 ft Retained: 1.5 ft
10	640.0	1 1 1 (2)	D-4		Silty SAND, sub-angular, very loose, dark gray, wet, homogeneous. Recovered: 1.5 ft Retained: 1.5 ft
		1 1 1 (2)	D-5		Sandy SILT, very loose, dark gray, wet, homogeneous. Recovered: 1.5 ft Retained: 1.5 ft
15	635.0	1 1 1 (2)	D-6	MC GS AL HT SG	ML, MC=46%, LL=26, PL=NP Sandy SILT, very loose, dark gray, wet, homogeneous. Recovered: 1.5 ft Retained: 1.5 ft
		0 1 1 (2)	D-7		Sandy SILT, very loose, dark gray, wet, homogeneous. Recovered: 1.5 ft Retained: 1.5 ft
20		1 1 1	D-8	MC GS	SM, MC=41%, LL=NA, PL=NP Silty SAND, sub-angular, very loose, dark gray, wet,

WSDOT

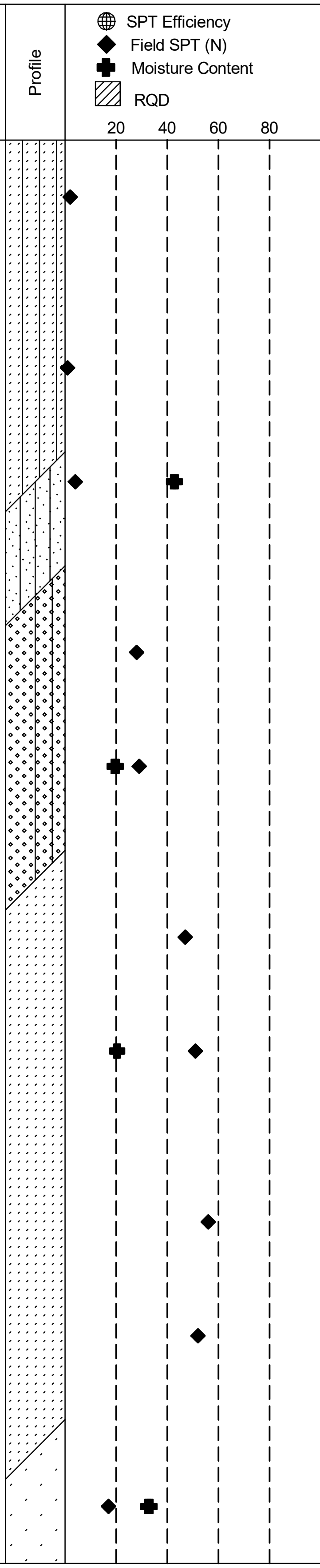
LOG OF TEST BORING

Job No. XL-5661 SR 241 Elevation 650.4 ft

HOLE No. H-5-19

Project SR-241 Mabton Vicinity - Retrofit Bridges

Driller Henderson, Danny



Depth (ft)	Elevation (ft)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material
	630	(2)			AL	homogeneous. Recovered: 1.3 ft Retained: 1.3 ft
		0 1 1 (2)		D-9		Silty SAND, sub-angular, very loose, dark gray, wet, homogeneous. Recovered: 1.5 ft Retained: 1.5 ft
25	625	0 0 1 (1)		D-10		Silty SAND, sub-angular, very loose, dark gray, wet, homogeneous. Recovered: 1.4 ft Retained: 1.4 ft
		1 1 3 (4)		D-11	MC GS AL	ML, MC=43%, LL=27, PL=NP Sandy SILT with organics including wood, very loose, dark gray, wet, homogeneous. Recovered: 1.5 ft Retained: 1.5 ft
30	620	8 12 16 (28)		D-12		Well graded SAND with silt, sub-angular, dense, dark gray, wet, homogeneous. Recovered: 1.5 ft Retained: 1.5 ft
		6 12 17 (29)		D-13	MC GS AL	SW-SM, MC=20%, LL=NA, PL=NP Well graded SAND with silt, sub-angular, dense, gray, wet, homogeneous. Recovered: 1.5 ft Retained: 1.5 ft
35	615	11 21 26 (47)		D-14		Poorly graded SAND, sub-angular, dense, gray, wet, homogeneous. Recovered: 1.5 ft Retained: 1.5 ft
		5 21 30 (51)		D-15	MC GS AL	SP, MC=21%, LL=NA, PL=NP Poorly graded SAND, sub-rounded, very dense, gray, wet, homogeneous. Recovered: 1.3 ft Retained: 1.3 ft
40	610	19 25 31 (56)		D-16		Poorly graded SAND, sub-angular, very dense, gray, wet, homogeneous. Recovered: 1.4 ft Retained: 1.4 ft
		16 23 29 (52)		D-17		Poorly graded SAND, sub-angular, very dense, gray, wet, homogeneous. Recovered: 1.0 ft Retained: 1.0 ft
45		7 7 10		D-18	MC GS	ML, MC=33%, PI=8 SILT, medium dense, gray, moist, homogeneous.

Groundwater | Instrument

WSDOT

LOG OF TEST BORING

Job No. XL-5661 SR 241 Elevation 650.4 ft

HOLE No. H-5-19

Sheet 3 of 6

Project SR-241 Mabton Vicinity - Retrofit Bridges

Driller Henderson, Danny

Depth (ft)	Elevation (ft)	Blows/6" (N) and/or RQD FF	Sample No. (Tube No.)	Lab Tests	Description of Material
	605	(17)		AL HT SG	Recovered: 1.3 ft Retained: 1.3 ft
			PS-19		SILT, gray, moist. Recovered: 1.7 ft Retained: 1.7 ft
			PS-20	MC GS AL HT SG	ML, MC=35%, PI=6 SILT, gray, moist. Recovered: 2.0 ft Retained: 2.0 ft
50	600				
		15 16 22 (38)	D-21	MC GS AL	SP-SM, MC=29%, LL=NA, PL=NP Poorly graded SAND with silt, sub-angular, dense, gray, wet, homogeneous. Recovered: 1.2 ft Retained: 1.2 ft
55	595				
		12 18 25 (43)	D-22		Poorly graded SAND with silt, sub-angular, dense, gray, wet, homogeneous. Recovered: 1.1 ft Retained: 1.1 ft
60	590				
		12 14 27 (41)	D-23		Poorly graded SAND with silt, sub-rounded, dense, gray, wet, homogeneous. Recovered: 1.3 ft Retained: 1.3 ft
65	585				
		10 14 20	D-24	MC GS	ML, MC=31%, LL=26, PL=NP SILT, dense, gray, wet, homogeneous.
70					

Legend: SPT Efficiency; Field SPT (N); Moisture Content; RQD (scale 20, 40, 60, 80)

LOG OF TEST BORING

WSDOT

Job No. XL-5661 | SR 241 | Elevation 650.4 ft | HOLE No. H-5-19

Sheet 4 of 6

Project SR-241 Mabton Vicinity - Retrofit Bridges | Driller Henderson, Danny

Depth (ft)	Elevation (ft)	Field SPT (N) / Moisture Content	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material
	580		(34)			AL HT SG	Recovered: 1.5 ft Retained: 1.5 ft
75	575	MC ~10; N 74	22 33 41 (74)		D-25	MC GS AL	GW-GM, MC=10%, LL=NA, PL=NP Well graded GRAVEL with silt and sand, sub-rounded, very dense, gray, wet, stratified. Recovered: 1.4 ft Retained: 1.4 ft
80	570	>>	29 31 50/1" (REF)		D-26		Well graded GRAVEL with silt and sand, sub-rounded, very dense, gray, wet, homogeneous. Recovered: 0.6 ft Retained: 0.6 ft
85	565	>>	34 50/6" (REF)		D-27		Well graded GRAVEL with silt and sand, sub-rounded, very dense, gray, wet, homogeneous. Recovered: 0.9 ft Retained: 0.9 ft
90	560	>>	32 50/3" (REF)		D-28		Well graded GRAVEL with silt and sand, sub-rounded, very dense, gray, wet, homogeneous. Recovered: 0.6 ft Retained: 0.6 ft
95		>>	50/5" (REF)		D-29		Silty GRAVEL with sand, sub-rounded, very dense, grayish brown, wet, homogeneous.

WSDOT

LOG OF TEST BORING

Job No. XL-5661 | SR 241 | Elevation 650.4 ft | HOLE No. H-5-19

Sheet 5 of 6

Project SR-241 Mabton Vicinity - Retrofit Bridges

Driller Henderson, Danny

Depth (ft)	Elevation (ft)	Profile	SPT Efficiency / Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	555							Recovered: 0.5 ft Retained: 0.5 ft		
			>>	50/3" (REF)		D-30		Silty GRAVEL with sand, sub-rounded, very dense, gray, wet, homogeneous. Recovered: 0.3 ft Retained: 0.3 ft		
100	550									
			>>	50/2" (REF)		D-31		Silty GRAVEL with sand, sub-rounded, very dense, gray, wet, homogeneous. Recovered: 0.2 ft Retained: 0.2 ft		
105	545									
			>>	50/4" (REF)		D-32		Silty GRAVEL with sand, sub-rounded, very dense, grayish brown, wet, homogeneous. Recovered: 0.3 ft Retained: 0.3 ft		
110	540									
			>>	50/6" (REF)		D-33	MC GS	GP-GM, MC=15% Poorly graded GRAVEL with silt and sand, sub-rounded, very dense, grayish brown, wet, homogeneous. Recovered: 0.5 ft Retained: 0.5 ft		
115	535							The implied accuracy of the borehole location information displayed on this boring log is typically sub-meter in (X,Y) when collected by the HQ Geotech Office and sub-centimeter in (X,Y,Z) when collected by the Region Survey Crew.		
120										

WSDOT

LOG OF TEST BORING

Job No. XL-5661 SR 241 Elevation 650.4 ft

HOLE No. H-5-19

Project SR-241 Mabton Vicinity - Retrofit Bridges

Driller Henderson, Danny

Depth (ft)	Elevation (ft)	Profile	SPT Efficiency / Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	530							End of test hole boring at 114.5 ft below ground elevation. This is a summary Log of Test Boring. Soil/Rock descriptions are derived from visual field identifications and laboratory test data. Note: REF = SPT Refusal At 6-18-2019, 12:13PM: Depth to mudline = 1.5 ft below water surface.		
125	525									
130	520									
135	515									
140	510									
145										

WSDOT

LOG OF TEST BORING

Start Card	SE70126 / AE54995
HOLE No.	H-8-19
Sheet	1 of 4
Job No.	XL-5661
SR	241
Elevation	649.8 ft
Project	SR-241 Mabton Vicinity - Retrofit Bridges
Driller	Henderson, Danny
Lic#	2742
Component	Bridge 241/2
Inspector	Cooper, Kerry #2552
Start	June 21, 2019
Completion	June 22, 2019
Well ID#	N/A
Equipment	CME 45 (9C4-4)
Station	M 20+31.40
Offset	23.6 feet right
Hole Dia (inches)	4
Historical SPT Efficiency	88.3%
Northing	326576.98
Easting	1767087.94
Collected by	Region Survey Crew
Method	Casing Advancer
Lat	46.2277922
Long	-119.9994801
Datum	NAD 83/91 HARN, NAVD88, SPS (ft)
Drill Fluid	Bentonite and Polymer

Legend: SPT Efficiency; ◆ Field SPT (N); ✚ Moisture Content; RQD (hatched). Plot scale: 20, 40, 60, 80

Depth (ft)	Elevation (ft)	Blows/6" (N) and/or RQD FF	Sample No. (Tube No.)	Lab Tests	Description of Material
0		1 1 1 (2)	D-1		Silty SAND with organics including roots, sub-angular, very loose, dark gray, wet, homogeneous. Recovered: 1.0 ft Retained: 1.0 ft
5	645.0				
		0 1 1 (2)	D-2	MC GS AL HT SG	SM, MC=44%, LL=NA, PL=NP Silty SAND, sub-angular, very loose, dark gray, wet, homogeneous. Recovered: 0.7 ft Retained: 0.7 ft
		1 2 1 (3)	D-3		Silty SAND, sub-angular, very loose, dark gray, wet, homogeneous. Recovered: 0.8 ft Retained: 0.8 ft
10	640.0				
		0 0 1 (1)	D-4	MC GS AL HT SG	SM, MC=39%, LL=NA, PL=NP Silty SAND, sub-angular, very loose, dark gray, wet, homogeneous. Recovered: 0.6 ft Retained: 0.6 ft
		1 2 2 (4)	D-5		Silty SAND, sub-angular, very loose, dark gray, wet, homogeneous. Recovered: 0.9 ft Retained: 0.9 ft
15	635.0				
		2 1 2 (3)	D-6		Silty SAND, sub-angular, very loose, dark gray, wet, homogeneous. Recovered: 1.2 ft Retained: 1.2 ft
		1 1 2	D-7		Silty SAND, sub-angular, very loose, dark gray, wet, homogeneous.
20	630.0				

WSDOT

LOG OF TEST BORING

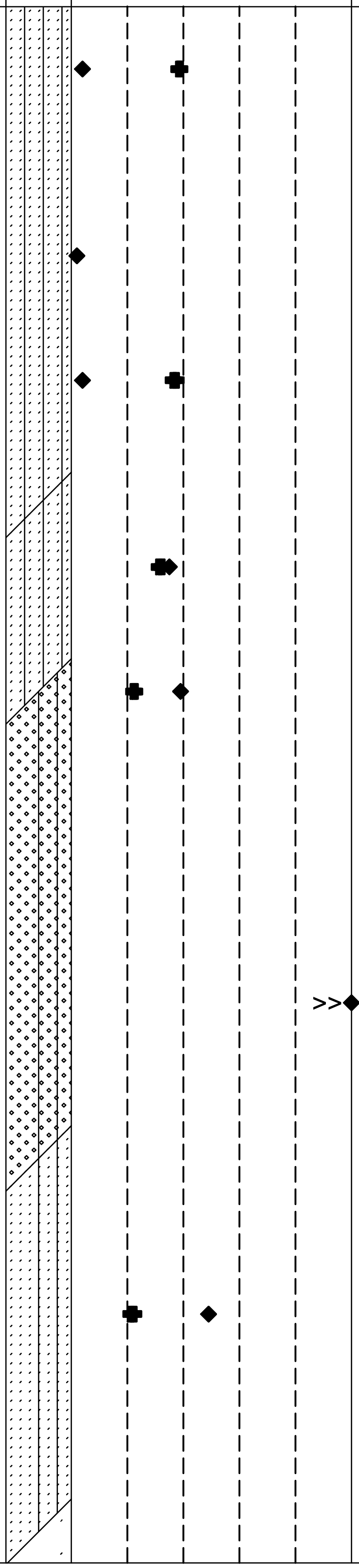
Job No. XL-5661 SR 241 Elevation 649.8 ft

HOLE No. H-8-19

Project SR-241 Mabton Vicinity - Retrofit Bridges

Driller Henderson, Danny

Legend: SPT Efficiency; Field SPT (N); Moisture Content; RQD (scale 20, 40, 60, 80)



Depth (ft)	Elevation (ft)	Blows/6" (N) and/or RQD FF	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
		(3)			Recovered: 1.1 ft Retained: 1.1 ft		
		1 2 2 (4)	D-8	MC GS AL HT SG	SM, MC=39%, LL=NA, PL=NP Silty SAND, sub-angular, very loose, dark gray, wet, homogeneous. Recovered: 1.4 ft Retained: 1.4 ft		
		2 1 1 (2)	D-9		Silty SAND, sub-angular, very loose, dark gray, wet, homogeneous. Recovered: 1.1 ft Retained: 1.1 ft		
25	625						
		1 2 2 (4)	D-10	MC GS AL HT SG	SM, MC=37%, LL=NA, PL=NP Silty SAND, sub-angular, very loose, dark gray, wet, homogeneous. Recovered: 1.5 ft Retained: 1.5 ft		
		5 18 17 (35)	D-11	MC GS AL HT SG	SM, MC=32%, LL=22, PL=NP Silty SAND, sub-rounded, dense, dark gray, wet, stratified. Recovered: 1.0 ft Retained: 1.0 ft		
30	620						
		8 21 18 (39)	D-12	MC GS AL	SW-SM, MC=23%, LL=NA, PL=NP Well graded SAND with silt and gravel, sub-rounded, dense, dark gray, wet, homogeneous. Recovered: 1.0 ft Retained: 1.0 ft		
35	615						
		33 50/6" (REF)	D-13		Well graded SAND with silt and gravel, sub-rounded, very dense, gray, wet, homogeneous. Recovered: 0.4 ft Retained: 0.4 ft		
40	610						
		20 19 30 (49)	D-14	MC GS AL	SP-SM, MC=22%, LL=NA, PL=NP Poorly graded SAND with silt, sub-angular, dense, gray, wet, homogeneous. Recovered: 1.5 ft Retained: 1.5 ft		
45	605						

LOG OF TEST BORING

WSDOT

Job No. XL-5661 | SR 241 | Elevation 649.8 ft | HOLE No. H-8-19

Sheet 3 of 4

Project SR-241 Mabton Vicinity - Retrofit Bridges

Driller Henderson, Danny

Legend: SPT Efficiency; Field SPT (N); Moisture Content; RQD (scale 20, 40, 60, 80)

Depth (ft)	Elevation (ft)	Blows/6" (N) and/or RQD FF	Sample No. (Tube No.)	Lab Tests	Description of Material
		5 7 10 (17)	D-15	MC GS AL HT SG	ML, MC=34%, PI=5 SILT with sand, medium dense, gray, wet, homogeneous. Recovered: 1.5 ft Retained: 1.5 ft
			PS-16		Sandy SILT, gray, wet. Recovered: 2.0 ft Retained: 2.0 ft
50	600		PS-17		Sandy SILT, gray, wet. Recovered: 2.0 ft Retained: 2.0 ft
55	595				
		15 20 29 (49)	D-18	MC GS AL	SP, MC=26%, LL=NA, PL=NP Poorly graded SAND, sub-angular, dense, gray, wet, homogeneous. Recovered: 1.5 ft Retained: 1.5 ft
60	590				
		6 8 13 (21)	D-19	MC GS AL HT SG	SM, MC=26%, LL=NA, PL=NP Silty SAND, sub-angular, medium dense, gray, wet, homogeneous. Recovered: 1.3 ft Retained: 1.3 ft
65	585				
		6 10 22 (32)	D-20	MC GS AL HT SG	ML, MC=30%, LL=23, PL=NP SILT, dense, gray, wet, homogeneous. Recovered: 1.5 ft Retained: 1.5 ft
70	580				

WSDOT

LOG OF TEST BORING

Job No. XL-5661 SR 241 Elevation 649.8 ft

HOLE No. H-8-19

Project SR-241 Mabton Vicinity - Retrofit Bridges

Driller Henderson, Danny

Legend: SPT Efficiency; Field SPT (N); Moisture Content; RQD (scale 20, 40, 60, 80)

Depth (ft)	Elevation (ft)	Blows/6" (N) and/or RQD FF	Sample No. (Tube No.)	Lab Tests	Description of Material
		>> 50/6" (REF)	D-21	MC GS AL	GM, MC=22%, LL=17, PL=NP Silty GRAVEL with sand, sub-rounded, very dense, gray, wet, homogeneous. Recovered: 0.5 ft Retained: 0.5 ft
75	575				
		>> 50/5" (REF)	D-22		Silty GRAVEL with sand, sub-rounded, very dense, gray, wet, homogeneous. Recovered: 0.4 ft Retained: 0.4 ft
		38 34 32 (66)	D-23	MC GS AL	SP-SM, MC=20%, LL=NA, PL=NP Poorly graded SAND with silt and gravel, sub-rounded, very dense, gray, wet, homogeneous. Recovered: 1.2 ft Retained: 1.2 ft
80	570				
		>> 50/1" (REF)	D-24		Well graded GRAVEL with sand, sub-rounded, very dense, gray, wet, homogeneous. Recovered: 0.1 ft Retained: 0.1 ft
85	565				
90	560				
95	555				

The implied accuracy of the borehole location information displayed on this boring log is typically sub-meter in (X,Y) when collected by the HQ Geotech Office and sub-centimeter in (X,Y,Z) when collected by the Region Survey Crew.

End of test hole boring at 84.1 ft below ground elevation.
This is a summary Log of Test Boring.
Soil/Rock descriptions are derived from visual field identifications and laboratory test data.
Note: REF = SPT Refusal

At 6-21-2019, 2:26PM: Depth to mudline = 1.5 ft below water surface.

WSDOT

LOG OF TEST BORING

Start Card RE-16099
HOLE No. H-9p-18
Sheet 1 of 7

Job No. XL-5661 | SR 241 | Elevation 679.6 ft

Project SR-241 Mabton Vicinity - Retrofit Bridges

Driller Henderson, Ted | Lic# 2902

Component Bridge 241/2

Inspector Shepherd, Robert #2710

Start November 8, 2018 | Completion November 10, 2018 | Well ID# BLA-679 | Equipment CME 45 (9C4-4)

Station M 19+36.00 | Offset 19.2 feet right | Hole Dia (inches) 6 | Historical SPT Efficiency 88.3%

Northing 326481.567 | Easting 1767083.816 | Collected by Region Survey Crew | Method Casing Advancer

Lat 46.2275306 | Long -119.9994988 | Datum NAD 83/91 HARN, NAVD88, SPS (ft) | Drill Fluid Bentonite

Legend: SPT Efficiency; Field SPT (N); Moisture Content; RQD (scale 20, 40, 60, 80)

Depth (ft)	Elevation (ft)	Blows/6" (N) and/or RQD FF	Sample No. (Tube No.)	Lab Tests	Description of Material
		8 12 10 13 (22)	D-1		Silty SAND, sub-rounded, medium dense, light brown, dry, homogeneous. HCl not tested. Recovered: 1.4 ft Retained: 1.4 ft
5	675.0	3 5 5 (10)	D-2	MC GS AL	SM, MC=8%, LL=NA, PL=NP Silty SAND, loose, light brown, moist, homogeneous. HCl not tested. Recovered: 0.6 ft Retained: 0.6 ft
		4 4 3 (7)	D-3		Silty SAND, loose, light brown, moist, homogeneous. HCl not tested. Recovered: 1.0 ft Retained: 1.0 ft
10	670.0	2 2 4 (6)	D-4		Silty SAND, loose, light brown, moist, homogeneous. HCl not tested. Recovered: 0.8 ft Retained: 0.8 ft
		4 4 5 (9)	D-5	MC GS AL	SM, MC=12%, LL=NA, PL=NP Silty SAND, loose, light brown, moist, homogeneous. HCl not tested. Recovered: 0.9 ft Retained: 0.9 ft
15	665.0	3 4 4 (8)	D-6		Silty SAND, loose, light brown, moist, homogeneous. HCl not tested. Recovered: 1.0 ft Retained: 1.0 ft
		4 4 3 (7)	D-7	MC GS AL	SM, MC=17%, LL=NA, PL=NP Silty SAND, loose, light brown, moist, homogeneous. HCl not tested. Recovered: 1.3 ft Retained: 1.3 ft
20	660.0	2	D-8	MC	ML, MC=22%, LL=NA, PL=NP

Groundwater: 11-09-2018; Groundwater readings were taken from 11-09-2018 to 06-20-2019

WSDOT

LOG OF TEST BORING

Job No. XL-5661 | SR 241 | Elevation 679.6 ft | HOLE No. H-9p-18

Sheet 2 of 7

Project SR-241 Mabton Vicinity - Retrofit Bridges | Driller Henderson, Ted

Legend: SPT Efficiency; ◆ Field SPT (N); ✚ Moisture Content; RQD — scale 20, 40, 60, 80

Depth (ft): 25, 30, 35, 40, 45 — Elevation (ft): 655, 650, 645, 640, 635

Blows/6" (N) and/or RQD FF	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater
2 4 (6)		GS AL	Sandy SILT, loose, brown, moist, homogeneous. HCl not tested. Recovered: 0.8 ft Retained: 0.8 ft NOTE: At 21.0 ft, lost drilling fluid.	
3 2 3 (5)	D-9	MC GS AL	ML, MC=21%, LL=NA, PL=NP Sandy SILT, loose, brown, wet, homogeneous. HCl not tested. Recovered: 1.0 ft Retained: 1.0 ft	
2 3 3 (6)	D-10		Sandy SILT, loose, brown, wet, homogeneous. HCl not tested. Recovered: 0.3 ft Retained: 0.3 ft	
			NOTE: At 27.0 ft, regained drilling fluid.	
2 1 1 (2)	D-11		Sandy SILT, very loose, brown, wet, homogeneous. HCl not tested. Recovered: 1.5 ft Retained: 1.5 ft	
2 1 1 (2)	D-12	MC GS AL	SM, MC=21%, LL=NA, PL=NP Silty SAND, very loose, brown, wet, homogeneous. HCl not tested. Recovered: 1.5 ft Retained: 1.5 ft	03-10-2019
			NOTE: At 33.0 ft, drilling indicates color change to gray.	
3 3 3 (6)	D-13	MC GS AL LOI	ML, MC=36%, LL=NA, PL=NP, LOI=2.1% Sandy SILT with organics including wood debris, loose, gray, wet, homogeneous. HCl not tested. Used 2-in I.D. oversize sampler to retain additional sample. Recovered: 0.7 ft Retained: 0.7 ft	
	PS-14	MC GS AL HT SG	SM, MC=35%, LL=NA, PL=NP Silty SAND, gray. HCl not tested. Recovered: 2.0 ft Retained: 2.0 ft	
2 1 2 (3)	D-15	MC GS AL HT SG	ML, MC=41%, LL=NA, PL=NP Sandy SILT, very loose, gray, wet, homogeneous. HCl not tested. Recovered: 1.4 ft Retained: 1.4 ft	
4	D-16	MC	SM, MC=35%, LL=NA, PL=NP	

WSDOT

LOG OF TEST BORING

Job No. XL-5661 SR 241 Elevation 679.6 ft HOLE No. H-9p-18

Sheet 3 of 7

Project SR-241 Mabton Vicinity - Retrofit Bridges Driller Henderson, Ted

Legend: SPT Efficiency; ◆ Field SPT (N); ✚ Moisture Content; RQD (scale 20, 40, 60, 80)

Depth (ft)	Elevation (ft)	Blows/6" (N) and/or RQD FF	Sample No. (Tube No.)	Lab Tests	Description of Material
		6 4 (10)		GS AL	Silty SAND, loose, gray, wet, homogeneous. HCl not tested. Recovered: 1.1 ft Retained: 1.1 ft
50	630	3 4 7 (11)	D-17		Silty SAND, medium dense, gray, wet, homogeneous. HCl not tested. Recovered: 1.5 ft Retained: 1.5 ft
55	625	3 6 6 (12)	D-18	MC GS AL	ML, MC=33%, LL=NA, PL=NP Sandy SILT, medium dense, gray, wet, stratified. HCl not tested. Recovered: 1.5 ft Retained: 1.5 ft NOTE: From 57.5 to 59.6 ft, drilling indicates coarse gravel.
60	620	29 21 20 (41)	D-19		Poorly graded SAND, sub-rounded, dense, gray, wet, homogeneous. HCl not tested. Recovered: 1.2 ft Retained: 1.2 ft
65	615	23 25 28 (53)	D-20		Poorly graded SAND, rounded, very dense, light gray, wet, homogeneous. HCl not tested. Recovered: 1.4 ft Retained: 1.4 ft
70	610	18	D-21		Poorly graded SAND, very dense, light brownish gray,

WSDOT

LOG OF TEST BORING

Job No. XL-5661 SR 241 Elevation 679.6 ft

HOLE No. H-9p-18

Project SR-241 Mabton Vicinity - Retrofit Bridges

Driller Henderson, Ted

Depth (ft)	Elevation (ft)	Field SPT (N) / Moisture Content	Blows/6" (N) and/or RQD FF	Sample No. (Tube No.)	Lab Tests	Description of Material
			29 35 (64)			wet, homogeneous. HCl not tested. Recovered: 1.2 ft Retained: 1.2 ft
75	605		5 5 7 (12)	D-22	MC GS AL	ML, MC=36%, PI=5 SILT, medium dense, light greenish gray, wet, homogeneous. HCl not tested. Recovered: 1.5 ft Retained: 1.5 ft
						NOTE: At 76.5 ft, drilling indicates change in material with increasing density.
80	600		19 24 25 (49)	D-23		Poorly graded SAND, dense, light brownish gray, wet, homogeneous. HCl not tested. Recovered: 1.3 ft Retained: 1.3 ft
85	595		18 20 13 (33)	D-24		Poorly graded SAND, dense, gray, wet, homogeneous. HCl not tested. Recovered: 1.4 ft Retained: 1.4 ft
90	590		6 7 14 (21)	D-25	MC GS AL HT SG	ML, MC=30%, LL=22, PL=NP SILT with sand, medium dense, light greenish gray, wet, stratified. HCl not tested. Recovered: 1.4 ft Retained: 1.4 ft
95	585		9	D-26		Sandy SILT, dense, light greenish gray, wet, stratified.

Legend: SPT Efficiency; Field SPT (N); Moisture Content; RQD. Scale: 20 40 60 80. Columns: Profile, Sample Type, Groundwater, Instrument.

Depth (ft)	Elevation (ft)	Blows/6" (N) and/or RQD FF	Sample No. (Tube No.)	Lab Tests	Description of Material
		13 16 (29)			HCl not tested. Recovered: 1.5 ft Retained: 1.5 ft
100	580	11 17 21 (38)	D-27		Silty SAND, dense, gray, wet, homogeneous. HCl not tested. Recovered: 1.2 ft Retained: 1.2 ft
					NOTE: At 102.0 ft, drilling indicates gravel.
105	575	26 40 40 (80)	D-28	MC GS	GW-GM, MC=14% Well graded GRAVEL with silt and sand, rounded, very dense, light gray, wet, homogeneous. HCl not tested. Recovered: 0.8 ft Retained: 0.8 ft
110	570	>> 50/1" (REF)	D-29		NOTE: From 109.5 to 114.5 ft, drilling indicates coarse gravel. Well graded GRAVEL with silt and sand, rounded, very dense, light gray, wet, homogeneous. HCl not tested. Recovered: 0.1 ft Retained: 0.1 ft
115	565	>> 50/2" (REF)	D-30		Well graded GRAVEL with silt and sand, sub-rounded, very dense, light gray, wet, homogeneous. HCl not tested. Recovered: 0.3 ft Retained: 0.3 ft
120	560	>> 100/2"	D-31		Well graded GRAVEL with silt and sand, sub-rounded,

WSDOT

LOG OF TEST BORING

Job No. XL-5661 SR 241 Elevation 679.6 ft

HOLE No. H-9p-18

Project SR-241 Mabton Vicinity - Retrofit Bridges

Driller Henderson, Ted

Legend: SPT Efficiency; Field SPT (N); Moisture Content; RQD (scale 20, 40, 60, 80)

Depth (ft)	Elevation (ft)	Blows/6" (N) and/or RQD FF	Sample No. (Tube No.)	Lab Tests	Description of Material
		(REF)			very dense, light brownish gray, wet, homogeneous. HCl not tested. Recovered: 0.2 ft Retained: 0.2 ft Sampler OD = 2.5 in, ID = 2 in
125	555	100/3" (REF)	D-32		Well graded GRAVEL with silt and sand, sub-angular, very dense, light brownish gray, wet, homogeneous. HCl not tested. Recovered: 0.3 ft Retained: 0.3 ft
130	550	50/3" (REF)	D-33		Well graded GRAVEL with silt and sand, sub-rounded, very dense, light brownish gray, wet, homogeneous. HCl not tested. Recovered: 0.3 ft Retained: 0.3 ft
135	545	50/3" (REF)	D-34		Well graded GRAVEL with silt and sand, rounded, very dense, light brownish gray, wet, homogeneous. HCl not tested. Recovered: 0.3 ft Retained: 0.3 ft
140	540	45 50/1" (REF)	D-35	MC GS	GP-GM, MC=15% Poorly graded GRAVEL with silt and sand, sub-rounded, very dense, light brown, wet, homogeneous. HCl not tested. Recovered: 0.6 ft Retained: 0.6 ft
145	535	50/3"	D-36		Silty SAND with gravel, sub-rounded, very dense, light

WSDOT

LOG OF TEST BORING

Job No. XL-5661 SR 241 Elevation 679.6 ft

HOLE No. H-9p-18

Project SR-241 Mabton Vicinity - Retrofit Bridges

Driller Henderson, Ted

Depth (ft)	Elevation (ft)	Profile	SPT Efficiency / Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
				(REF)				brown, wet, homogeneous. HCl not tested. Recovered: 0.3 ft Retained: 0.3 ft		
	530		>>	50/2" (REF)		D-37		Silty SAND with gravel, sub-angular, very dense, brown, wet, homogeneous. HCl not tested. Recovered: 0.2 ft Retained: 0.2 ft		
150										
155	525									
160	520									
165	515									
170	510									

A standpipe monument was installed on this boring.

The implied accuracy of the borehole location information displayed on this boring log is typically sub-meter in (X,Y) when collected by the HQ Geotech Office and sub-centimeter in (X,Y,Z) when collected by the Region Survey Crew.

End of test hole boring at 149.7 ft below ground surface.
This is a summary Log of Test Boring.
Soil/Rock descriptions are derived from visual field identifications and laboratory test data.
Note: REF = SPT Refusal

Bail/Recharge test: Test was not conducted due to heaving sands.

Water Levels at the Time of and After Drilling:
11-9-2018: 3.0 ft
11-10-2018: 27.5 ft
11-11-2018: 27.5 ft

Job No. **XL-5661** Date **January 25, 2019**

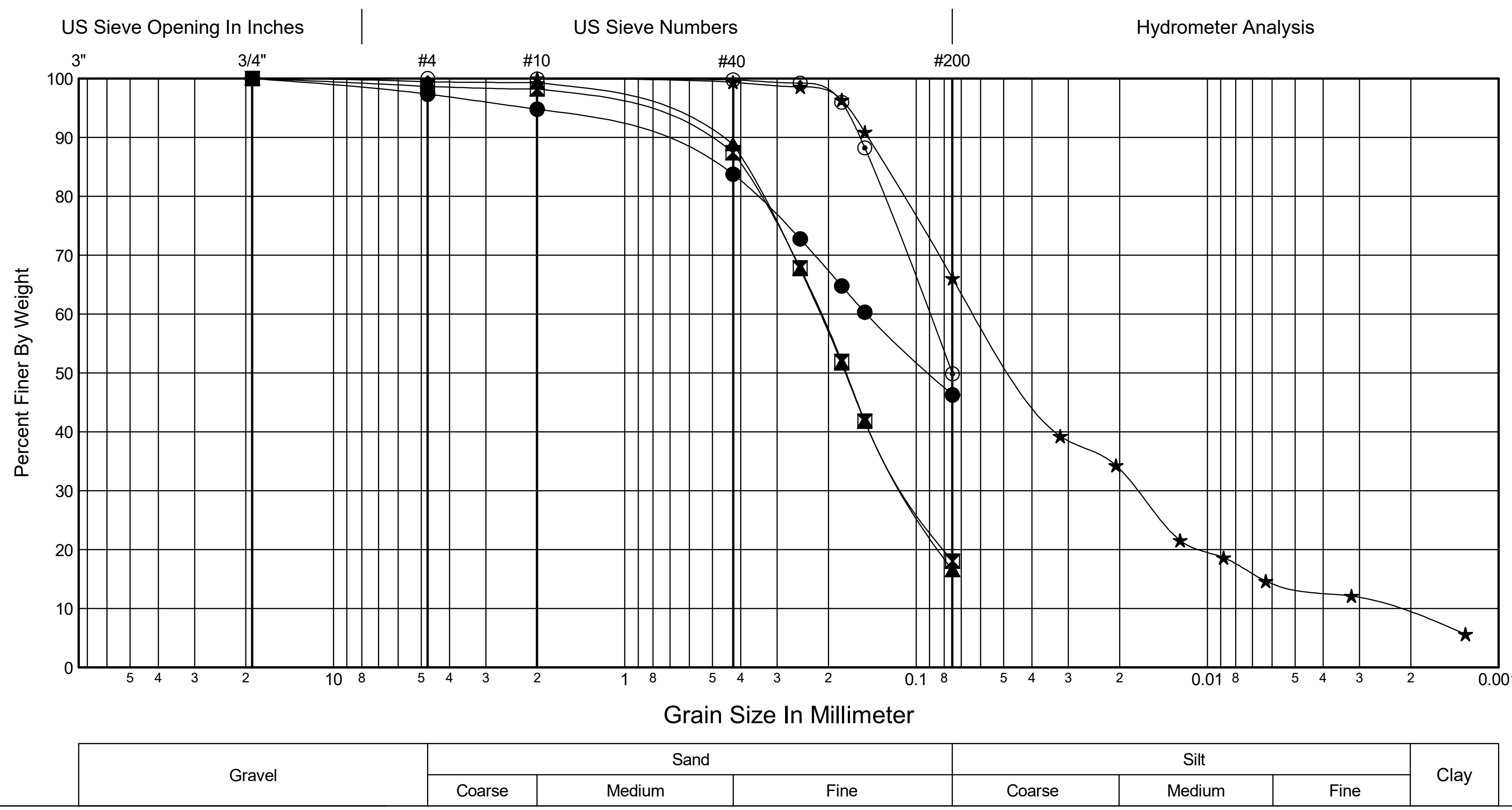
Hole No. **H-1p-18** Sheet **1**

Project **SR-241 Mabton Vicinity - Retrofit Bridges**

Laboratory Summary

WSDOT

	Depth (ft)	Sample No.	USCS	Description	MC%	LL	PL	PI	Moist Density (lbs/ft³)	Specific Gravity	Gravel (%)	Sand (%)	Fines (%)	Cc	Cu	D60	D50	D30	D20	D10
●	5.5	D-2	SM	SILTY SAND	16	NA	NP	NA			2.6	51.1	46.3			0.148	0.09			
⧗	15.5	D-6	SM	SILTY SAND	17	NA	NP	NA			1.3	80.6	18.1			0.213	0.17	0.11	0.08	
▲	23.5	D-9	SM	SILTY SAND	23	NA	NP	NA			0.6	83.0	16.5			0.214	0.17	0.11	0.08	
★	25.6	D-11	ML	SANDY SILT	38	27	NP	NA		2.74	0.0	33.9	66.1	2.0	25.9	0.062	0.05	0.02	0.01	0.002
⊙	33.5	D-14	SM	SILTY SAND	39	25	NP	NA			0.0	50.1	49.9			0.090	0.08			



Job No. **XL-5661** Date **January 25, 2019**

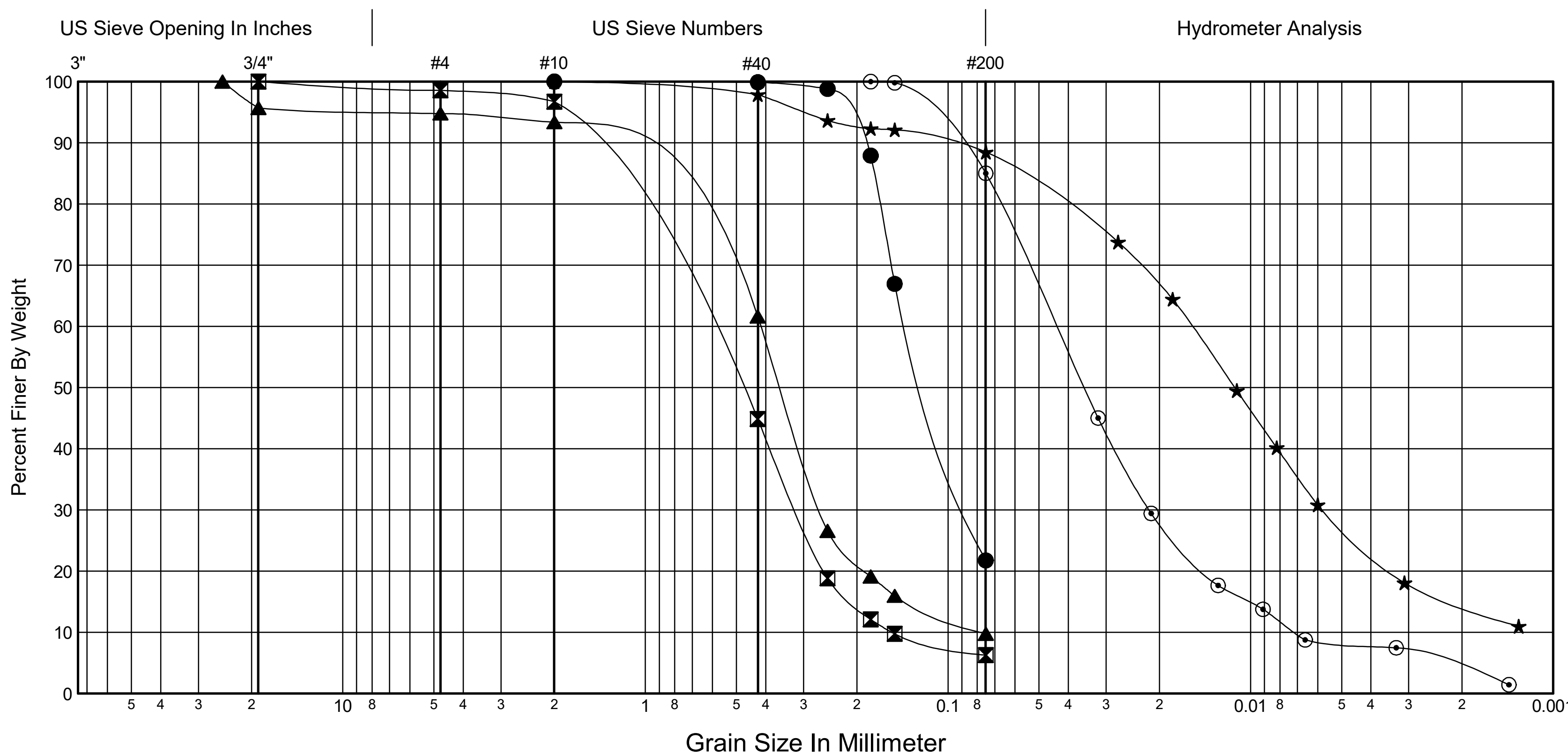
Hole No. **H-1p-18** Sheet **2**

Project **SR-241 Mabton Vicinity - Retrofit Bridges**

Laboratory Summary

WSDOT

	Depth (ft)	Sample No.	USCS	Description	MC%	LL	PL	PI	Moist Density (lbs/ft³)	Specific Gravity	Gravel (%)	Sand (%)	Fines (%)	Cc	Cu	D60	D50	D30	D20	D10
●	**35.5**	**D-15**	**SM**	**SILTY SAND**	**29**	**NA**	**NP**	**NA**			**0.0**	**78.3**	**21.7**			**0.135**	**0.12**	**0.09**		
⧗	**45.5**	**D-17**	**SP-SM**	**POORLY GRADED SAND with SILT**	**22**	**NA**	**NP**	**NA**			**1.4**	**92.3**	**6.3**	**1.0**	**4.4**	**0.668**	**0.50**	**0.31**	**0.26**	**0.153**
▲	**55.5**	**D-19**	**SP-SM**	**POORLY GRADED SAND with SILT**	**19**	**NA**	**NP**	**NA**			**5.2**	**85.0**	**9.7**	**2.2**	**5.4**	**0.415**	**0.36**	**0.26**	**0.19**	**0.077**
★	**65.5**	**D-21**	**ML**	**SILT**	**33**	**29**	**24**	**5**		**2.74**	**0.0**	**11.5**	**88.5**			**0.016**	**0.01**	**0.01**	**0.00**	
⊙	**67.5**	**PS-22**	**ML**	**SILT**	**29**	**26**	**NP**	**NA**	**125**	**2.72**	**0.0**	**15.0**	**85.0**	**1.5**	**6.1**	**0.044**	**0.04**	**0.02**	**0.01**	**0.007**



<table>
<tr><td rowspan="2">Gravel</td><td colspan="3">Sand</td><td colspan="3">Silt</td><td rowspan="2">Clay</td></tr>
<tr><td>Coarse</td><td>Medium</td><td>Fine</td><td>Coarse</td><td>Medium</td><td>Fine</td></tr>
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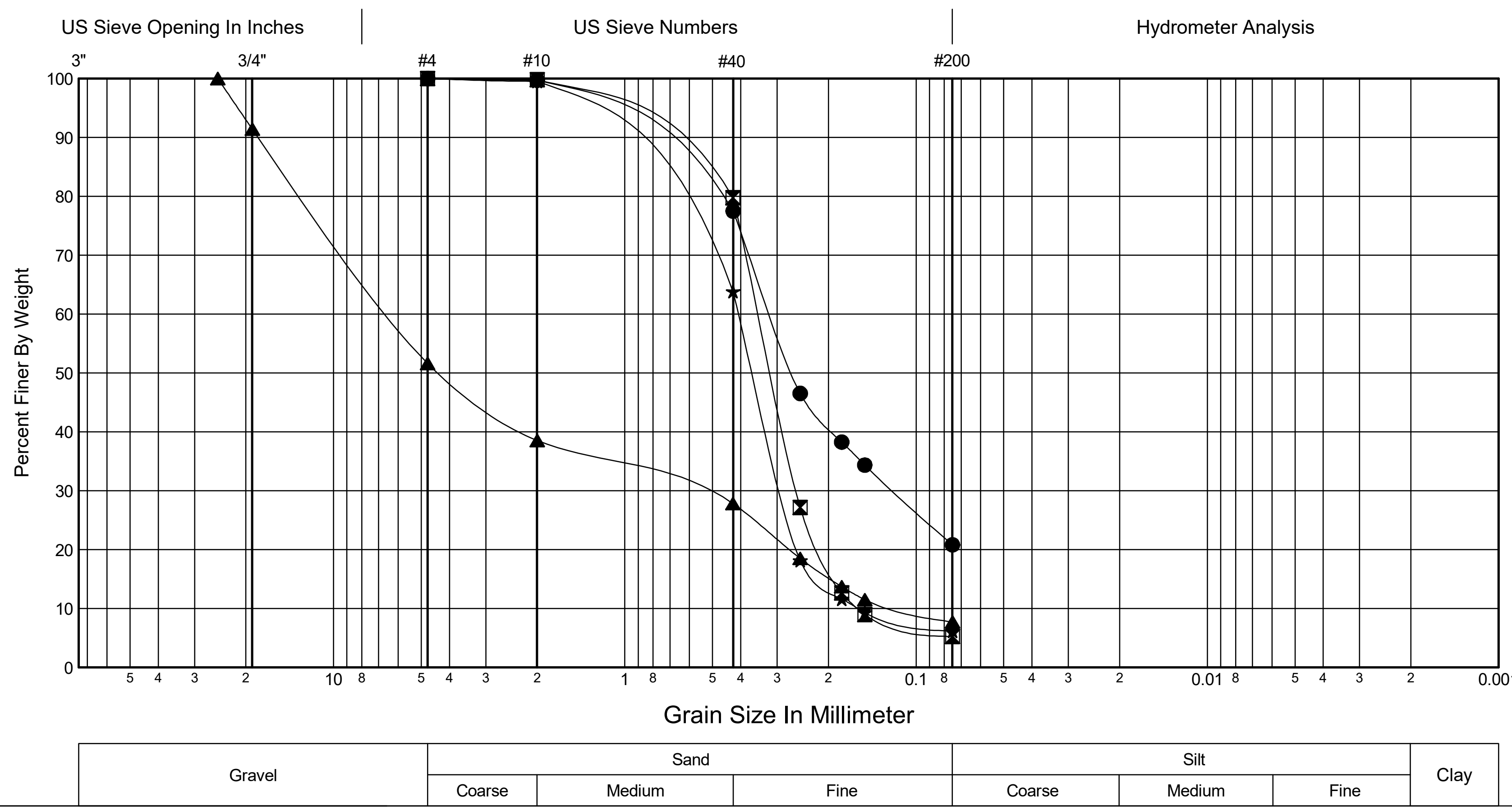
Job No.	XL-5661	Date	January 25, 2019
Hole No.	H-1p-18	Sheet	3
Project	SR-241 Mabton Vicinity - Retrofit Bridges		

Laboratory Summary

WSDOT

	Depth (ft)	Sample No.	USCS	Description	MC%	LL	PL	PI	Moist Density (lbs/ft³)	Specific Gravity	Gravel (%)	Sand (%)	Fines (%)	Cc	Cu	D60	D50	D30	D20	D10
●	69.0	D-23	SM	SILTY SAND	25	NA	NP	NA			0.0	79.2	20.8			0.315	0.27	0.12		
⧗	80.5	D-25	SP-SM	POORLY GRADED SAND with SILT	23	NA	NP	NA			0.0	94.7	5.3	1.2	2.2	0.348	0.31	0.26	0.21	0.158
▲	95.5	D-28	GP-GM	POORLY GRADED GRAVEL with SILT and SAND	10	NA	NP	NA			48.4	43.9	7.7	0.5	55.8	6.360	4.27	0.58	0.27	0.114
★	105.5	D-30	SP-SM	POORLY GRADED SAND with SILT	21	NA	NP	NA			0.0	93.8	6.2	1.3	2.6	0.406	0.36	0.29	0.26	0.159

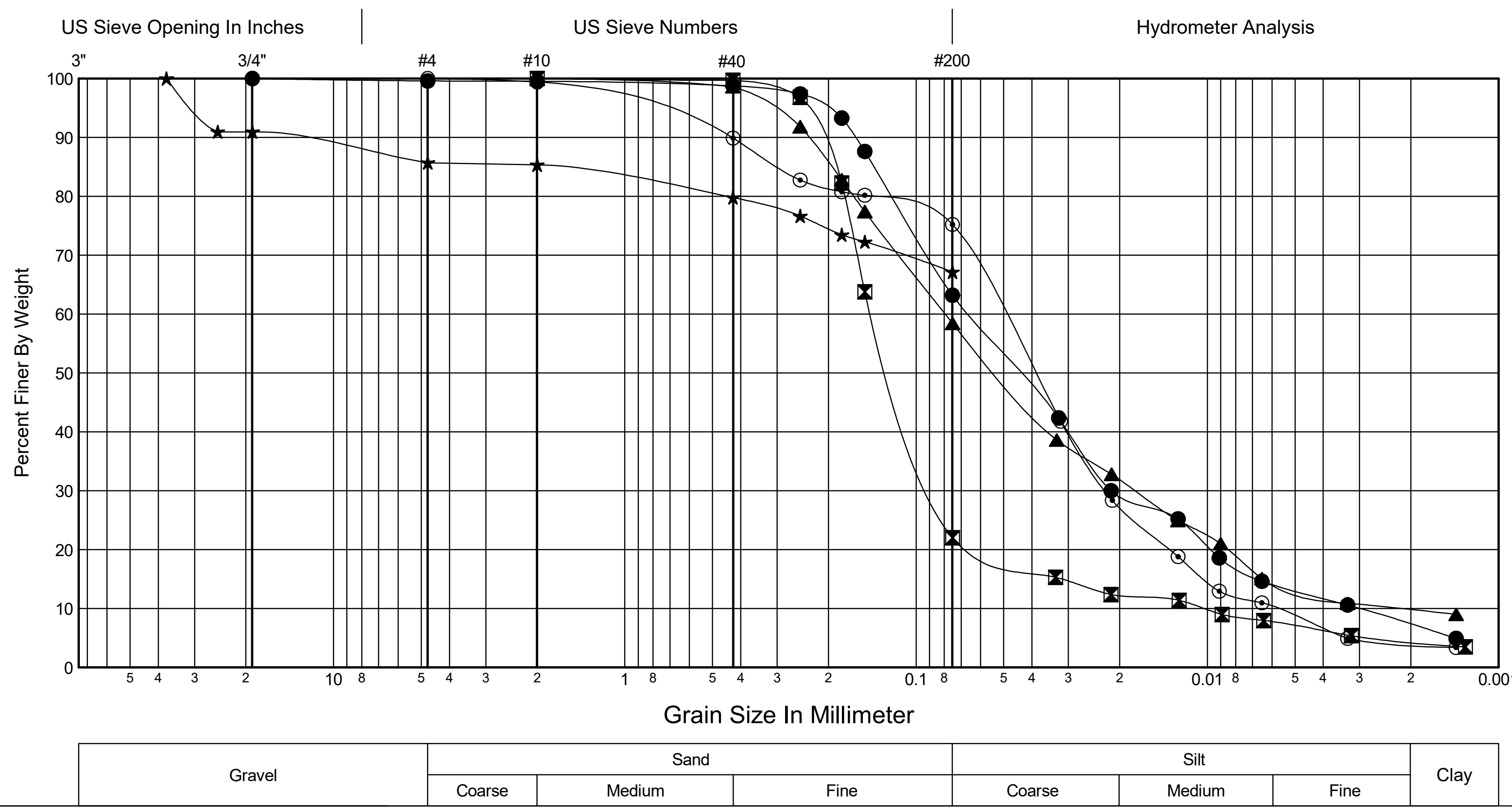


Job No.	XL-5661	Date	June 28, 2019
Hole No.	H-2-19	Sheet	1
Project	SR-241 Mabton Vicinity - Retrofit Bridges		

Laboratory Summary

WSDOT

	Depth (ft)	Sample No.	USCS	Description	MC%	LL	PL	PI	Moist Density (lbs/ft³)	Specific Gravity	Gravel (%)	Sand (%)	Fines (%)	Cc	Cu	D60	D50	D30	D20	D10
●	0.0	D-1	ML	SANDY SILT and organics	41	27	NP	NA		2.71	0.4	36.4	63.2	2.3	21.8	0.066	0.04	0.02	0.01	0.003
⧗	10.0	D-4	SM	SILTY SAND	33	NA	NP	NA		2.78	0.0	78.0	22.0	5.1	13.7	0.141	0.12	0.09	0.06	0.010
▲	18.0	D-7	ML	SANDY SILT	45	27	NP	NA		2.71	0.0	41.6	58.4	1.8	35.8	0.079	0.05	0.02	0.01	0.002
★	20.0	D-8	ML	SANDY SILT	48	27	NP	NA			14.3	18.5	67.2							
⊙	25.0	D-10	ML	SILT with SAND	25	23	NP	NA		2.78	0.0	24.8	75.2	1.7	8.7	0.051	0.04	0.02	0.01	0.006



Job No. **XL-5661** Date **June 28, 2019**

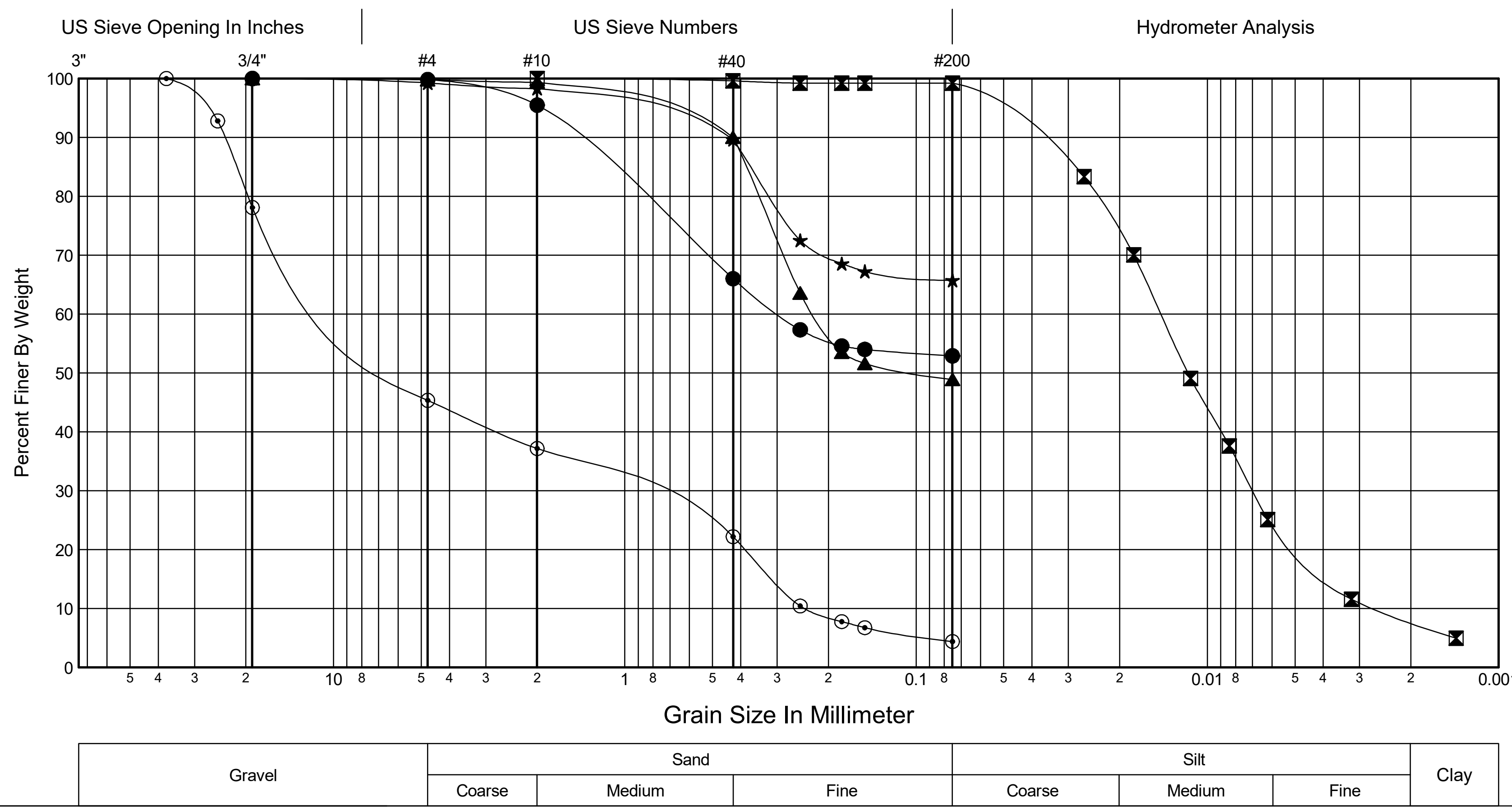
Hole No. **H-2-19** Sheet **2**

Project **SR-241 Mabton Vicinity - Retrofit Bridges**

Laboratory Summary

WSDOT

	Depth (ft)	Sample No.	USCS	Description	MC%	LL	PL	PI	Moist Density (lbs/ft³)	Specific Gravity	Gravel (%)	Sand (%)	Fines (%)	Cc	Cu	D60	D50	D30	D20	D10
●	30.0	D-12	ML	SANDY SILT	20	NA	NP	NA			0.2	46.9	52.9			0.294				
⧗	45.0	D-15	ML	SILT	34	33	27	6		2.76	0.0	0.8	99.2	1.3	5.5	0.014	0.01	0.01	0.00	0.003
▲	55.0	D-18	SM	SILTY SAND	22	NA	NP	NA			0.2	50.9	48.9			0.222	0.10			
★	60.0	D-19	ML	SANDY SILT	27	16	NP	NA			0.8	33.5	65.7							
⊙	85.0	D-24	GP	POORLY GRADED GRAVEL with SAND	10	NA	NP	NA			54.7	41.0	4.4	0.4	37.2	8.834	5.79	0.95	0.38	0.237



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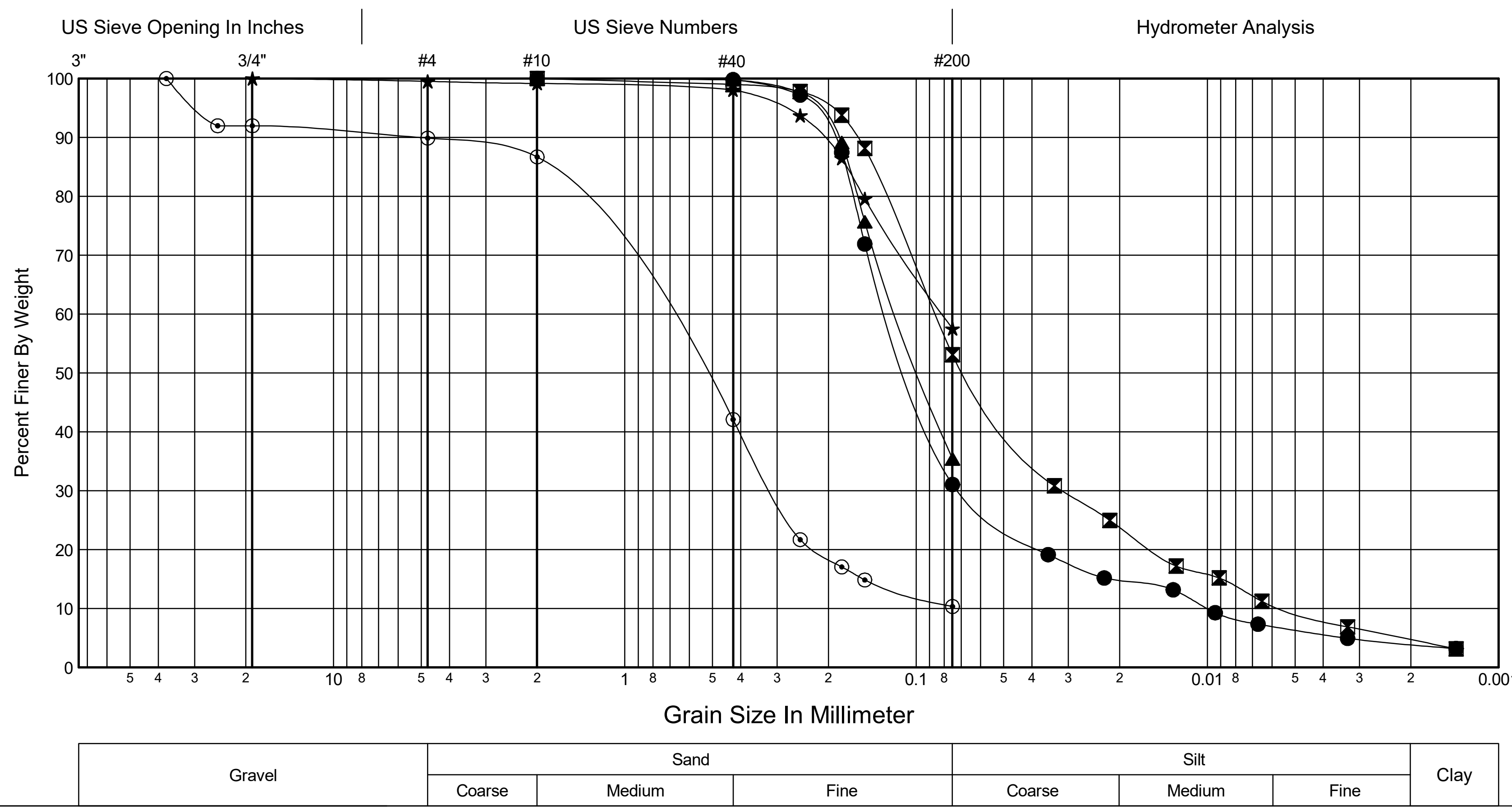
Job No.	XL-5661	Date	July 19, 2019
Hole No.	H-5-19	Sheet	1
Project	SR-241 Mabton Vicinity - Retrofit Bridges		

Laboratory Summary

WSDOT

	Depth (ft)	Sample No.	USCS	Description	MC%	LL	PL	PI	Moist Density (lbs/ft^3)	Specific Gravity	Gravel (%)	Sand (%)	Fines (%)	Cc	Cu	D60	D50	D30	D20	D10
●	6.0	D-3	SM	SILTY SAND	41	NA	NP	NA		2.71	0.0	69.0	31.0	4.0	12.3	0.123	0.10	0.07	0.04	0.010
⧗	14.0	D-6	ML	SANDY SILT	46	26	NP	NA		2.76	0.0	46.9	53.1	2.2	16.0	0.086	0.07	0.03	0.02	0.005
▲	19.0	D-8	SM	SILTY SAND	41	NA	NP	NA			0.0	64.6	35.4			0.115	0.10			
★	26.0	D-11	ML	SANDY SILT and organics	43	27	NP	NA			0.5	42.0	57.5			0.081				
⊙	31.0	D-13	SW-SM	WELL-GRADED SAND with SILT	20	NA	NP	NA			10.1	79.5	10.3	1.7	11.1	0.792	0.56	0.31	0.22	



XL-5661 241 MABTON VICINITY - RETROFIT BRIDGES.GPJ PUBLIC-COMMON LIBRARY.GLB 7/19/19

Job No. **XL-5661** Date **July 19, 2019**

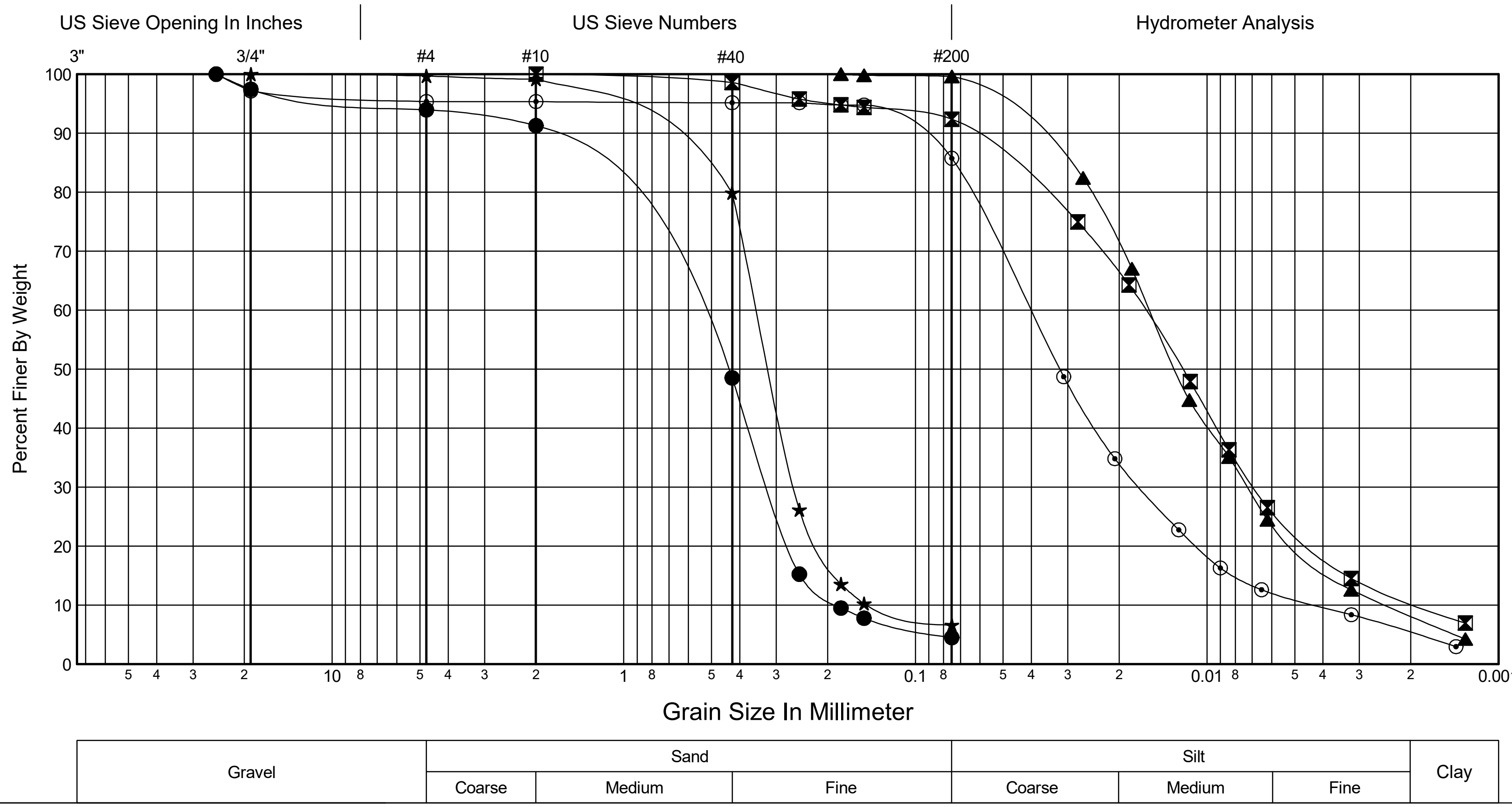
Hole No. **H-5-19** Sheet **2**

Project **SR-241 Mabton Vicinity - Retrofit Bridges**

Laboratory Summary

WSDOT

	Depth (ft)	Sample No.	USCS	Description	MC%	LL	PL	PI	Moist Density (lbs/ft^3)	Specific Gravity	Gravel (%)	Sand (%)	Fines (%)	Cc	Cu	D60	D50	D30	D20	D10
●	36.0	D-15	SP	POORLY GRADED SAND	21	NA	NP	NA			6.0	89.5	4.5	0.8	3.5	0.644	0.45	0.32	0.27	0.185
⧗	44.0	D-18	ML	SILT	33	32	24	8		2.78	0.0	7.6	92.4	1.6	8.7	0.016	0.01	0.01	0.00	0.002
▲	47.2	PS-19	ML	SILT	35	34	28	6	121	2.80	0.0	0.4	99.6	1.4	6.5	0.016	0.01	0.01	0.00	0.002
★	54.0	D-21	SP-SM	POORLY GRADED SAND with SILT	29	NA	NP	NA			0.3	93.1	6.6	1.4	2.4	0.349	0.32	0.26	0.21	0.143
⊙	69.0	D-24	ML	SILT	31	26	NP	NA		2.75	4.6	9.6	85.7	1.7	9.7	0.041	0.03	0.02	0.01	0.004



XL-5661 241 MABTON VICINITY - RETROFIT BRIDGES.GPJ PUBLIC-COMMON LIBRARY.GLB 7/19/19

Job No. **XL-5661** Date **July 19, 2019**

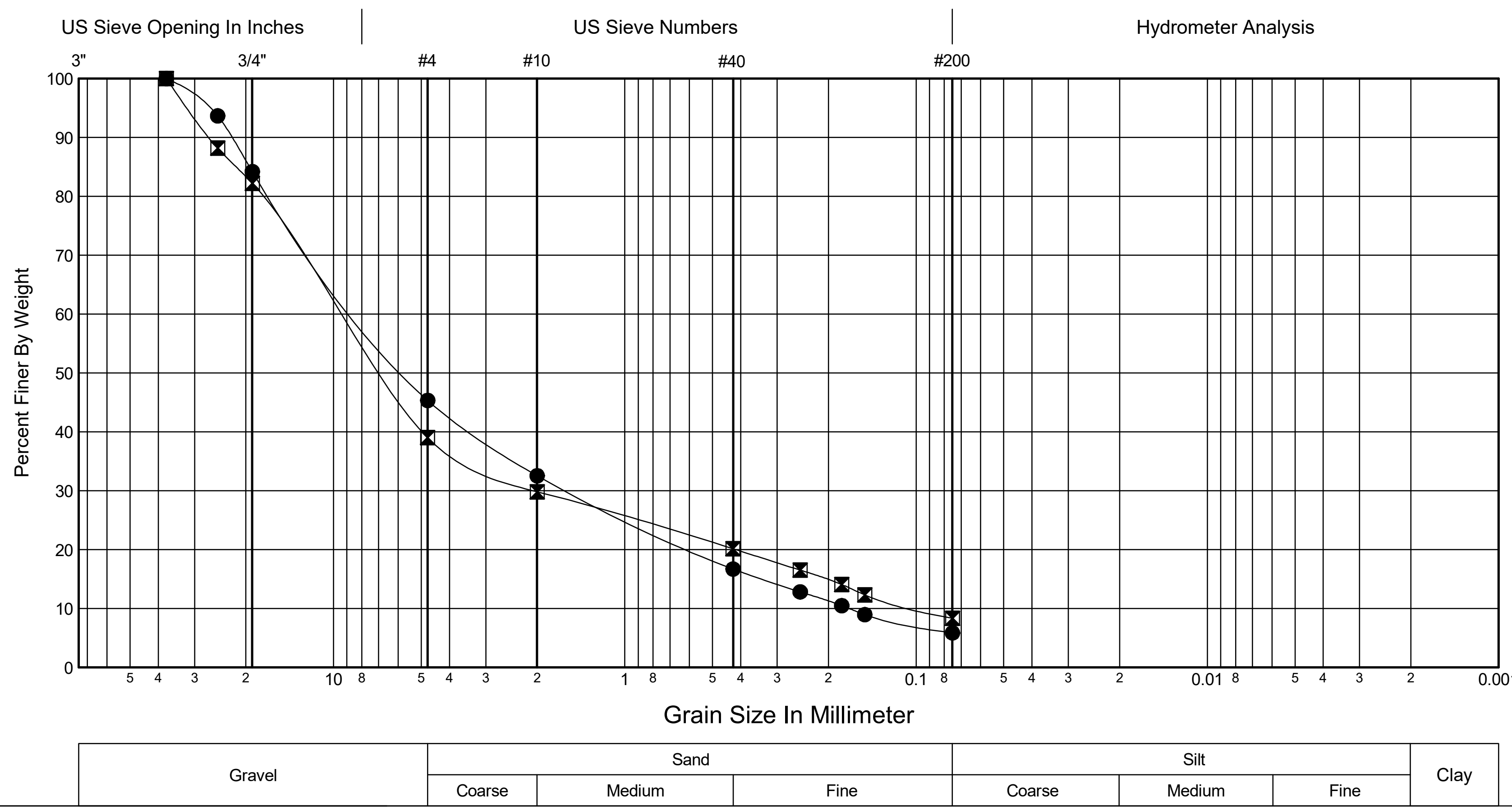
Hole No. **H-5-19** Sheet **3**

Project **SR-241 Mabton Vicinity - Retrofit Bridges**

Laboratory Summary

WSDOT

	Depth (ft)	Sample No.	USCS	Description	MC%	LL	PL	PI	Moist Density (lbs/ft^3)	Specific Gravity	Gravel (%)	Sand (%)	Fines (%)	Cc	Cu	D60	D50	D30	D20	D10
●	**74.0**	**D-25**	**GW-GM**	**WELL-GRADED GRAVEL with SILT and SAND**	**10**	**NA**	**NP**	**NA**			**54.7**	**39.5**	**5.9**	**1.8**	**47.2**	**8.017**	**5.61**	**1.56**	**0.59**	**0.170**
⧗	**114.0**	**D-33**	**GP-GM**	**POORLY GRADED GRAVEL with SILT and SAND**	**15**						**61.0**	**30.7**	**8.3**	**4.4**	**92.7**	**9.313**	**6.76**	**2.03**	**0.42**	**0.100**



Job No. **XL-5661** Date **July 12, 2019**

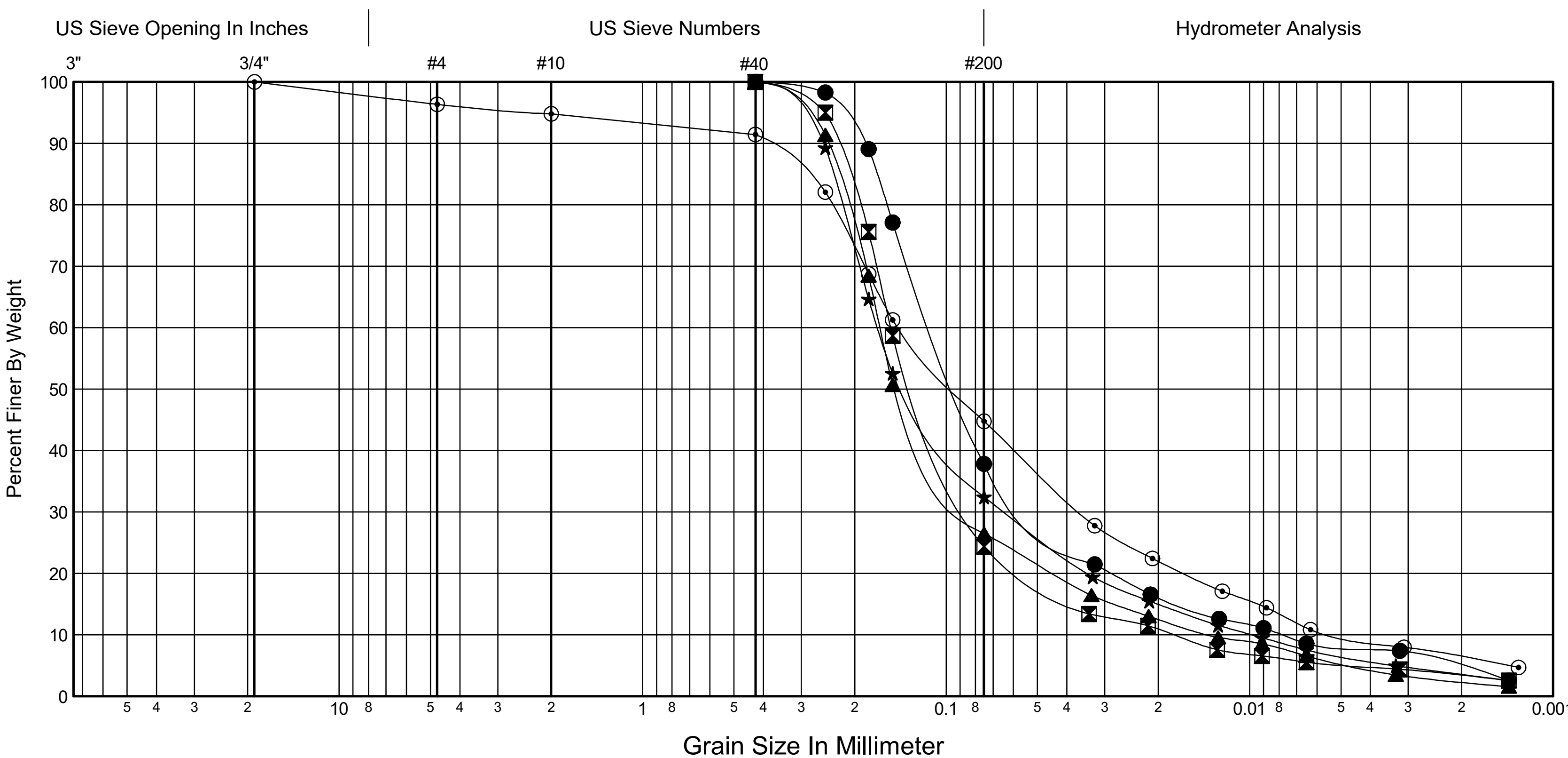
Hole No. **H-8-19** Sheet **1**

Project **SR-241 Mabton Vicinity - Retrofit Bridges**

Laboratory Summary

WSDOT

	Depth (ft)	Sample No.	USCS	Description	MC%	LL	PL	PI	Moist Density (lbs/ft^3)	Specific Gravity	Gravel (%)	Sand (%)	Fines (%)	Cc	Cu	D60	D50	D30	D20	D10
●	6.0	D-2	SM	SILTY SAND	44	NA	NP	NA		2.72	0.0	62.2	37.8	2.9	14.2	0.111	0.09	0.05	0.03	0.008
⧗	11.0	D-4	SM	SILTY SAND	39	NA	NP	NA		2.77	0.0	75.7	24.3	2.6	8.6	0.152	0.13	0.08	0.05	0.018
▲	21.0	D-8	SM	SILTY SAND	39	NA	NP	NA		2.75	0.0	73.5	26.5	3.1	12.2	0.165	0.15	0.08	0.04	0.014
★	26.0	D-10	SM	SILTY SAND	37	NA	NP	NA		2.71	0.0	67.5	32.5	2.5	17.1	0.168	0.14	0.06	0.03	0.010
⊙	29.0	D-11	SM	SILTY SAND	32	22	NP	NA		2.88	3.6	51.6	44.8	1.8	27.8	0.142	0.09	0.04	0.02	0.005



Gravel	Sand			Silt			Clay
	Coarse	Medium	Fine	Coarse	Medium	Fine	

Job No. **XL-5661** Date **July 12, 2019**

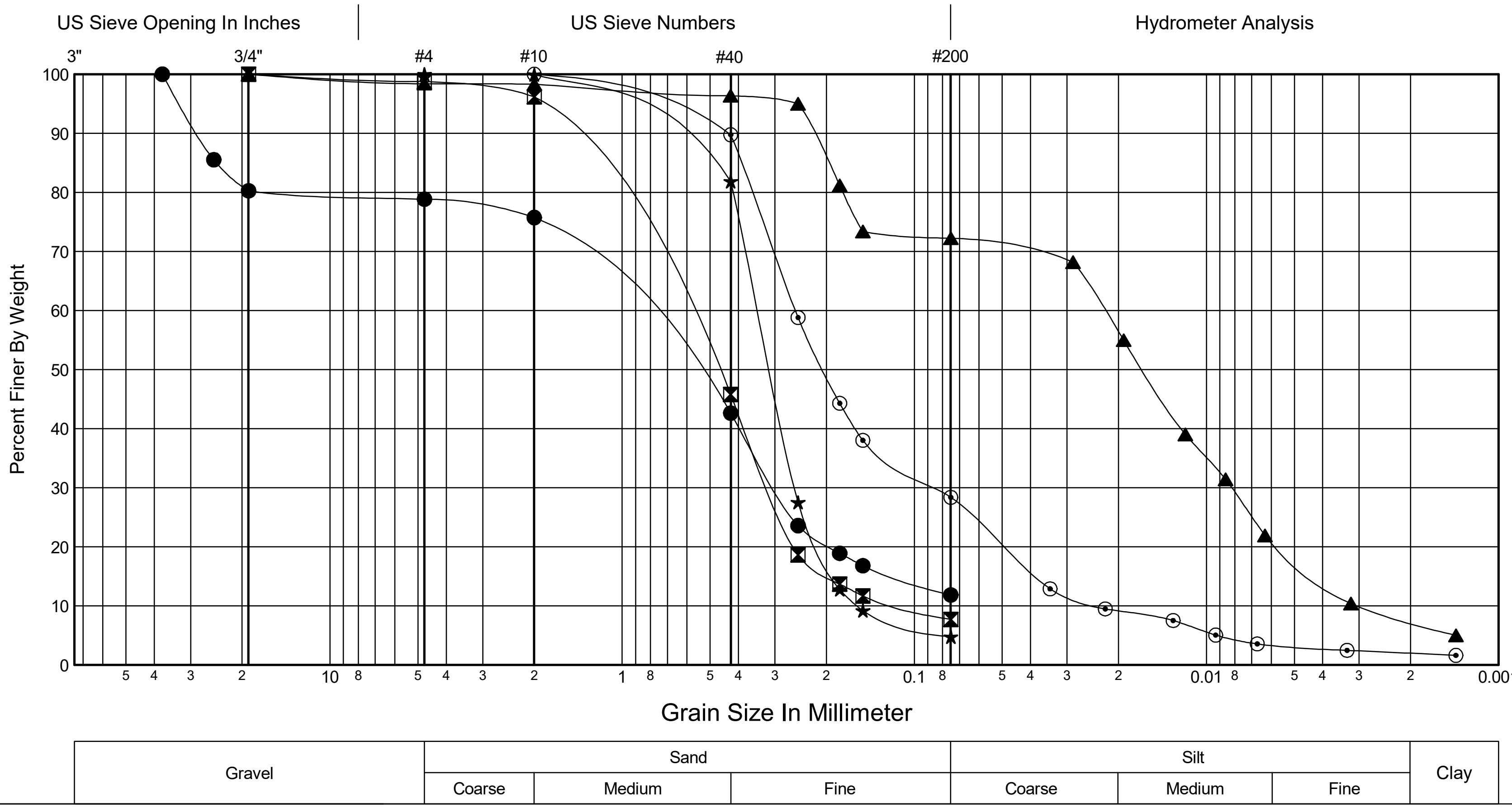
Hole No. **H-8-19** Sheet **2**

Project **SR-241 Mabton Vicinity - Retrofit Bridges**

Laboratory Summary

WSDOT

	Depth (ft)	Sample No.	USCS	Description	MC%	LL	PL	PI	Moist Density (lbs/ft^3)	Specific Gravity	Gravel (%)	Sand (%)	Fines (%)	Cc	Cu	D60	D50	D30	D20	D10
●	**31.0**	**D-12**	**SW-SM**	**WELL-GRADED SAND with SILT and GRAVEL**	**23**	**NA**	**NP**	**NA**			**21.2**	**67.0**	**11.8**	**1.6**	**16.5**	**0.958**	**0.60**	**0.30**	**0.19**	
⧗	**41.0**	**D-14**	**SP-SM**	**POORLY GRADED SAND with SILT**	**22**	**NA**	**NP**	**NA**			**1.2**	**91.0**	**7.7**	**1.3**	**5.9**	**0.658**	**0.48**	**0.31**	**0.26**	**0.112**
▲	**46.0**	**D-15**	**ML**	**SILT with SAND**	**34**	**29**	**24**	**5**		**2.76**	**1.6**	**26.2**	**72.2**	**1.0**	**7.4**	**0.022**	**0.02**	**0.01**	**0.01**	**0.003**
★	**56.0**	**D-18**	**SP**	**POORLY GRADED SAND**	**26**	**NA**	**NP**	**NA**			**0.0**	**95.2**	**4.8**	**1.2**	**2.2**	**0.343**	**0.31**	**0.26**	**0.21**	**0.156**
⊙	**61.0**	**D-19**	**SM**	**SILTY SAND**	**26**	**NA**	**NP**	**NA**		**2.74**	**0.0**	**71.6**	**28.4**	**1.2**	**10.8**	**0.255**	**0.20**	**0.08**	**0.05**	**0.024**



Job No. **XL-5661** Date **July 12, 2019**

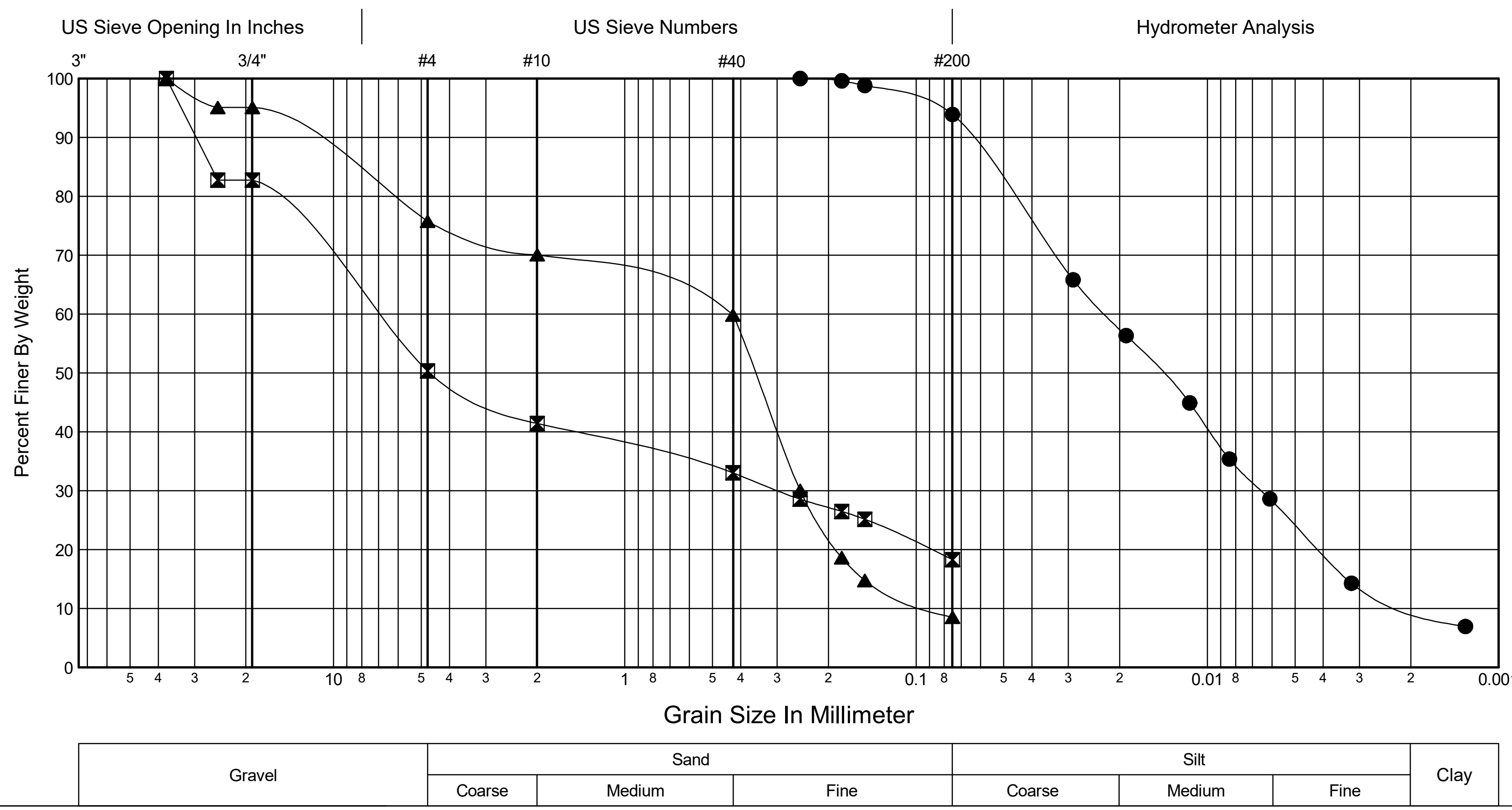
Hole No. **H-8-19** Sheet **3**

Project **SR-241 Mabton Vicinity - Retrofit Bridges**

Laboratory Summary

WSDOT

	Depth (ft)	Sample No.	USCS	Description	MC%	LL	PL	PI	Moist Density (lbs/ft^3)	Specific Gravity	Gravel (%)	Sand (%)	Fines (%)	Cc	Cu	D60	D50	D30	D20	D10
●	**66.0**	**D-20**	**ML**	**SILT**	**30**	**23**	**NP**	**NA**		**2.79**	**0.0**	**6.1**	**93.9**	**1.0**	**11.8**	**0.022**	**0.01**	**0.01**	**0.00**	**0.002**
⧗	**71.0**	**D-21**	**GM**	**SILTY GRAVEL with SAND**	**22**	**17**	**NP**	**NA**			**49.7**	**32.1**	**18.3**			**7.183**	**4.60**	**0.30**	**0.09**	
▲	**79.0**	**D-23**	**SP-SM**	**POORLY GRADED SAND with SILT and GRAVEL**	**20**	**NA**	**NP**	**NA**			**24.2**	**67.2**	**8.5**	**1.6**	**4.9**	**0.436**	**0.36**	**0.25**	**0.19**	**0.088**

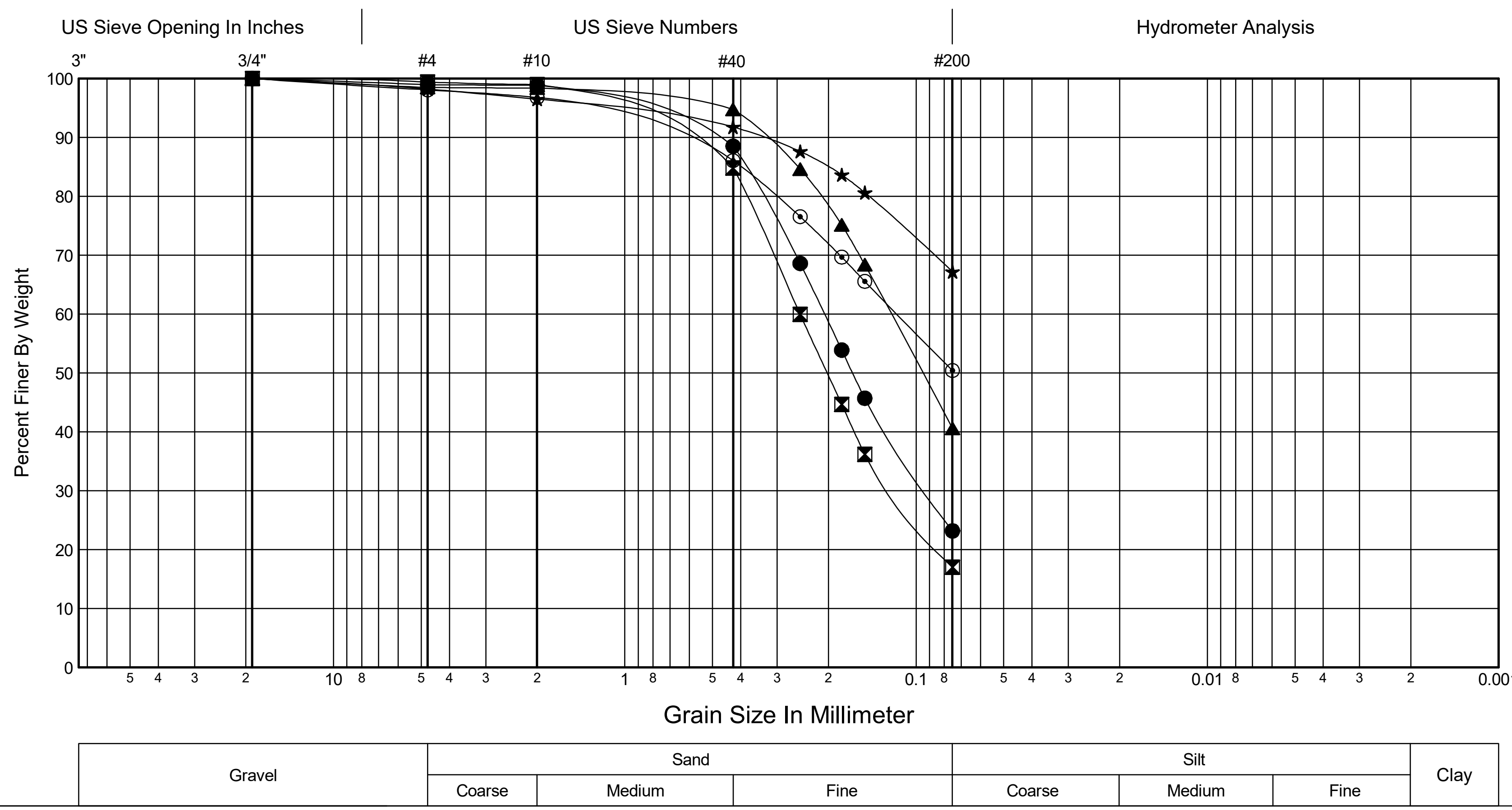


Job No.	XL-5661	Date	May 13, 2019
Hole No.	H-9p-18	Sheet	1
Project	SR-241 Mabton Vicinity - Retrofit Bridges		

Laboratory Summary

WSDOT

	Depth (ft)	Sample No.	USCS	Description	MC%	LL	PL	PI	Moist Density (lbs/ft^3)	Specific Gravity	Gravel (%)	Sand (%)	Fines (%)	Cc	Cu	D60	D50	D30	D20	D10
●	4.5	D-2	SM	SILTY SAND	8	NA	NP	NA			1.1	75.8	23.2			0.206	0.17	0.09		
⧗	12.5	D-5	SM	SILTY SAND	12	NA	NP	NA			0.6	82.4	17.0			0.250	0.20	0.12	0.08	
▲	17.5	D-7	SM	SILTY SAND	17	NA	NP	NA			1.5	57.9	40.6			0.122	0.09			
★	19.5	D-8	ML	SANDY SILT	22	NA	NP	NA			1.8	31.0	67.2							
⊙	22.5	D-9	ML	SANDY SILT	21	NA	NP	NA			1.9	47.7	50.4			0.116				



XL-5661 241 MABTON VICINITY - RETROFIT BRIDGES.GPJ PUBLIC-COMMON LIBRARY.GLB 5/13/19

Job No. **XL-5661** Date **May 13, 2019**

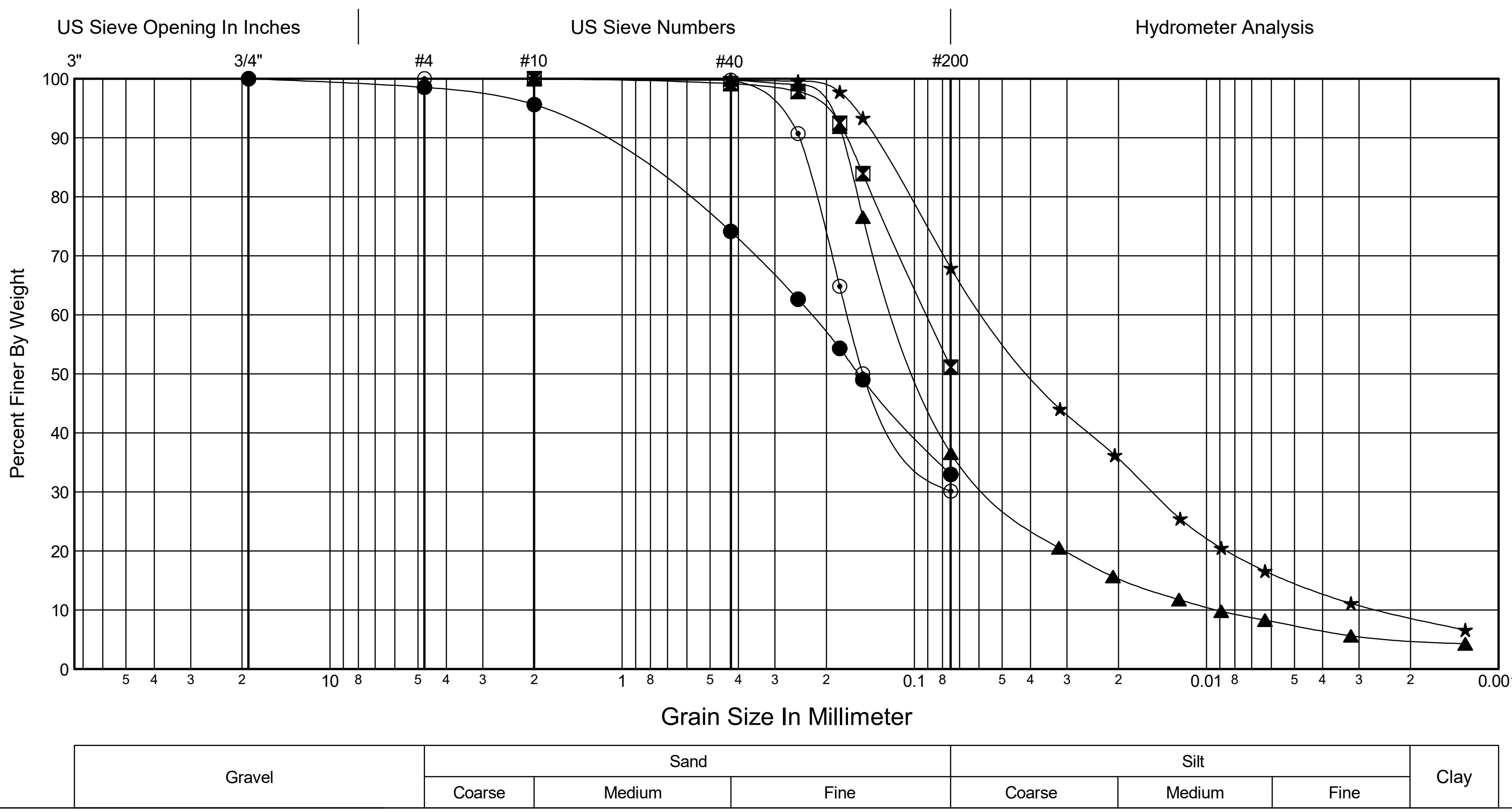
Hole No. **H-9p-18** Sheet **2**

Project **SR-241 Mabton Vicinity - Retrofit Bridges**

Laboratory Summary

WSDOT

	Depth (ft)	Sample No.	USCS	Description	MC%	LL	PL	PI	Moist Density (lbs/ft³)	Specific Gravity	Gravel (%)	Sand (%)	Fines (%)	Cc	Cu	D60	D50	D30	D20	D10
●	29.5	D-12	SM	SILTY SAND	21	NA	NP	NA			1.5	65.6	32.9			0.225	0.16			
⧗	34.5	D-13	ML	SANDY SILT	36	NA	NP	NA			0.0	48.9	51.1			0.090				
▲	36.5	PS-14	SM	SILTY SAND	35	NA	NP	NA	121	2.77	0.0	63.5	36.5	2.7	12.2	0.113	0.09	0.05	0.03	0.009
★	38.5	D-15	ML	SANDY SILT	41	NA	NP	NA		2.72	0.0	32.1	67.9	1.6	22.1	0.056	0.04	0.02	0.01	0.003
⊙	44.5	D-16	SM	SILTY SAND	35	NA	NP	NA			0.0	69.9	30.1			0.170	0.15			



Job No. **XL-5661** Date **May 13, 2019**

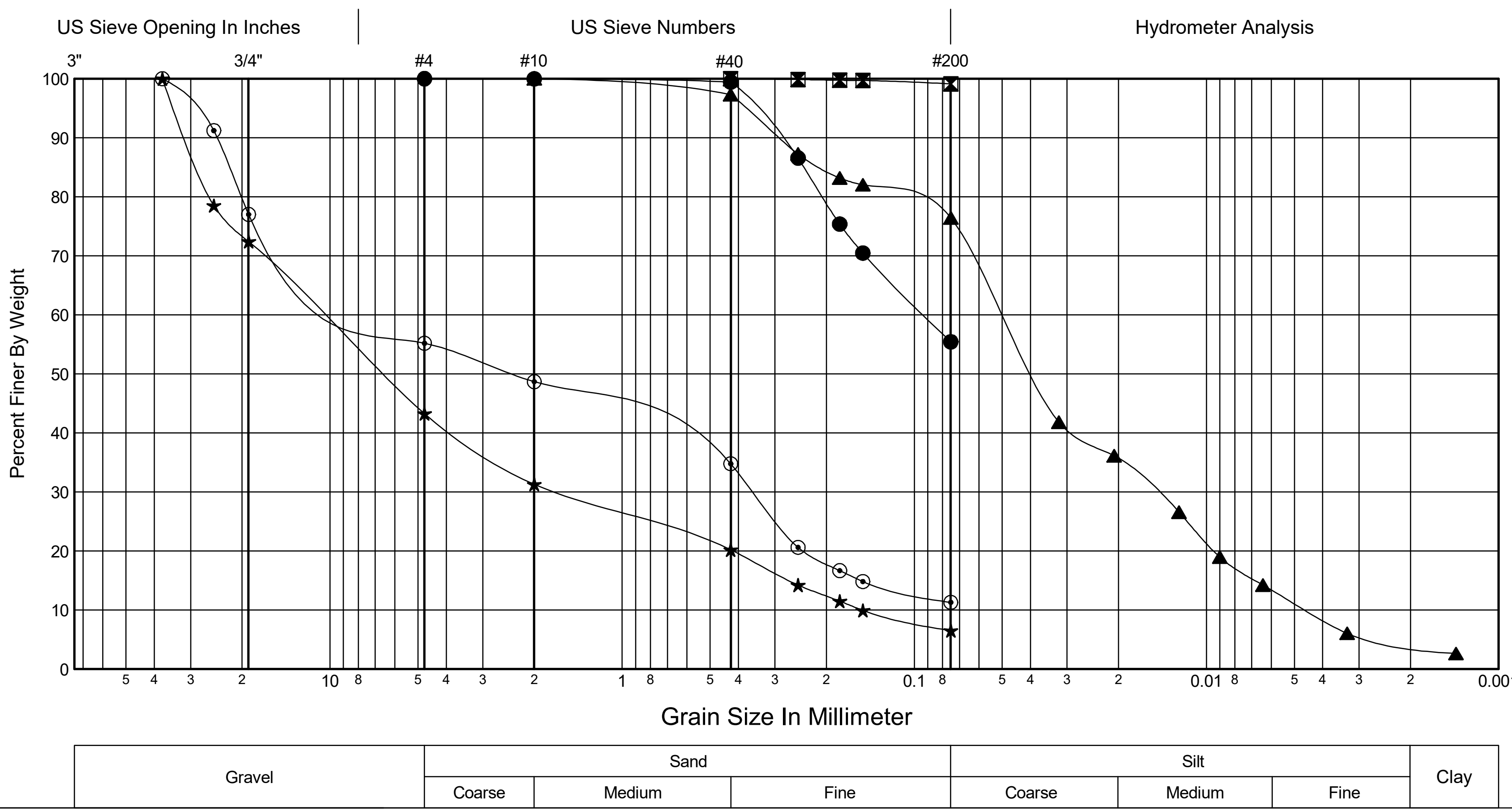
Hole No. **H-9p-18** Sheet **3**

Project **SR-241 Mabton Vicinity - Retrofit Bridges**

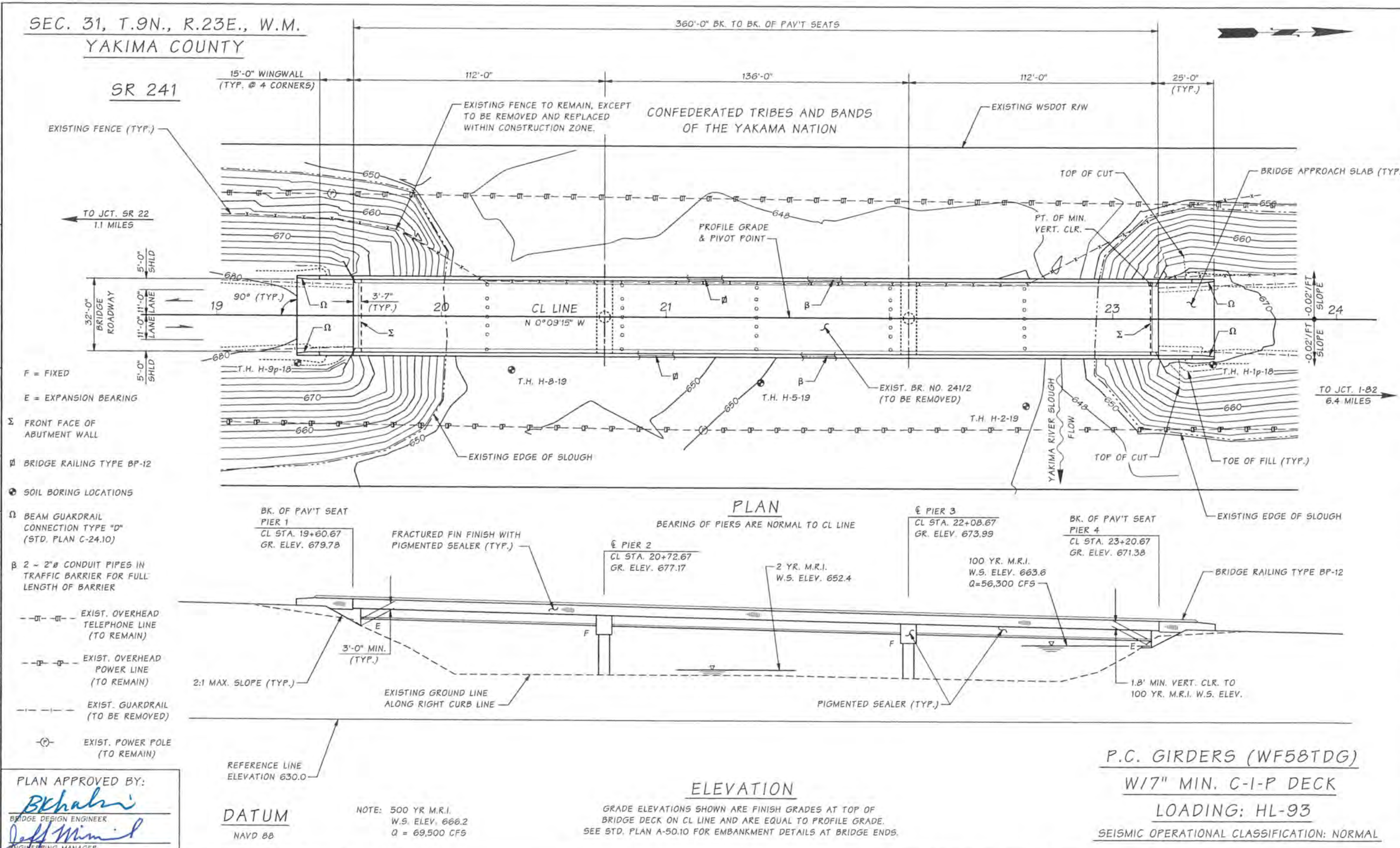
Laboratory Summary

WSDOT

	Depth (ft)	Sample No.	USCS	Description	MC%	LL	PL	PI	Moist Density (lbs/ft^3)	Specific Gravity	Gravel (%)	Sand (%)	Fines (%)	Cc	Cu	D60	D50	D30	D20	D10
●	54.5	D-18	ML	SANDY SILT	33	NA	NP	NA			0.0	44.6	55.4			0.093				
⧗	74.5	D-22	ML	SILT	36	34	29	5			0.0	0.9	99.1							
▲	89.5	D-25	ML	SILT with SAND	30	22	NP	NA		2.69	0.0	23.6	76.4	1.0	11.0	0.050	0.04	0.01	0.01	0.005
★	104.5	D-28	GW-GM	WELL-GRADED GRAVEL with SILT and SAND	14						56.7	36.8	6.5	1.8	69.6	10.525	6.54	1.67	0.42	0.151
⊙	139.5	D-35	GP-GM	POORLY GRADED GRAVEL with SILT and SAND	15						44.8	43.9	11.3	0.3	110.8	6.448	2.38	0.36	0.24	



Appendix F – Preliminary Layout of the Proposed 241/2 Structure



PT. OF MIN. VERT. CLR: CL STA. 23+17.1 (15.3' LT.)

USCG STRUCTURE CLASSIFICATION	DATE OF DETERMINATION BY 13TH COAST GUARD DISTRICT
NO USCG JURISDICTION	9-9-2019

DESIGN: APPROACH FILLS; WF58TDG P.C. GIRDERS WITH 7" MIN. C-I-P DECK; "A" DIMENSION = 1' (PRELIMINARY - NOT FOR DESIGN); DECK PROTECTIVE SYSTEM 1 (EPOXY COATED REBARS); CAST-IN-PLACE CONCRETE STRENGTH SHALL BE 4000 PSI

PLAN APPROVED BY:
BRIDGE DESIGN ENGINEER
ENGINEERING MANAGER

Bridge Design Engr.	BKhalegi 10/14/19		
Supervisor			
Designed By			
Checked By			
Detailed By	Waldron, G	9/19	
Bridge Proj. Unit Mgr.			
Prelim. Plan By	Bauer, M	9/19	
Architect/Specialist			

M:\PRELIMINARY PLANS\SR 241 MABTON BRIDGES\MABTON LAYOUT.MAN

DATE	REVISION	BY	APP'D

REGION NO.	STATE	FED. AID PROJ. NO.	SHEET NO.	TOTAL SHEETS
10	WASH.			
JOB NUMBER				

BRIDGE AND STRUCTURES OFFICE

BIJAN KHALEGHI STATE OF WASHINGTON PROFESSIONAL ENGINEER

PRELIMINARY
Washington State Department of Transportation
NOT FOR CONSTRUCTION

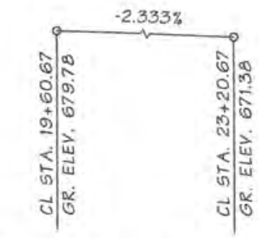
SR 241
MABTON VICINITY
RETROFIT BRIDGES
PRELIMINARY PLAN

BRIDGE SHEET NO. 1
SHEET OF SHEETS

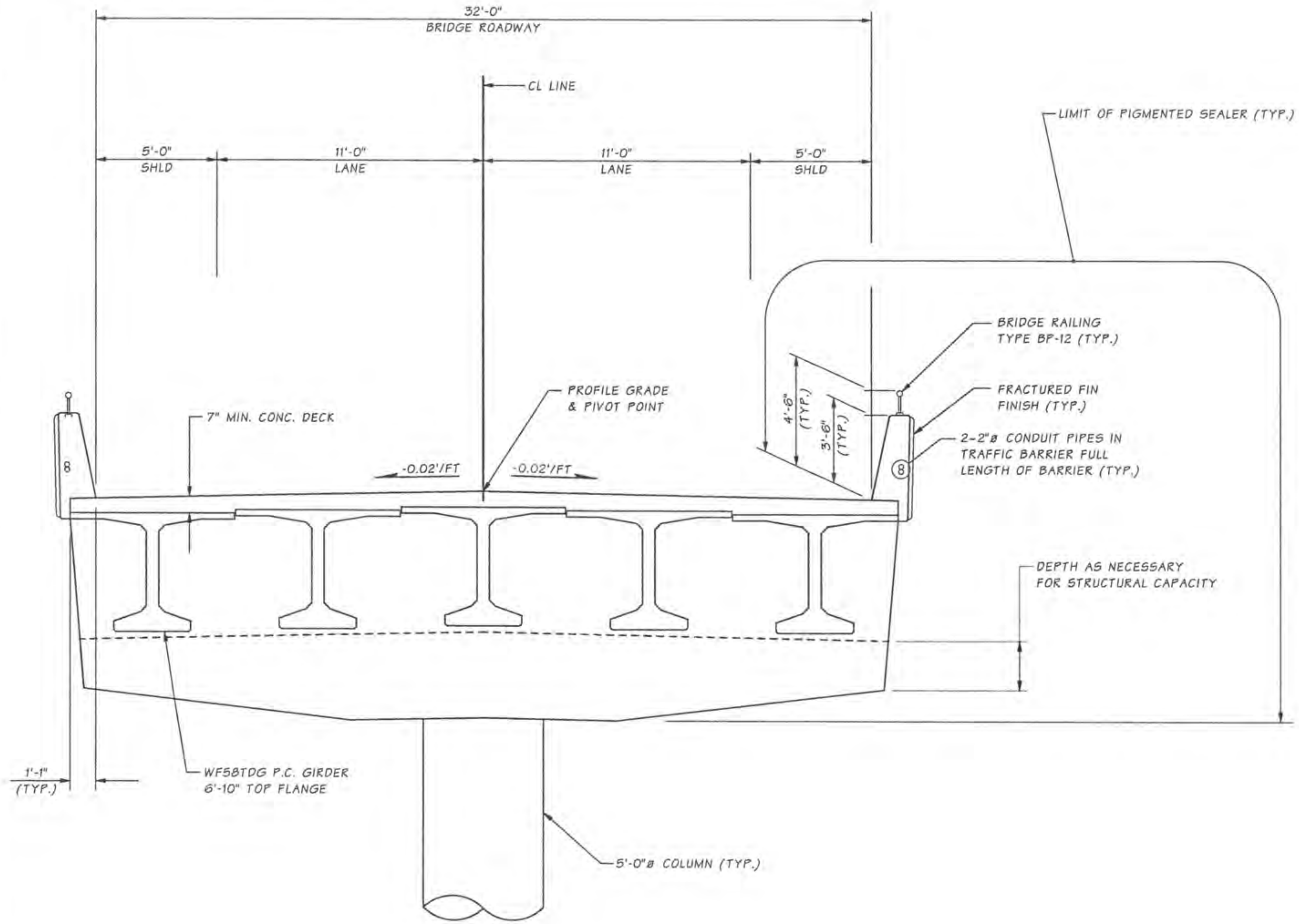
SR 241 SHEET 1 OF 2

Mon Oct 14 10:47:28 2019

C.S. 3938 ~ PROJ. NO. XL5661 ~ SOUTH CENTRAL REGION ~ SR 241 ~ MABTON VICINITY RETROFIT BRIDGES ~ YAKIMA RIVER SLOUGH BR. NO. 241/2 REPLACEMENT



CL LINE PROFILE



TYPICAL SECTION

SHOWN NEAR PIER 2
SUBSTRUCTURE DIMENSION IS APPROXIMATE

NOTES TO REGION

1. THE CL LINE PROFILE GRADE PROVIDED DOES NOT INCLUDE THE BRIDGE APPROACH SLAB LIMITS NOR ANY ROADWAY APPROACH. PLEASE PROVIDE A REVISED PROFILE EXTENDED SUFFICIENTLY TO INCLUDE THE BRIDGE APPROACH SLABS.
2. STRUCTURAL REVIEW OF THE BRIDGE DECK REQUIRED ADJUSTMENT OF THE THICKNESS, REDUCING MINIMUM VERTICAL CLEARANCE ABOVE 100 YEAR MRI WATER SURFACE TO 1.8 FEET. PLEASE CONFIRM IF THIS REVISED CLEARANCE IS ACCEPTABLE.

Bridge Design Engr.	BKhaleghi 10/14/19	M:\PRELIMINARY PLANS\SR 241 MABTON BRIDGES\MABTON TYP SEC.MAN			
Supervisor					
Designed By					
Checked By					
Detailed By	Waldron, G	9/19			
Bridge Proj. Unit Mgr.					
Prelim. Plan By	Bauer, MH	9/19			
Architect/Specialist		DATE	REVISION	BY	APP'D

REGION NO.	STATE	FED. AID PROJ. NO.	SHEET NO.	TOTAL SHEETS
10	WASH.			
JOB NUMBER				

Mon Oct 14 10:47:28 2019

BRIDGE AND STRUCTURES OFFICE

BIJAN KHALEGHI — STATE OF WASHINGTON — 27690 — PROFESSIONAL ENGINEER — STRUCTURAL ENGINEER

PRELIMINARY

Washington State Department of Transportation

NOT FOR CONSTRUCTION

SR 241
MABTON VICINITY
RETROFIT BRIDGES

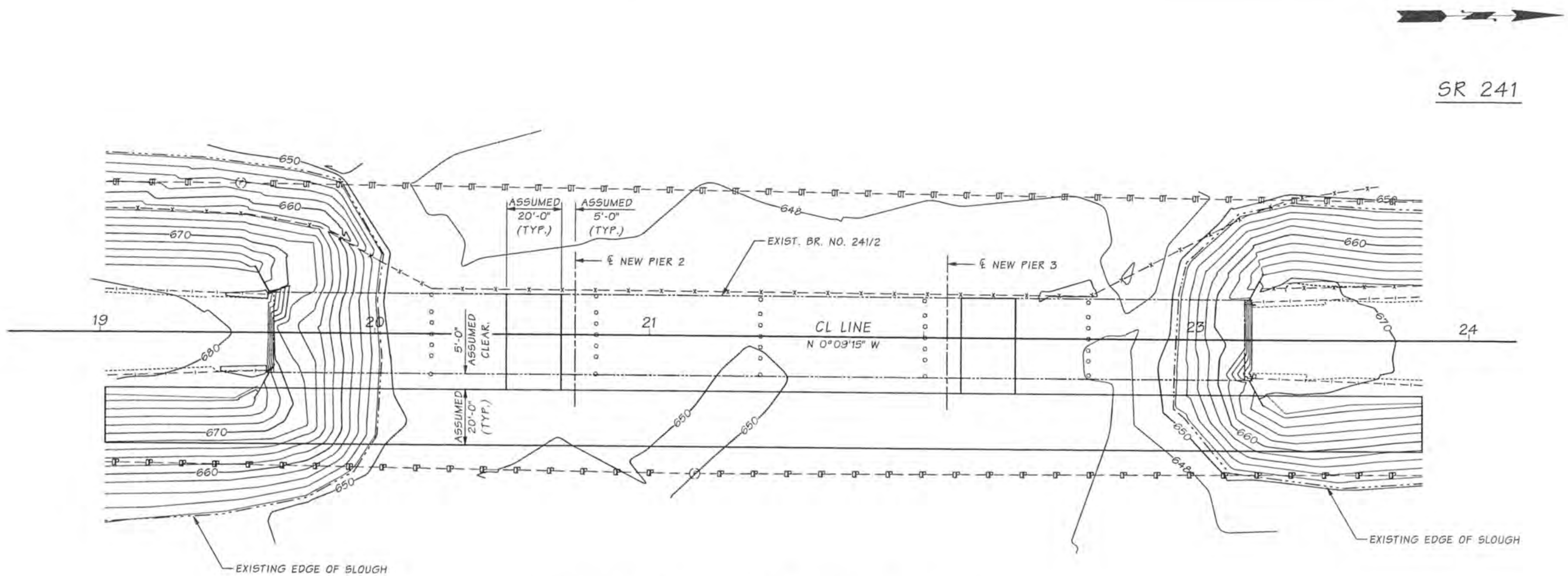
PRELIMINARY PLAN

BRIDGE SHEET NO. 2

SHEET OF SHEETS

SR 241 SHEET 2 OF 3

C.S. 3938 ~ PROJ. NO. XL5661 ~ SOUTH CENTRAL REGION ~ SR 241 ~ MABTON VICINITY RETROFIT BRIDGES ~ YAKIMA RIVER SLOUGH BR. NO. 241/2 REPLACEMENT



CONCEPTUAL WORK ACCESS PLAN

Bridge Design Engr.	BKhalaghi 10/14/19		
Supervisor			
Designed By			
Checked By			
Detailed By	Waldron, G	9/19	
Bridge Proj. Unit Mgr.			
Prelim. Plan By	Bauer, M	9/19	
Architect/Specialist			

M:\PRELIMINARY PLANS\SR 241 MABTON BRIDGES\MABTON WORK ACCESS PLAN.MAN

DATE	REVISION	BY	APP'D

REGION NO.	STATE	FED. AID PROJ. NO.	SHEET NO.	TOTAL SHEETS
10	WASH.			

JOB NUMBER

Mon Oct 14 10:47:28 2019

BRIDGE AND STRUCTURES OFFICE

BIJAN KHALEGHI — STATE OF WASHINGTON — 37595 — PROFESSIONAL ENGINEER

PRELIMINARY

Washington State Department of Transportation

NOT FOR CONSTRUCTION

SR 241
MABTON VICINITY
RETROFIT BRIDGES

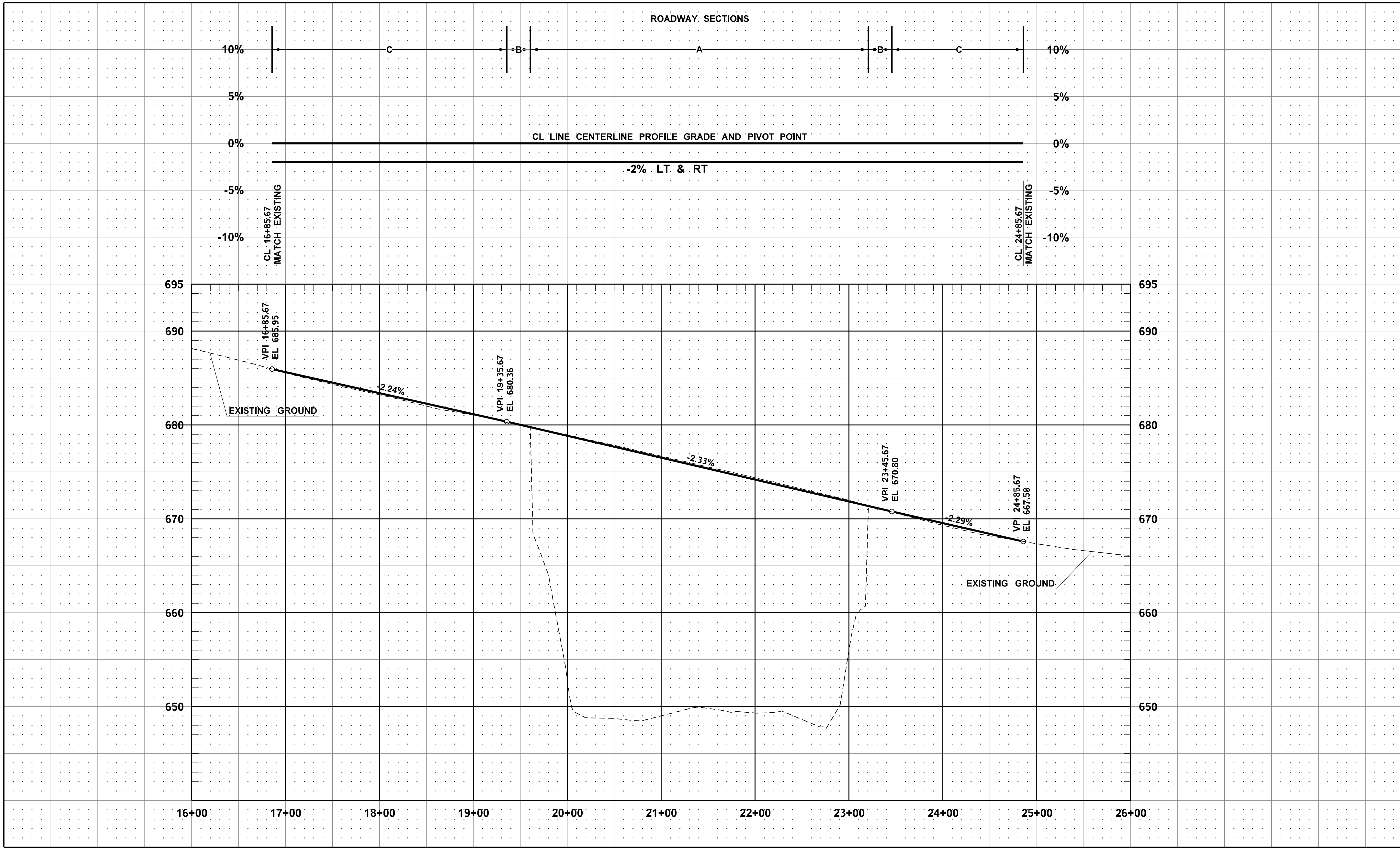
PRELIMINARY PLAN

BRIDGE SHEET NO. 3

SHEET OF SHEETS

SR 241 SHEET 1 OF 3

C.S. 3938 ~ PROJ. NO. XL5661 ~ SOUTH CENTRAL REGION ~ SR 241 ~ MABTON VICINITY RETROFIT BRIDGES ~ YAKIMA RIVER SLOUGH BR. NO. 241/2 REPLACEMENT



FILE NAME	K:\454306\Projects\XL5661 - SR 241 Mabton Vicinity - Retrofit Bridges\CAD_BaseFiles\Bridge\Bridge Site Data\Submittal\Sheet Files\Roadway Profile - Revision 1.dgn
TIME	7:22:38 AM
DATE	11/19/2019
PLOTTED BY	meltonm
DESIGNED BY	M. MELTON
ENTERED BY	M. MELTON
CHECKED BY	K. SABONG
PROJ. ENGR.	A. SANGUINO
REGIONAL ADM.	T. TREPANIER

REVISION	DATE	BY

REGION NO.	STATE	FED.AID PROJ.NO.
10	WASH	
JOB NUMBER		
CONTRACT NO.		LOCATION NO.

ALEJANDRO SANGUINO STATE OF WASHINGTON REGISTERED PROFESSIONAL ENGINEER

PRELIMINARY

DATE

P.E. STAMP BOX

DATE

P.E. STAMP BOX

Washington State Department of Transportation

SR 241
MABTON VICINITY - RETROFIT BRIDGES

ROADWAY PROFILE

Plot 1

PLAN REF. NO.

SHEET

OF

SHEETS

From:	Heilman, Julie
To:	Bauer, Mike
Cc:	Assink, Luke; Sabong, Khamouan; Melton, Mark; Adams, Michael H.; Sanguino, Alejandro; Aldrich, Brian; White, Brian; Sauriol, William
Subject:	Re: SR 241, Mabton Bridge No. 241/2 Replacement - Revisiting Bridge Clearance
Date:	Wednesday, December 18, 2019 7:48:27 PM

The freeboard that is available as shown on the preliminary bridge plans has HQ hydraulic Concurrence based on the region indicating there is low risk for debris flow in this location.

Thanks,
Julie Heilman

On Dec 18, 2019, at 4:07 PM, Bauer, Mike <BauerM@wsdot.wa.gov> wrote:

What is the status of reaching a decision on the waterway clearance issue?

Michael Bauer
Bridge Project Support Engineer
Bridge Special Provisions and Cost Estimates
WSDOT Bridge and Structures Office
Olympia, WA 98504-7340
(360) 705-7190

From: Bauer, Mike
Sent: Monday, October 14, 2019 3:44 PM
To: Heilman, Julie <HeilmaJ@WSDOT.WA.GOV>; Assink, Luke <AssinkL@wsdot.wa.gov>; Sabong, Khamouan (Owen) <SabongK@wsdot.wa.gov>; Melton, Mark <MeltonM@WSDOT.WA.GOV>; Adams, Michael H. <AdamsM@wsdot.wa.gov>; Sanguino, Alejandro <SanguiA@wsdot.wa.gov>
Cc: Aldrich, Brian <AldricB@wsdot.wa.gov>; White, Brian <WhiteB@wsdot.wa.gov>; Sauriol, William <SaurioW@wsdot.wa.gov>
Subject: RE: SR 241, Mabton Bridge No. 241/2 Replacement - Revisiting Bridge Clearance

The bridge preliminary plan for this bridge has just been sent to SCR for their official review and approval. The PEO and HQ Hydraulics were included in the distribution.

Of the two notes to Region left to be addressed by this review, agreement on the freeboard clearance to 100 year MRI water surface is one.

For background, the WF58TDG girder with 11-inch “A” dimension for 69-inch superstructure depth provides 3-feet or more of vertical clearance above 100 year MRI water surface for the length of the bridge except for the very northernmost 50-feet of span 3.

If flow and drift are such that 3-feet of vertical clearance is functionally required, then we will have to consider other structure alternatives.

Michael Bauer

Bridge Project Support Engineer
Bridge Special Provisions and Cost Estimates
WSDOT Bridge and Structures Office
Olympia, WA 98504-7340
(360) 705-7190

From: Heilman, Julie <HeilmaJ@wsdot.wa.gov>
Sent: Thursday, October 10, 2019 3:55 PM
Cc: Assink, Luke <AssinkL@wsdot.wa.gov>; Sabong, Khamouan (Owen) <SabongK@wsdot.wa.gov>; Melton, Mark <MeltonM@wsdot.wa.gov>; Sanguino, Alejandro <SanguiA@wsdot.wa.gov>; Adams, Michael H. <AdamsM@wsdot.wa.gov>; Bauer, Mike <BauerM@wsdot.wa.gov>; Aldrich, Brian <AldricB@wsdot.wa.gov>; White, Brian <WhiteB@wsdot.wa.gov>; Sauriol, William <SaurioW@wsdot.wa.gov>
Subject: Re: SR 241, Mabton Bridge No. 241/2 Replacement - Revisiting Bridge Clearance

I really need to get some input from the region maintenance office and the region special crews office. On how much if any debris issues or past work has happened on the existing structure.

Region management needs to also weigh in on how much risk they are willing to live with here.

Thanks,
Julie Heilman

> On Oct 10, 2019, at 3:41 PM, Bauer, Mike <BauerM@wsdot.wa.gov> wrote:
>
> Julie, Luke, Owen, and Mark,
>
> Internal review comments concerning structure design issues and bridge deck thicknesses and such have affected the overall bridge depth, and thus necessitate revisiting the vertical clearance issue.
>
> The structure configuration and depth, and the 2.3-feet of vertical clearance specified in September were all based on information currently specified in the Bridge Design Manual.
>
> Since the publication of the current BDM, geometric adjustments are in the works to address lessons learned from C9197 – a project using WF58TDG girders same as the Mabton project. C9197 showed that the five-inch cast-in-place deck previously specified was not sufficient to place the two layers of steel reinforcing mats desired for load continuity with proper concrete clearances.
>
> Implementing the lessons-learned improvements from C9197 results in a seven-inch deck with an 11-inch “A” dimension for the 58-inch girders in the configuration shown for Mabton. This reduces the available vertical

clearance to the 100-year MRI water surface from the previous 2.3-feet to 1.8-feet.

Use of the thin-deck prestressed concrete girders still offers a 1-1/2-inch structure depth dimension over a conventional WF58 girder with cast-in-place deck.

A change to WF50G girders would reduce the structure depth – gaining 8-inches for clearance, but would require a change to a four span configuration with three-intermediate piers – probably a more significant affect against zero-net-rise.

The three-span configuration with WF58TDG girders appears to remain the better choice given the desire to retain the existing SR 241 profile as-is – provided the 1.8-feet of clearance to the 100-year MRI water surface can be accepted.

Please advise if 1.8-feet of vertical clearance is acceptable, or if other alternatives need to be investigated.

Michael Bauer
Bridge Project Support Engineer
Bridge Special Provisions and Cost Estimates
WSDOT Bridge and Structures Office
Olympia, WA 98504-7340
(360) 705-7190

From: Heilman, Julie <HeilmaJ@wsdot.wa.gov>
Sent: Wednesday, October 2, 2019 2:35 PM
To: Melton, Mark <MeltonM@wsdot.wa.gov>
Cc: Bauer, Mike <BauerM@wsdot.wa.gov>; Assink, Luke <AssinkL@wsdot.wa.gov>; Sanguino, Alejandro <SanguiA@wsdot.wa.gov>; Adams, Michael H. <AdamsM@wsdot.wa.gov>; Sabong, Khamouan (Owen) <SabongK@wsdot.wa.gov>; Aldrich, Brian <AldricB@wsdot.wa.gov>
Subject: Re: SR 241, Mabton Bridge No. 241/2 Replacement - Bridge Configuration and Clearance Alternatives

Yes 2.3 feet of free board for this project will be sufficient from a hydraulics perspective. We will include our justification in the final hydraulics design report.

Thanks,
Julie Heilman

On Oct 2, 2019, at 1:50 PM, Melton, Mark <MeltonM@wsdot.wa.gov> wrote:

Hi Julie,

One of the items we discussed during the Mabton Bridge replacement coordination meeting on Monday was whether the freeboard in the preliminary bridge plans is sufficient. The preliminary bridge plans that Mike Bauer sent out (attached) currently show 2.3' of freeboard. Since this is less than 3' my understanding is that we need HQ hydraulic approval. Will 2.3' be sufficient for this bridge?

Thanks,

Mark Melton, PE
<image001.gif>
Transportation Engineer 2
WSDOT Richland PE Office
1655 Fowler St / Richland WA 99352
Phone: 509-222-2415 * Cell: 206-681-8326
Email: MeltonM@wsdot.wa.gov

From: Melton, Mark
Sent: Tuesday, September 17, 2019 10:25 AM
To: Bauer, Mike <BauerM@wsdot.wa.gov>; Sabong, Khamouan (Owen) <SabongK@wsdot.wa.gov>; Assink, Luke <AssinkL@wsdot.wa.gov>; Heilman, Julie <HeilmaJ@WSDOT.WA.GOV>; Casey Kramer <CKramer@nhcweb.com>
Cc: Sanguino, Alejandro <SanguiA@wsdot.wa.gov>; Adams, Michael H. <AdamsM@wsdot.wa.gov>
Subject: RE: SR 241, Mabton Bridge No. 241/2 Replacement - Bridge Configuration and Clearance Alternatives

Hi Mike,

Thanks for the configuration options. Do you think that there would be a big cost difference between the two options?

Since we are not able to make any changes to the existing roadway profile I see this mostly as a question for the hydraulics office and whatever clearance they feel is adequate. For this reason I have added Julie and Casey to the email chain.

One last thought I want to bring up is are we no longer considering a two span option? From our last meeting I felt like we all agreed that a two span bridge likely was not an option, based on the 100–year WSE and not being able to change the

existing profile, but should we still consider the best case two span bridge as one of our options?

Thanks,

Mark

From: Bauer, Mike <BauerM@wsdot.wa.gov>
Sent: Monday, September 16, 2019 3:12 PM
To: Sabong, Khamouan (Owen) <SabongK@wsdot.wa.gov>; Melton, Mark <MeltonM@wsdot.wa.gov>; Assink, Luke <AssinkL@wsdot.wa.gov>
Subject: SR 241, Mabton Bridge No. 241/2 Replacement - Bridge Configuration and Clearance Alternatives

Owen, Mark, and Luke,

Thanks for the Structure Site Data for Bridge No. 241/2. Glenn and I have started work on the Bridge Preliminary Plan.

I have two 3-span bridge configurations - both for 360-feet overall – for you to consider:

<!--[if !supportLists]-->• <!--[endif]-->112-136-112 using WF58DTG girders to provide 2.0-feet of vertical clearance above 100-year MRI flow at Elevation 663.6.

<!--[if !supportLists]-->• <!--[endif]-->120-120-120 using WF50DTG girders to provide 2.6-feet of vertical clearance above 100-year MRI flow at Elevation 663.6

Are both configurations acceptable…or only one…or neither one?

Michael Bauer
Bridge Project Support Engineer
Bridge Special Provisions and Cost Estimates
WSDOT Bridge and Structures Office
Olympia, WA 98504-7340
(360) 705-7190

<MABTON PROJECT.pdf>

Appendix G – Existing Conditions SRH-2D Model Results

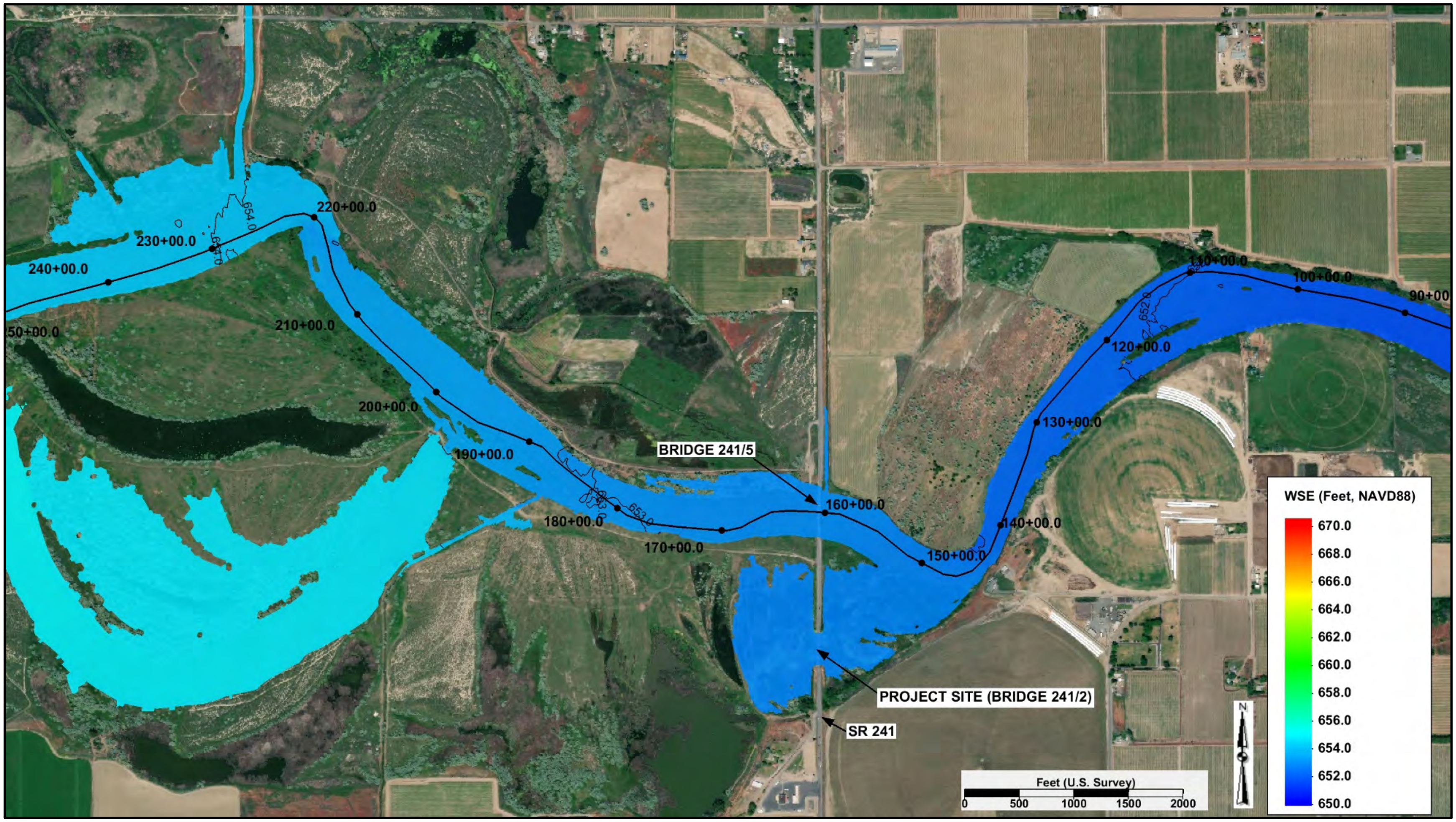


Figure G-1. Existing Conditions 2-Year Water Surface Elevation (WSE) Near the SR 241/2 Yakima River Crossing

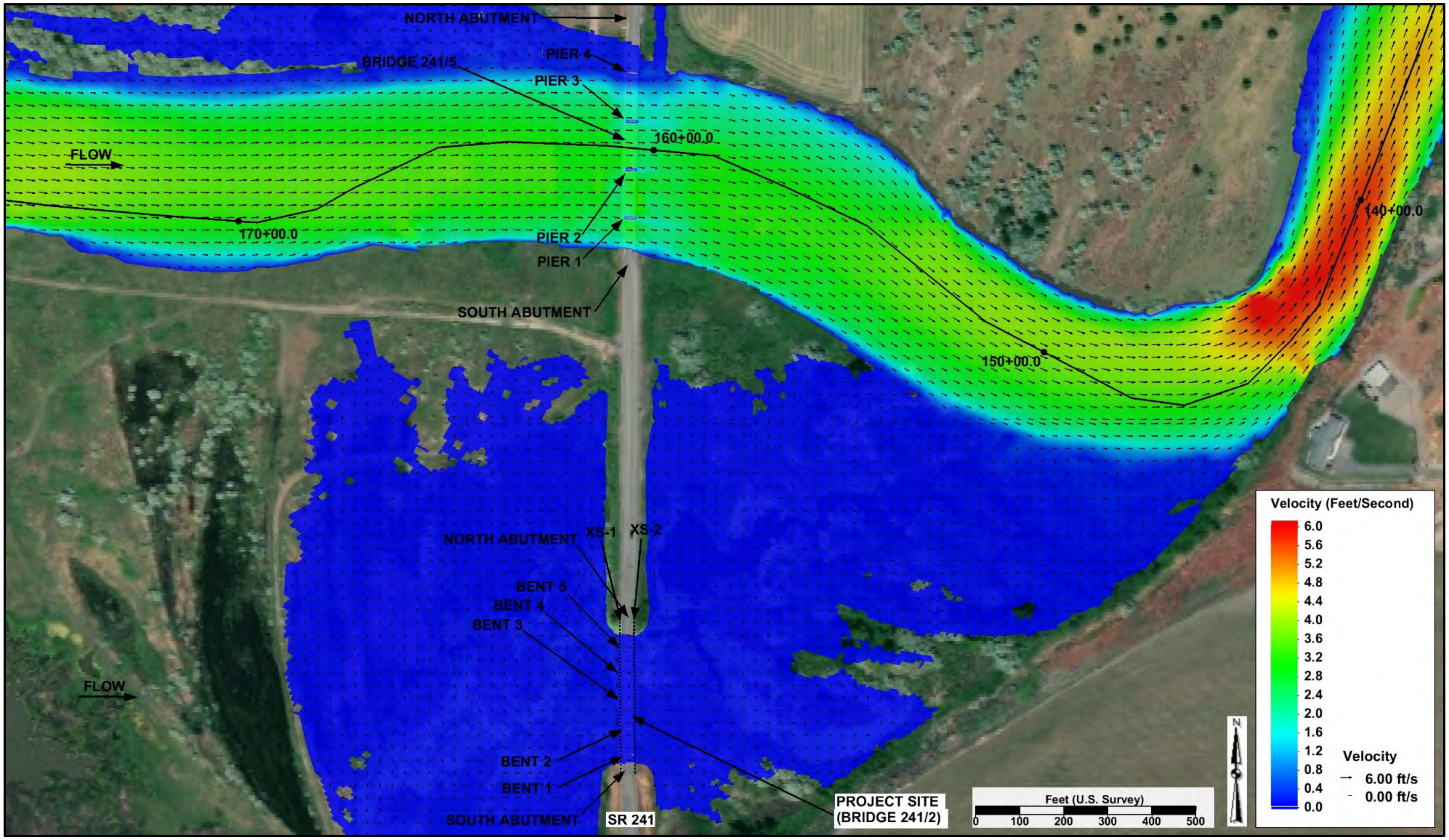


Figure G-2. Existing Conditions 2-Year Velocity Near the Existing SR 241/2 Yakima River Crossing

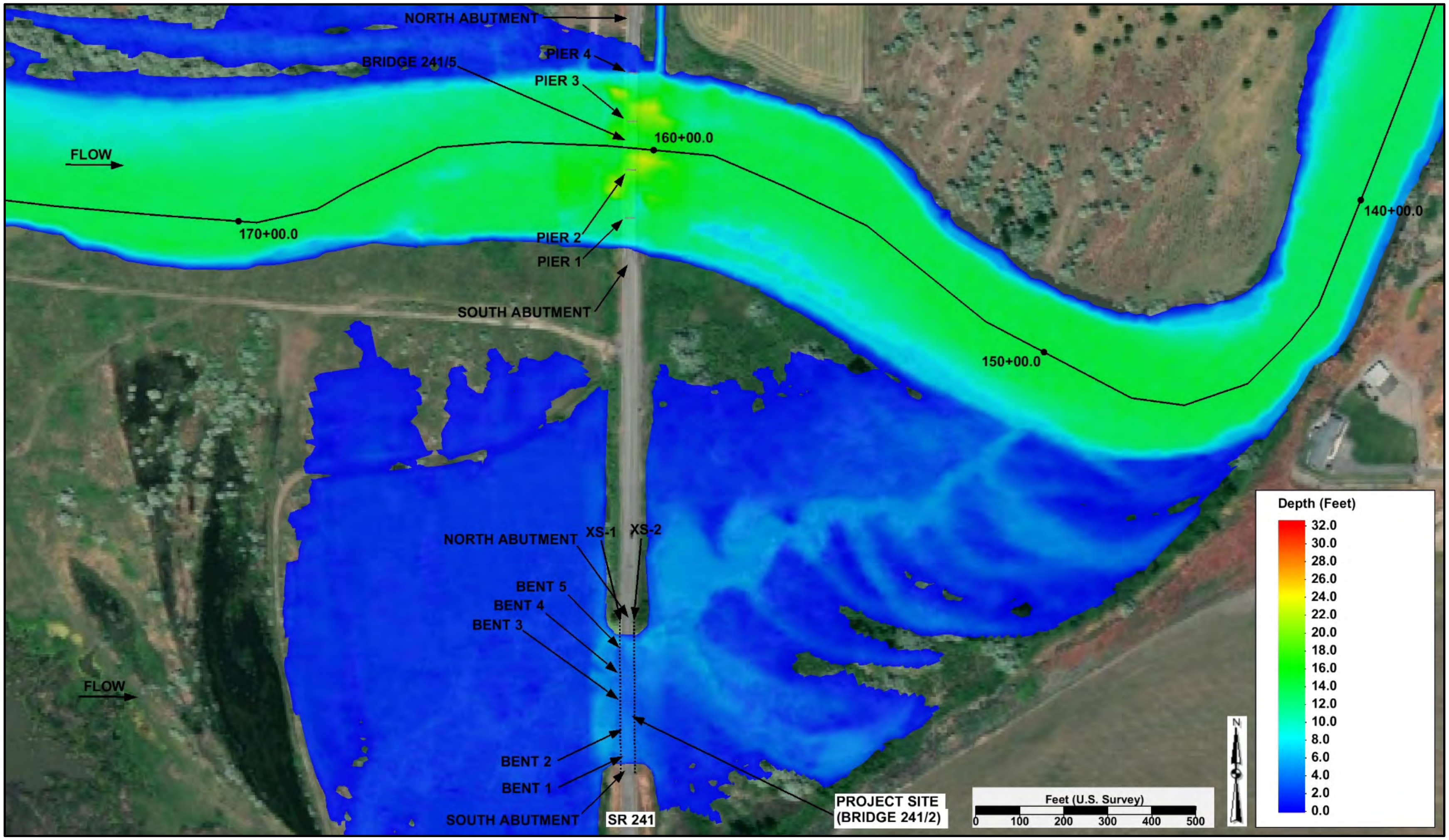


Figure G-3. Existing Conditions 2-Year Depth Near the Existing SR 241/2 Yakima River Crossing

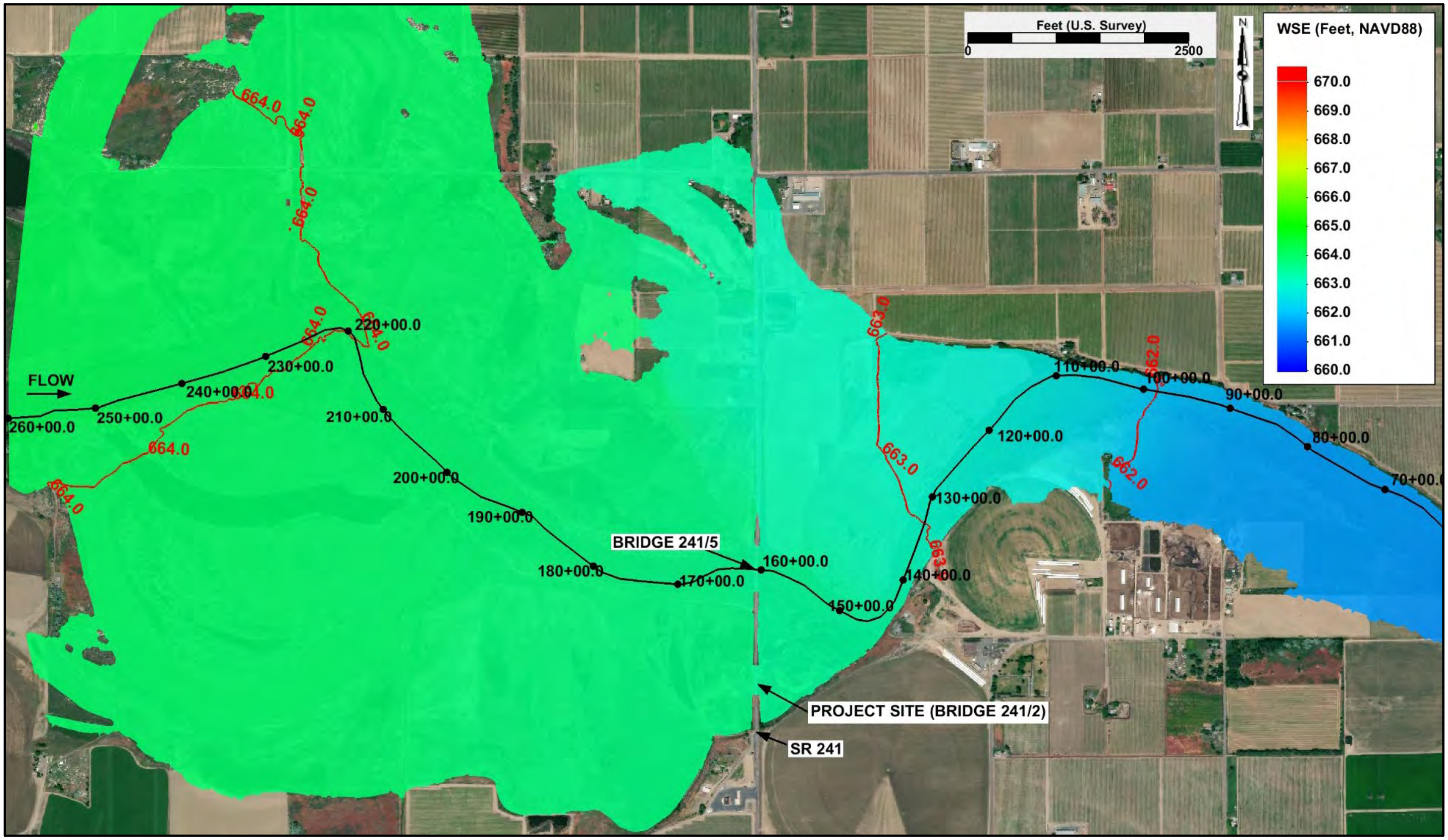


Figure G-4. Existing Conditions 100-Year Water Surface Elevation (WSE) Near the Existing SR 241/2 Yakima River Crossing

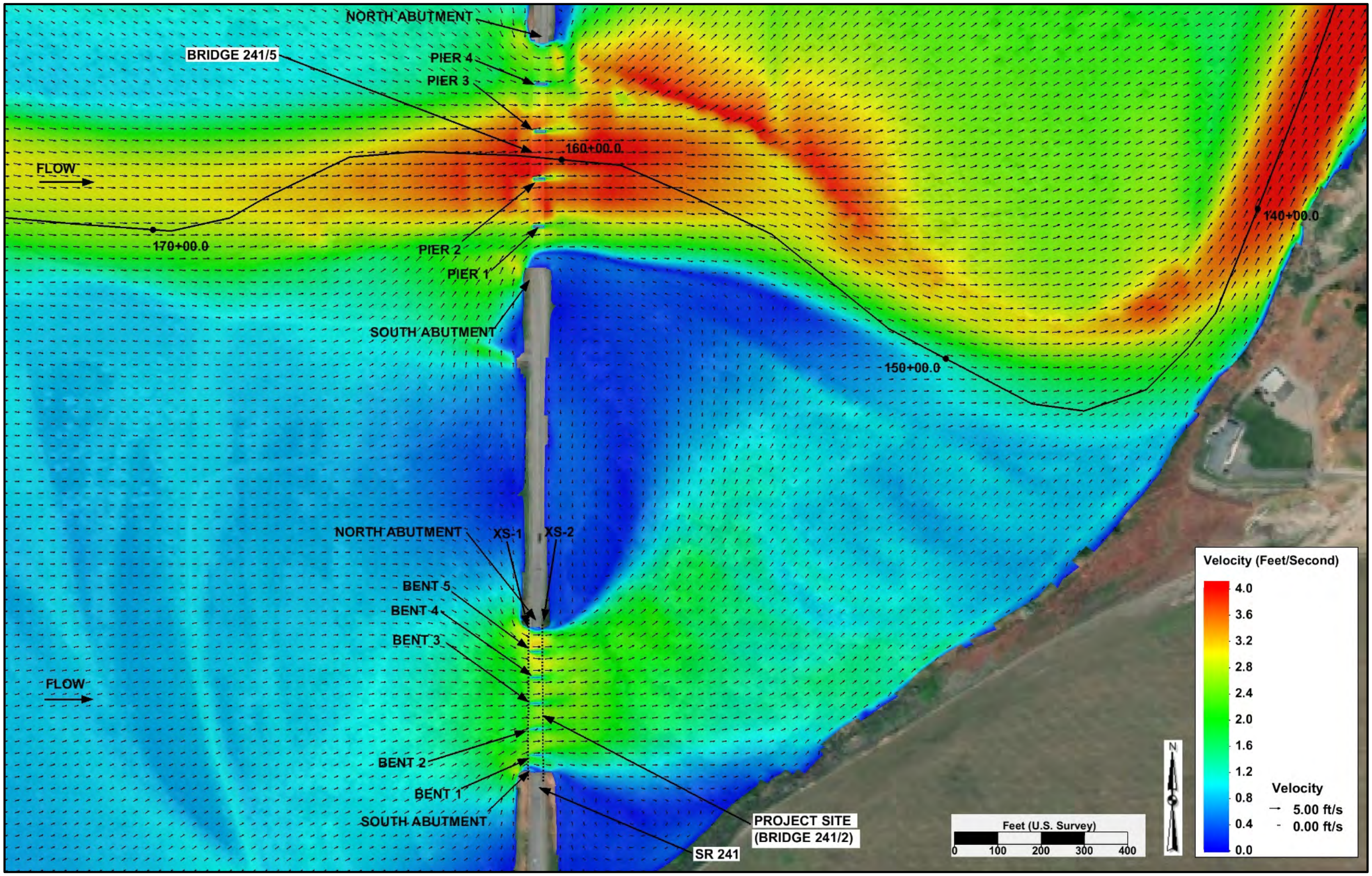


Figure G-5. Existing Conditions 100-Year Velocity Near the Existing SR 241/2 Yakima River Crossing

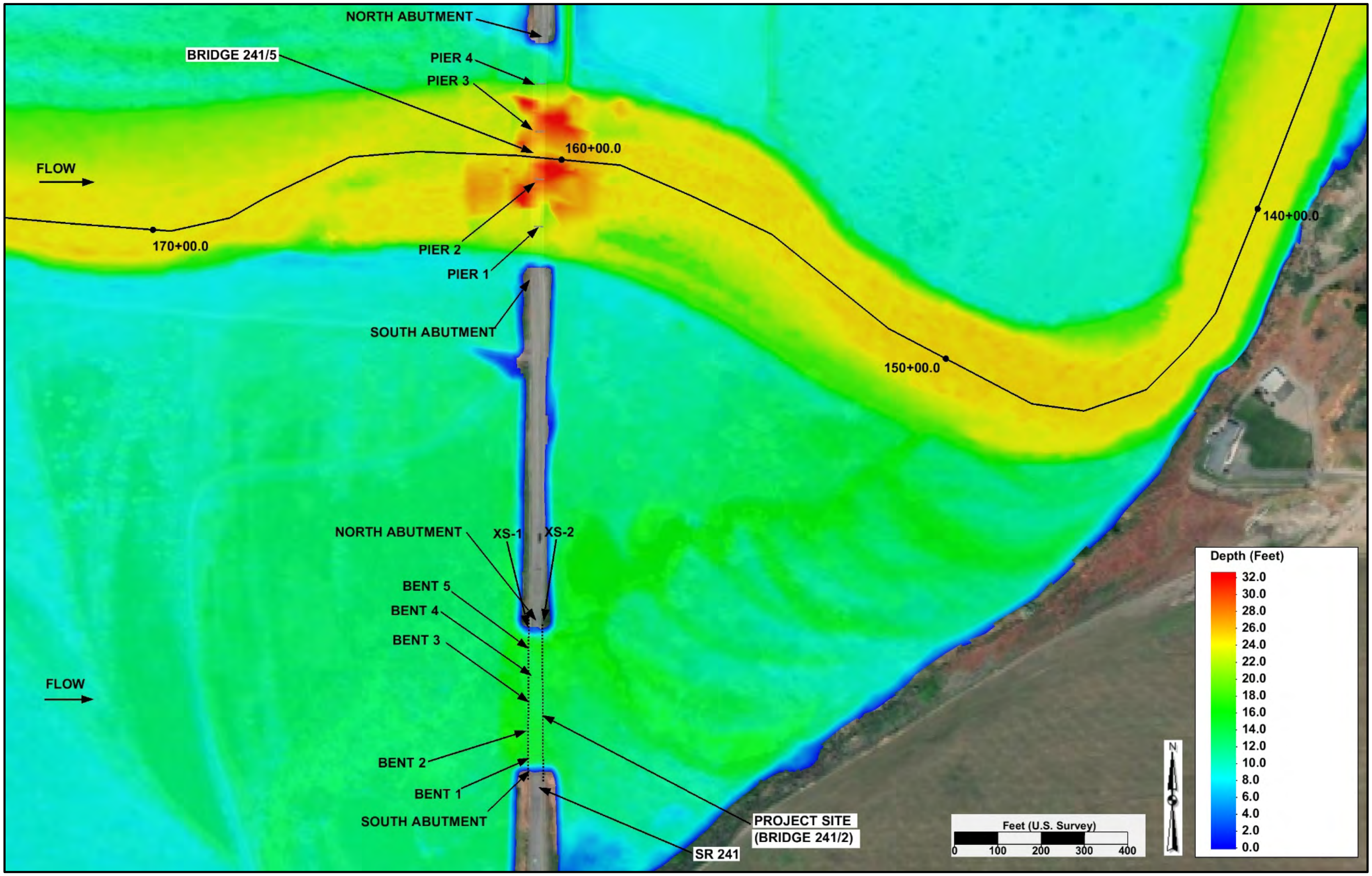


Figure G-6. Existing Conditions 100-Year Depth Near the Existing SR 241/2 Yakima River Crossing

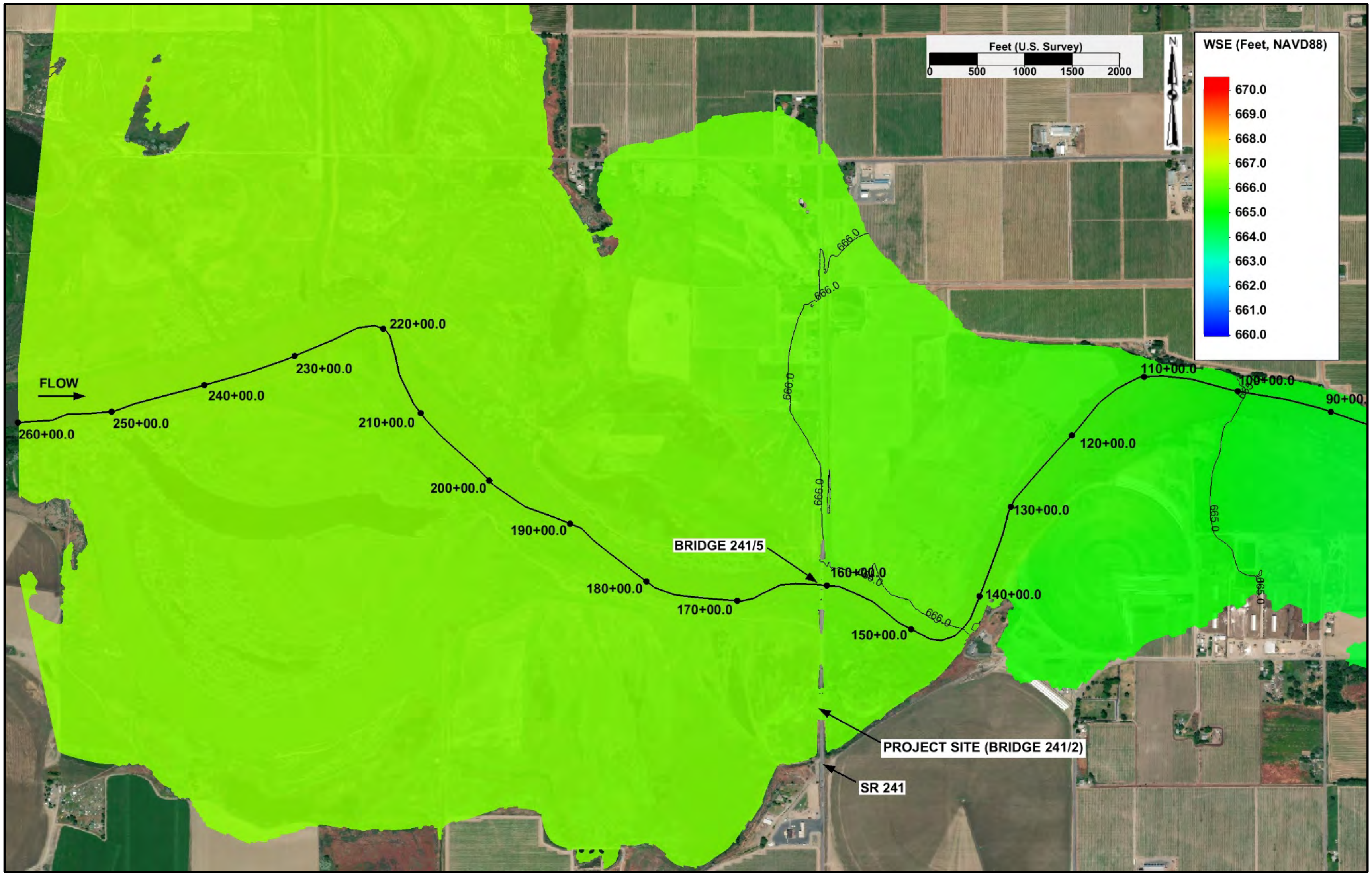


Figure G-7. Existing Conditions 500-Year Water Surface Elevation (WSE) Near the Existing SR 241/2 Yakima River Crossing

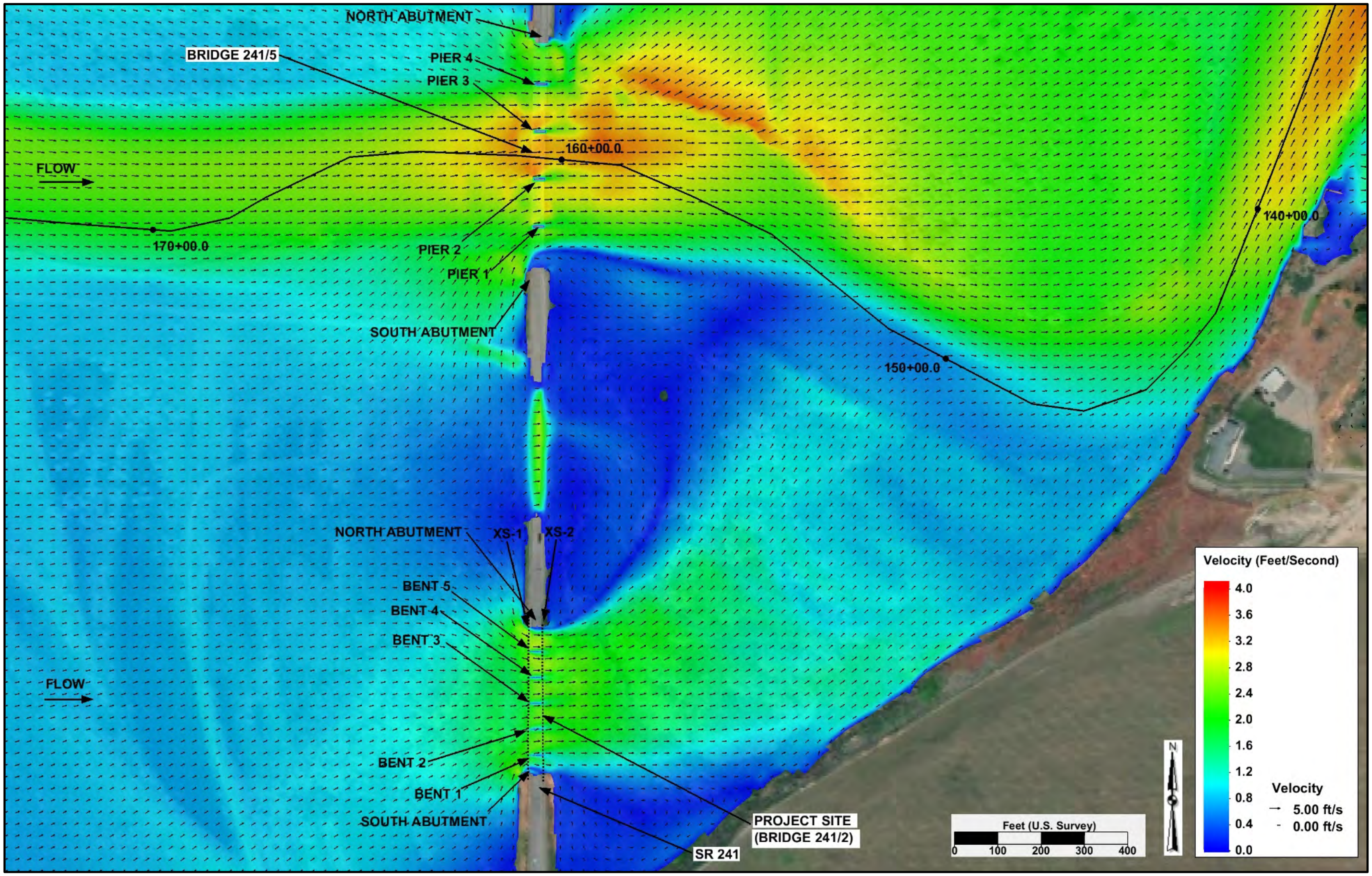


Figure G-8. Existing Conditions 500-Year Velocity Near the Existing SR 241/2 Yakima River Crossing

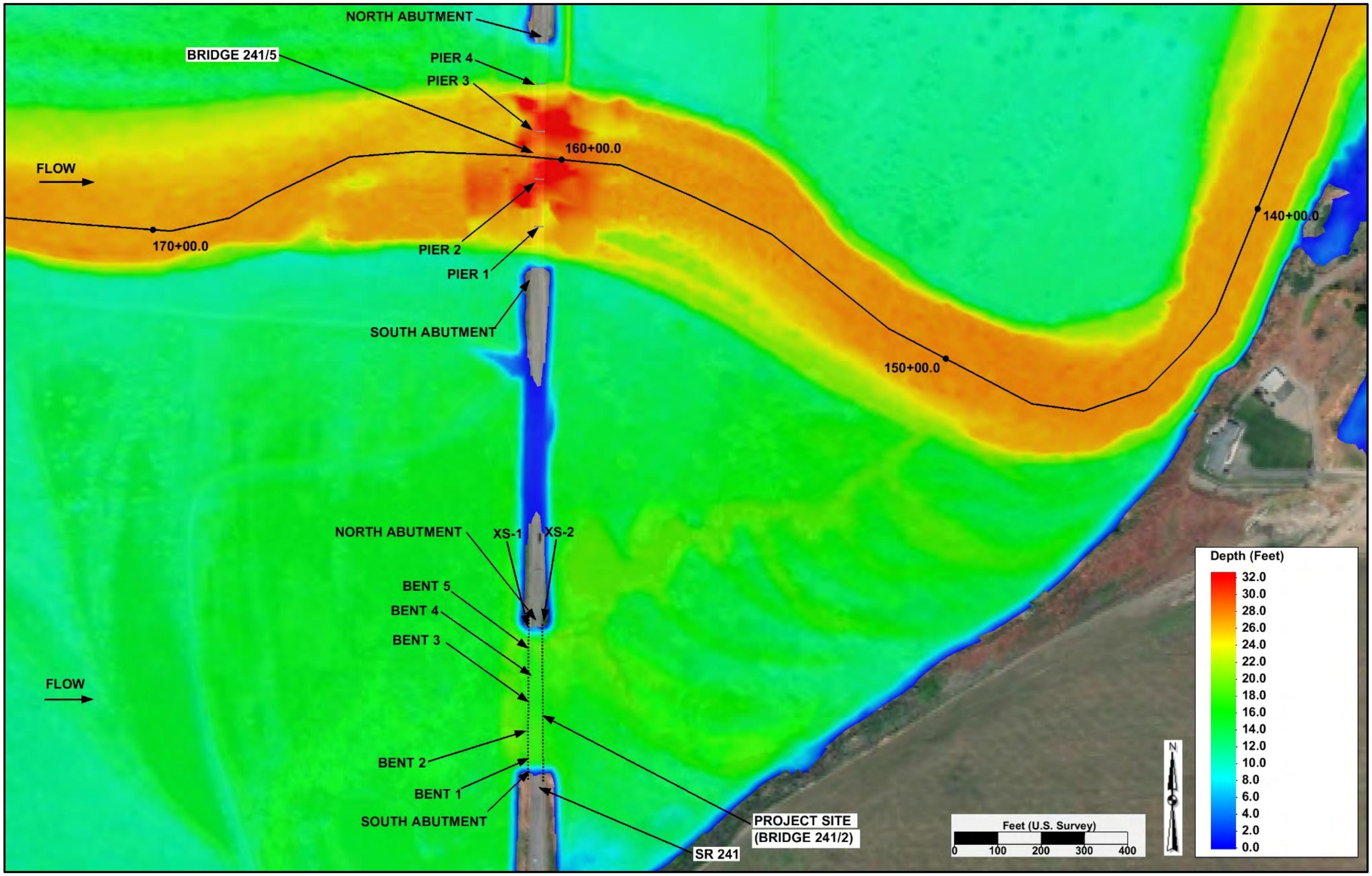


Figure G-9. Existing Conditions 500-Year Depth Near the Existing SR 241/2 Yakima River Crossing

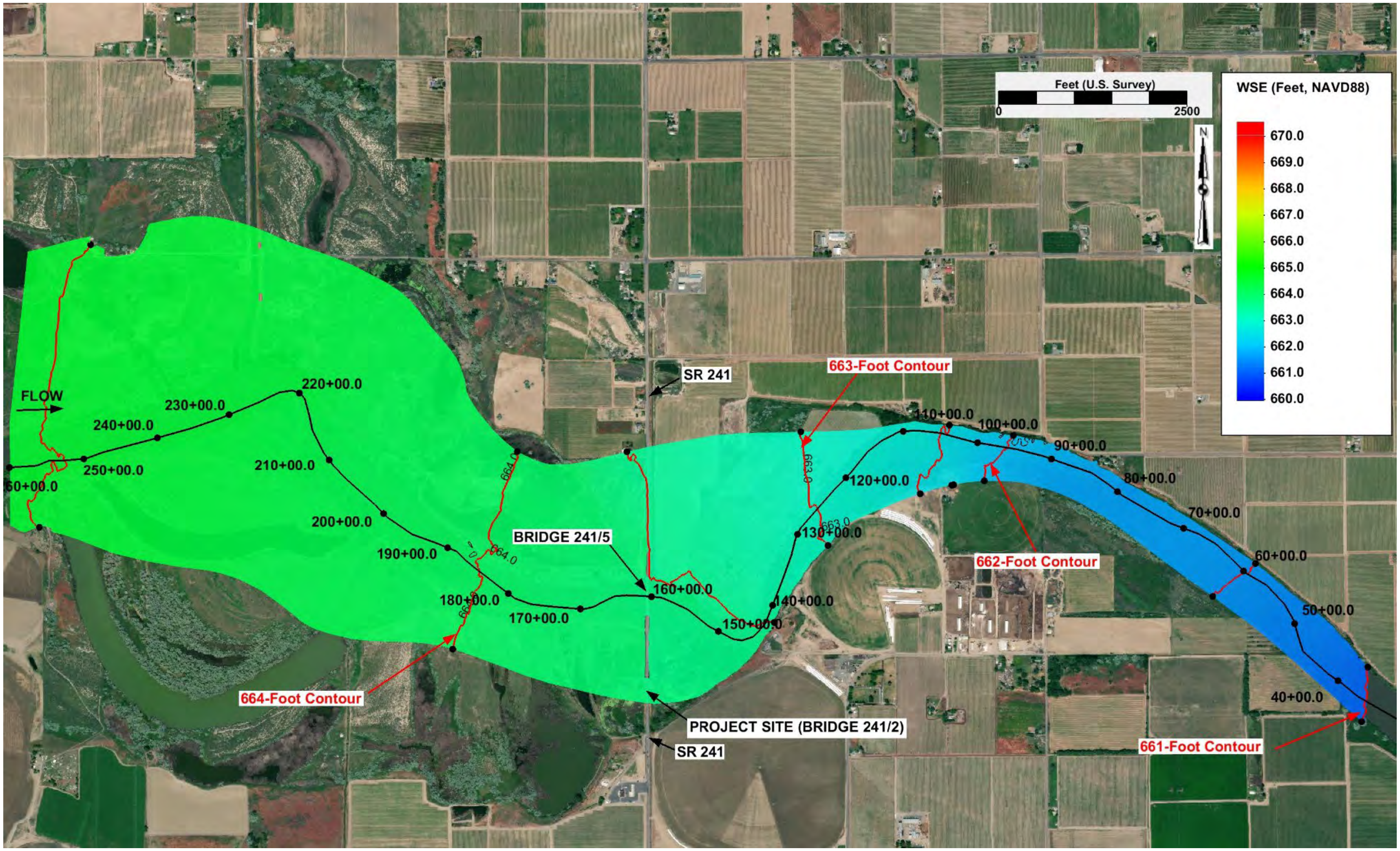


Figure G-10. Existing Conditions 100-Year Water Surface Elevation (WSE) Within the Floodway Near the Existing SR 241/2 Yakima River Crossing

Appendix H – Proposed Conditions SRH-2D Model Results

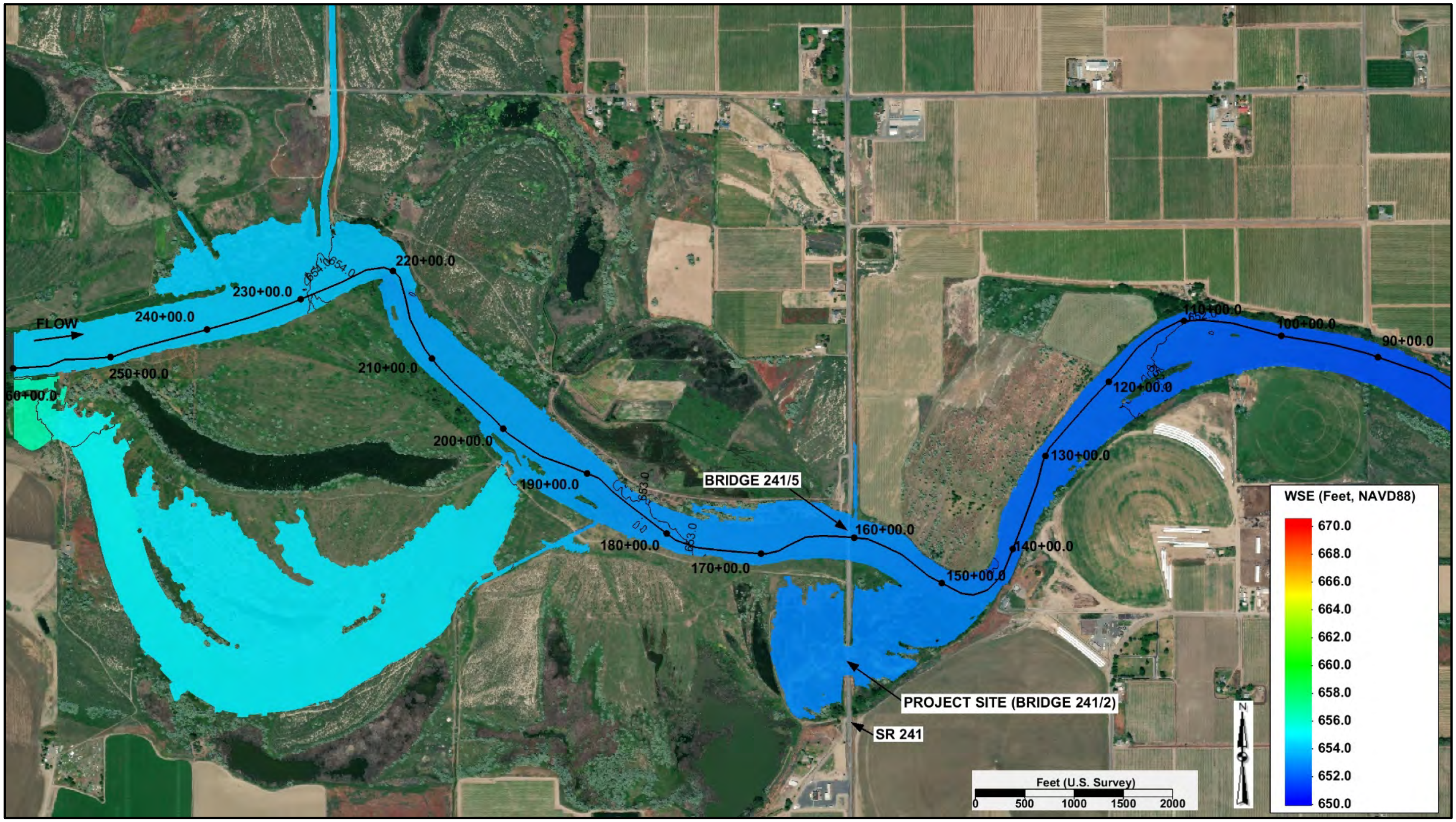


Figure H-1. Proposed Conditions 2-Year Water Surface Elevation (WSE) Near the SR 241/2 Yakima River Crossing

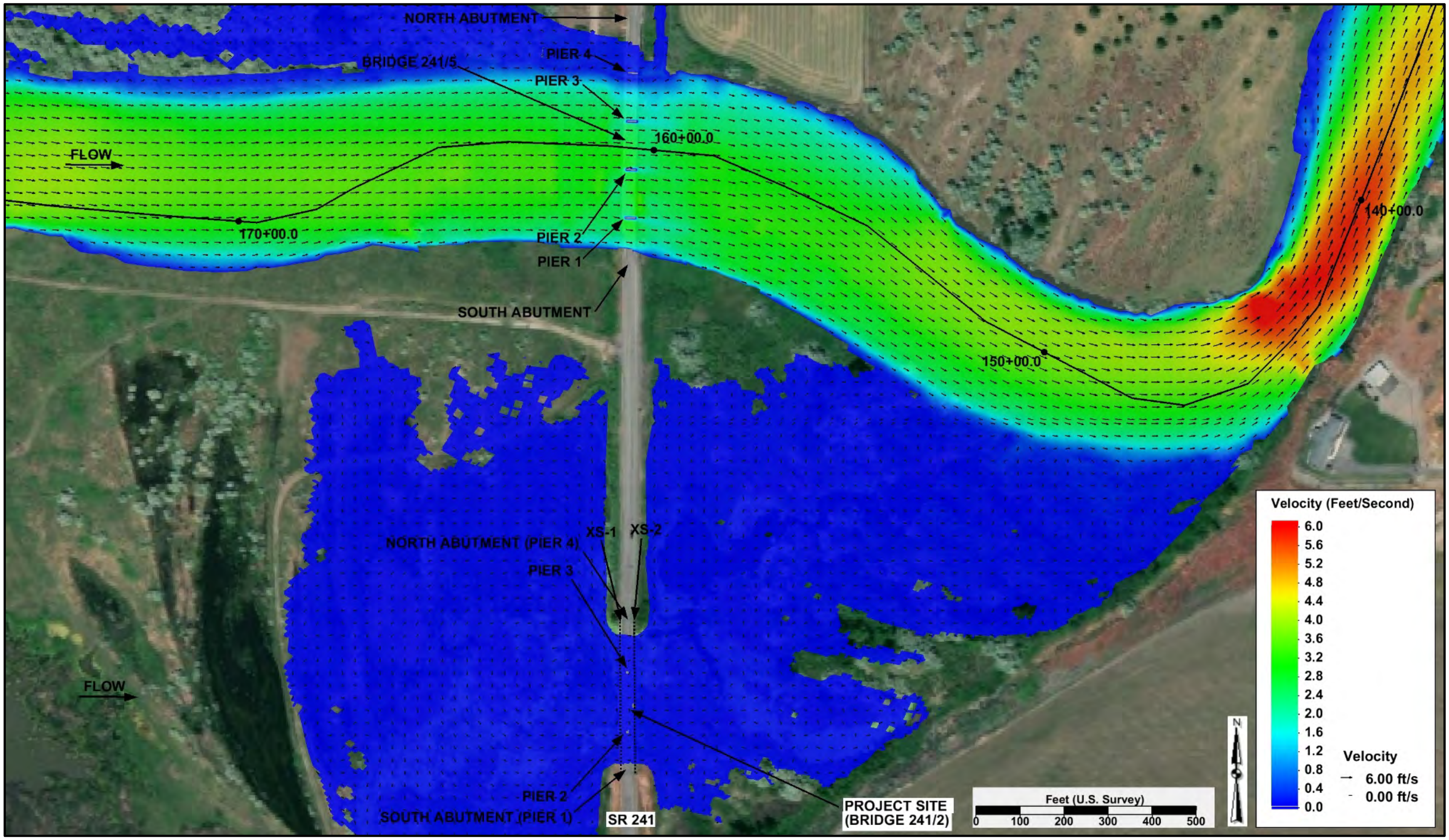


Figure H-2. Proposed Conditions 2-Year Velocity Near the Proposed SR 241/2 Yakima River Crossing

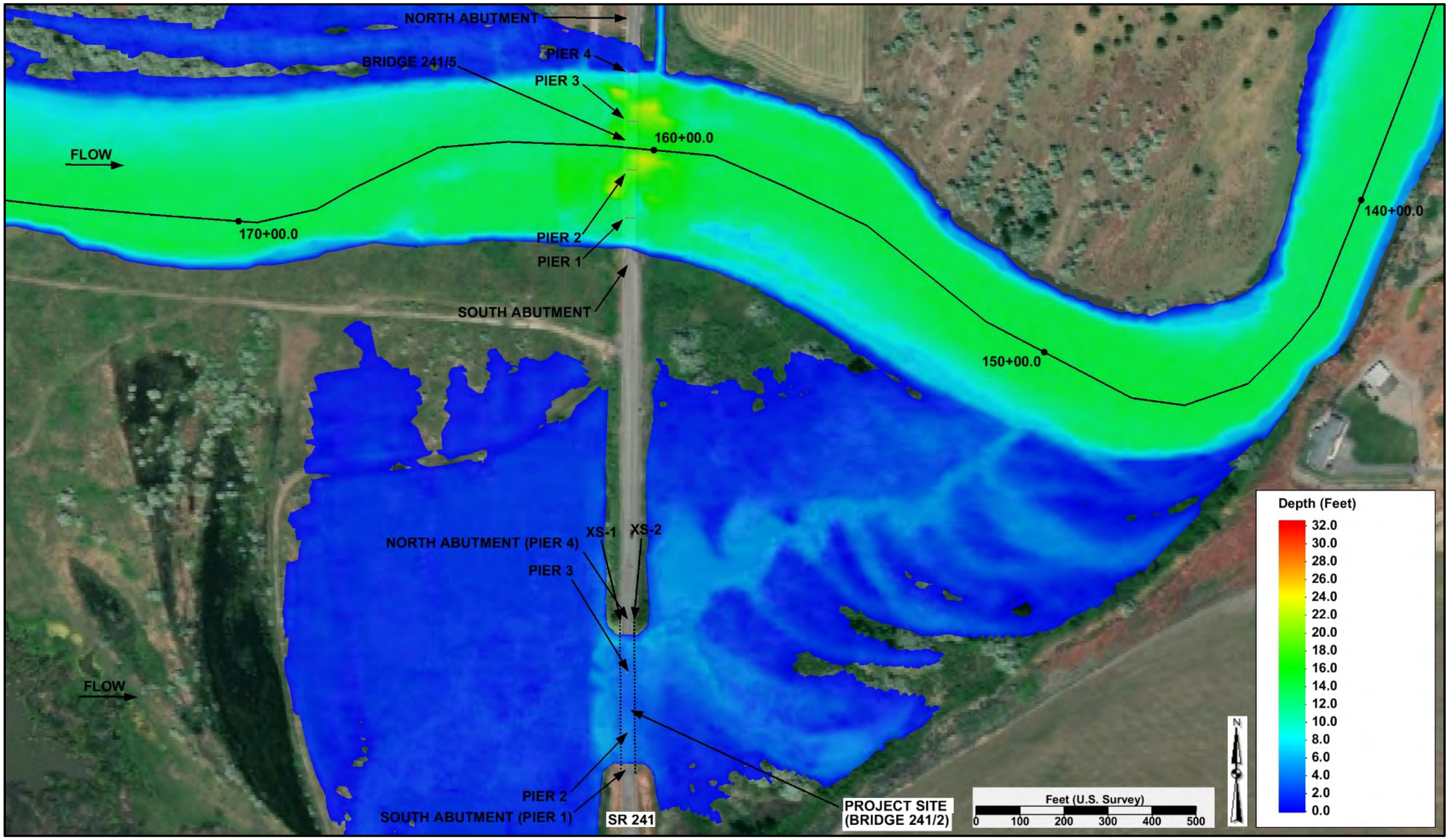


Figure H-3. Proposed Conditions 2-Year Depth Near the Proposed SR 241/2 Yakima River Crossing

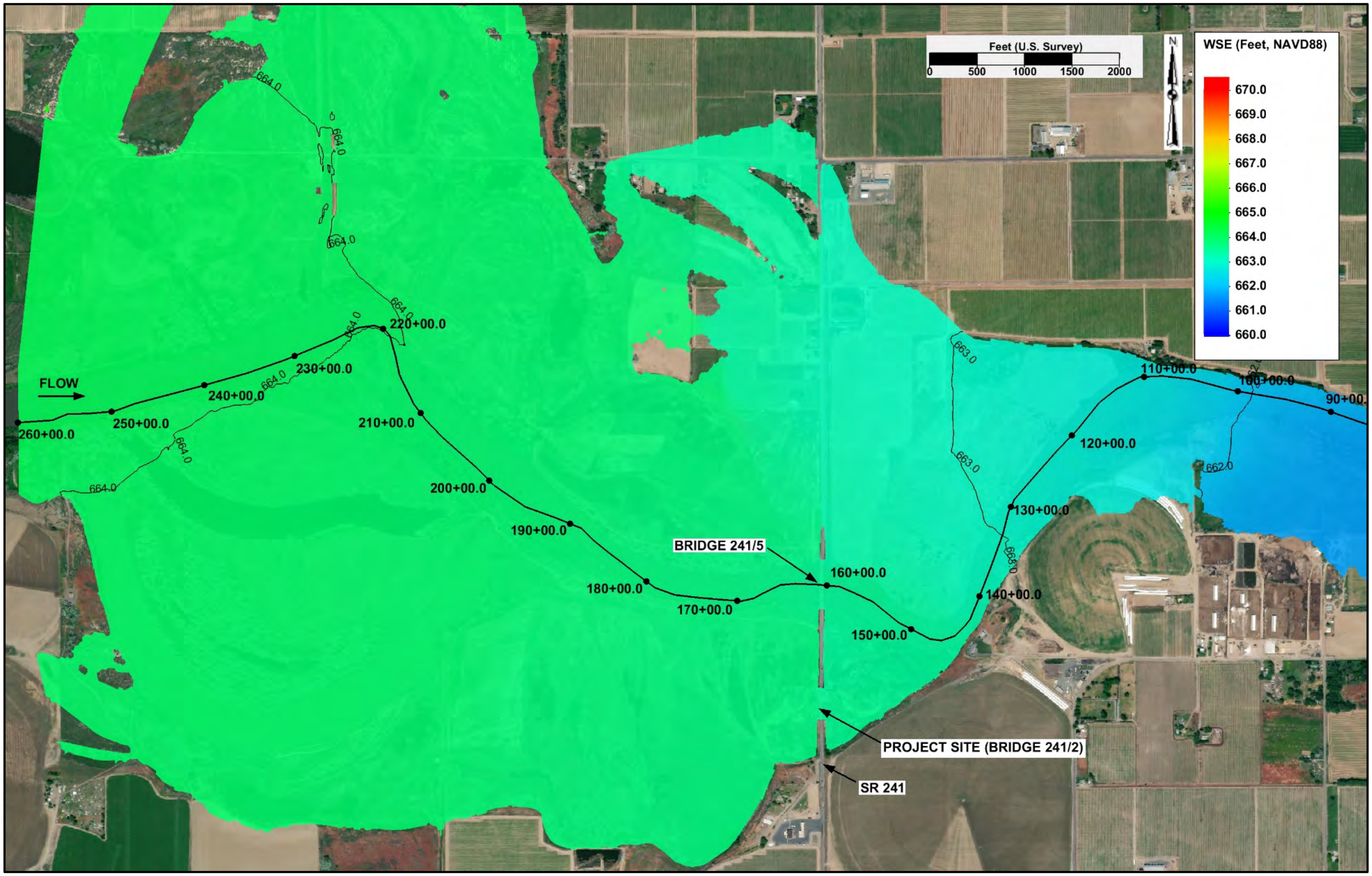


Figure H-4. Proposed Conditions 100-Year Water Surface Elevation (WSE) Near the Proposed SR 241/2 Yakima River Crossing

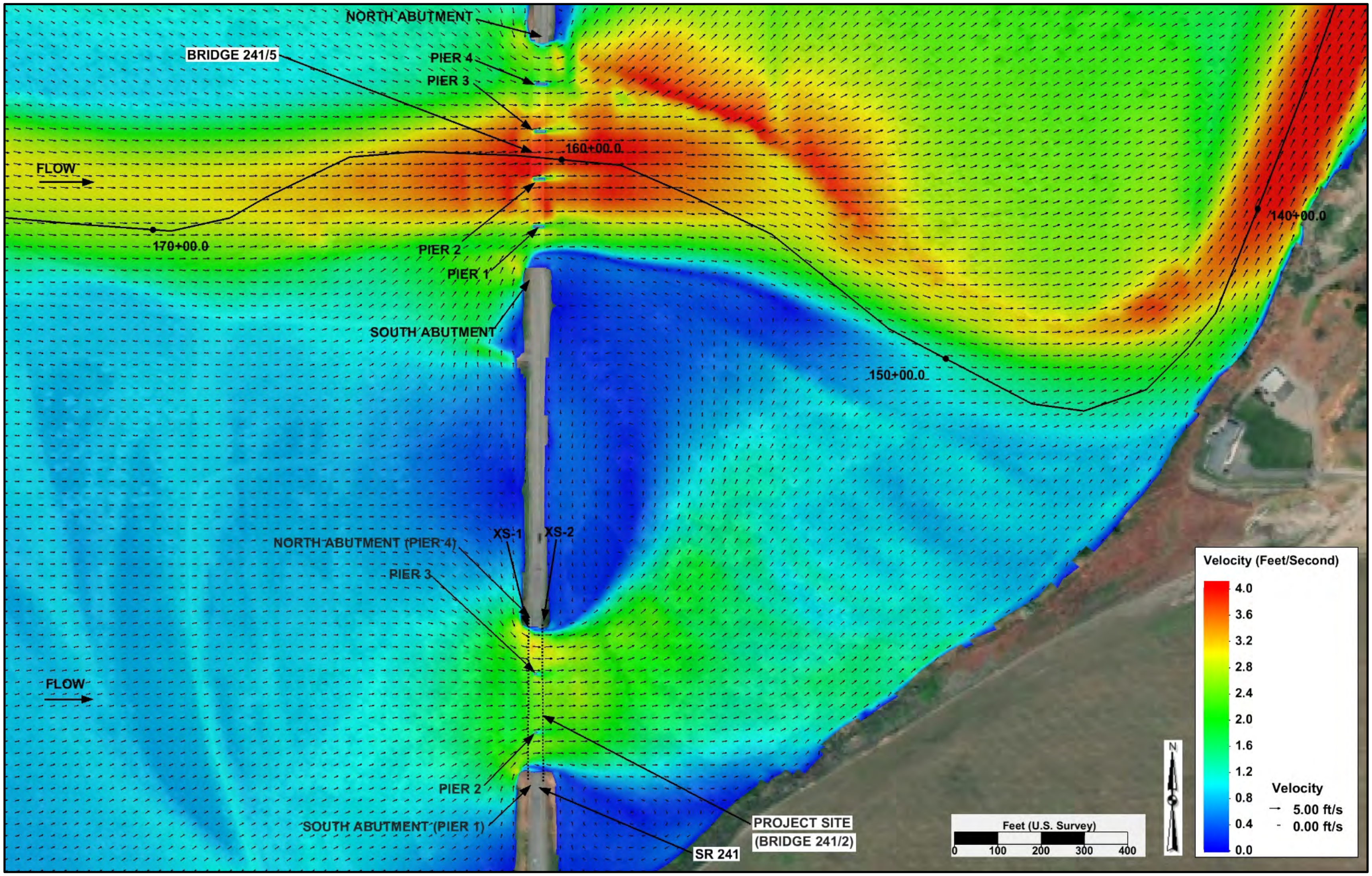


Figure H-5. Proposed Conditions 100-Year Velocity Near the Proposed SR 241/2 Yakima River Crossing

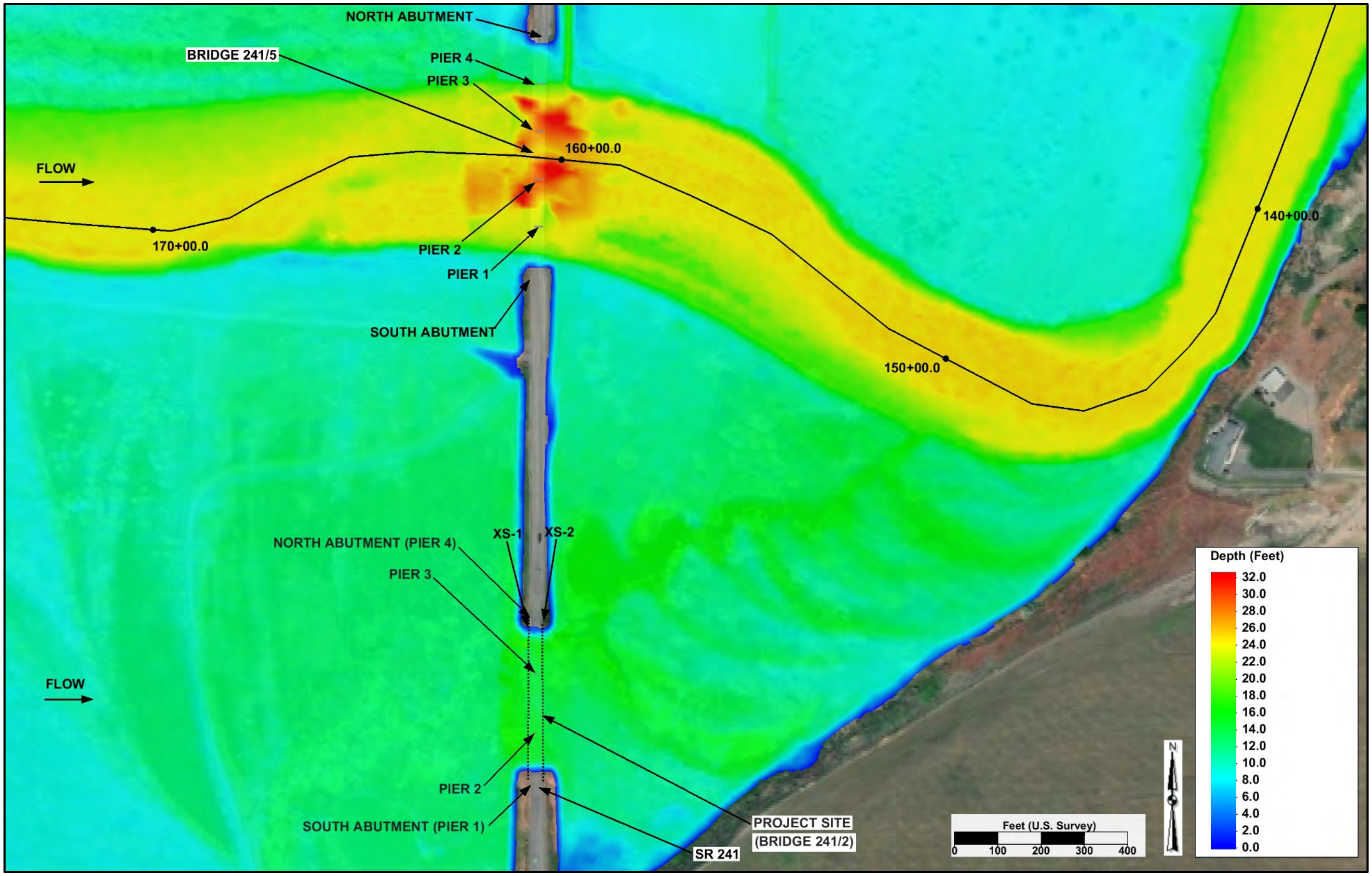


Figure H-6. Proposed Conditions 100-Year Depth Near the Proposed SR 241/2 Yakima River Crossing

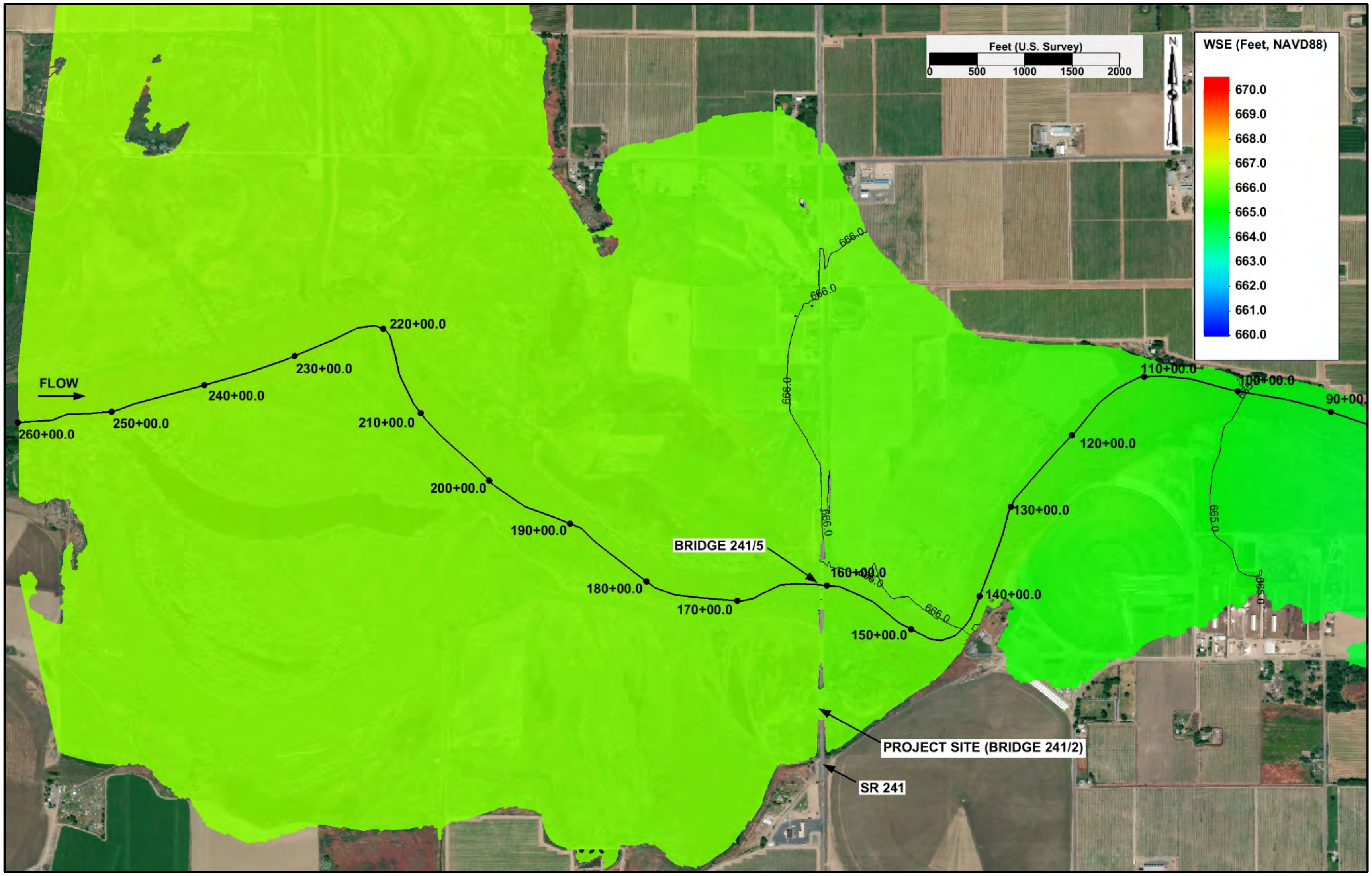


Figure H-7. Proposed Conditions 500-Year Water Surface Elevation (WSE) Near the Proposed SR 241/2 Yakima River Crossing

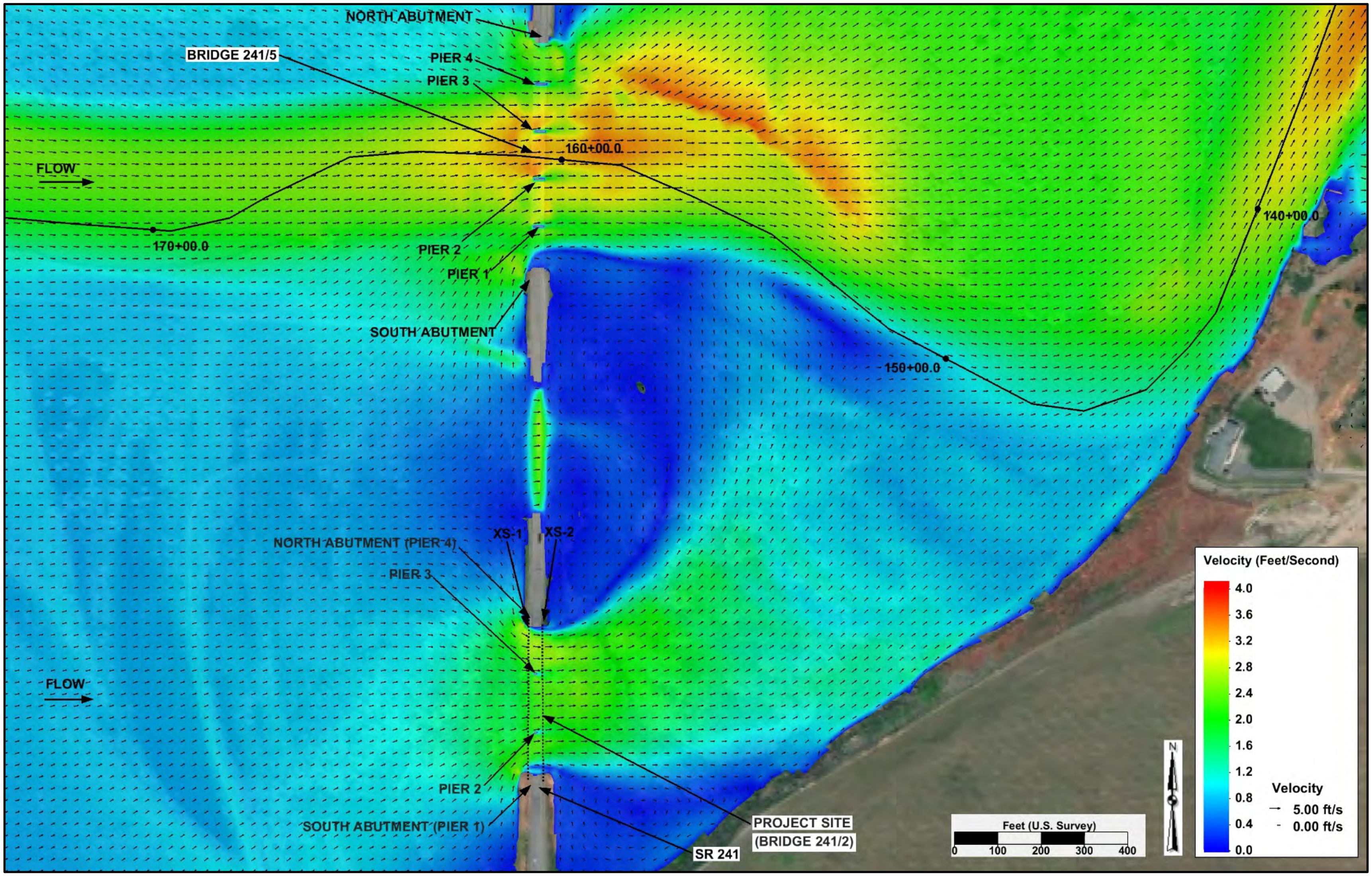


Figure H-8. Proposed Conditions 500-Year Velocity Near the Proposed SR 241/2 Yakima River Crossing

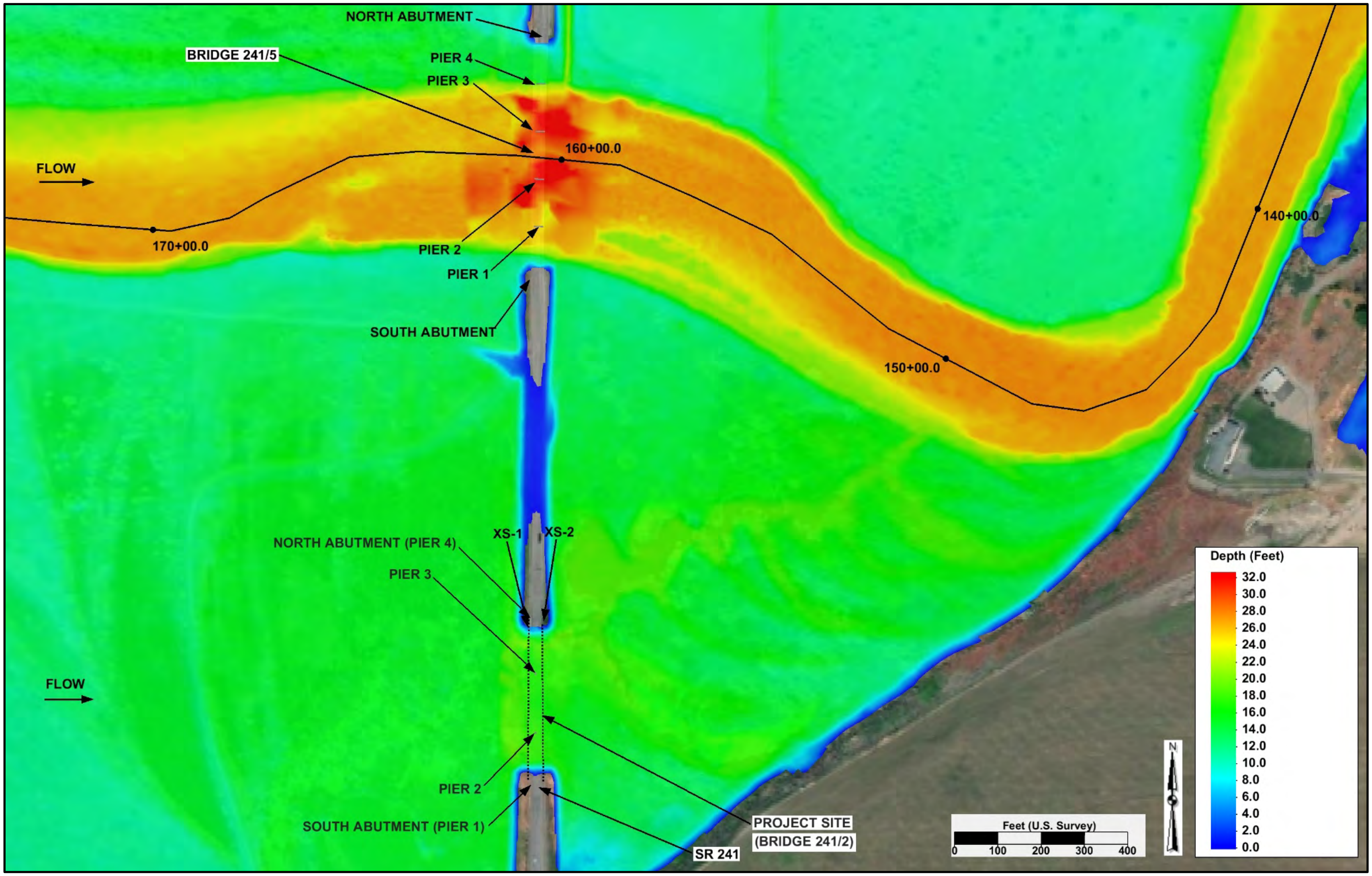


Figure H-9. Proposed Conditions 500-Year Depth Near the Proposed SR 241/2 Yakima River Crossing

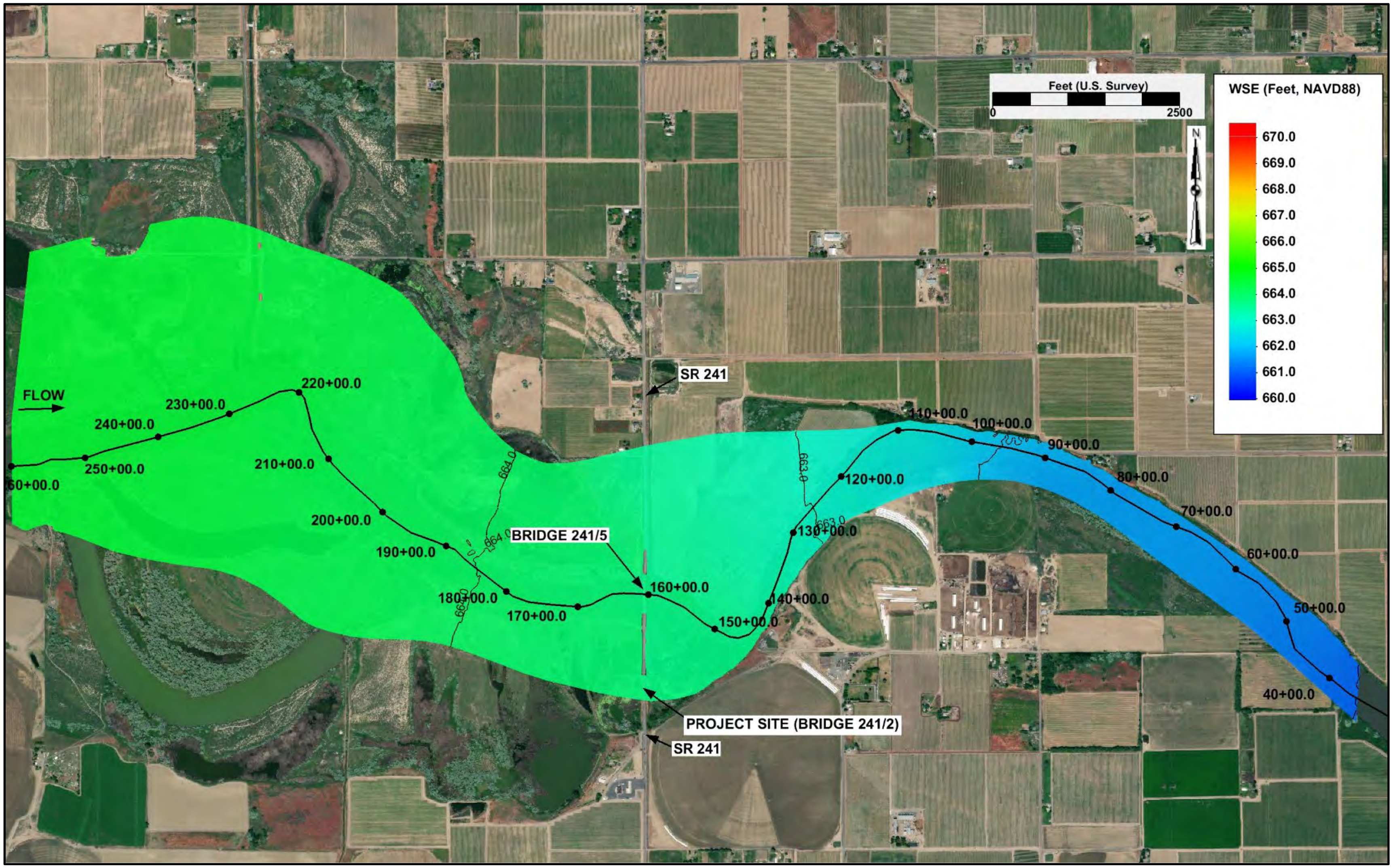


Figure H-10. Proposed Conditions 100-Year Water Surface Elevation (WSE) Within the Floodway Near the Existing SR 241/2 Yakima River Crossing

Appendix I – Scour Calculations

Hydraulic Analysis Report

Project Data

Project Title: SR 241 MP 1.12 Yakima River Bridge (241/2) Replacement

Designer: A. Tsakiris

Project Date: Thursday, January 02, 2020

Project Units: U.S. Customary Units

Notes:

Bridge Scour Analysis: General (Contraction) Scour, 100-Year Peak Flow

Notes: This is the general (contraction) scour analysis for the proposed SR 241/2 crossing of the Yakima River under the 100-year peak flow using the Laursen contraction scour equation.

Contraction Scour

Computation Type: Clear-Water or Live-Bed Scour

Input Parameters		**Notes**
Average Depth Upstream of Contraction:	10.3 ft	Average depths at cross-sections extracted 356; 532; 881; 1152; 1410; and 1923 feet upstream of the SR 241/2 bridge upstream end were assessed to determine the scour condition.
D_{50}:	0.00025 ft (0.003 inches)	Average D_{50} at the surface from the 3 cores.
Average Velocity Upstream:	0.8 ft/s	Average velocities at cross-sections extracted 356; 532; 881; 1152; 1410; and 1923 feet upstream of the SR 241/2 bridge upstream end were assessed to determine the scour condition.
Results of Scour Condition		
Critical velocity above which bed material of size D and smaller will be transported:	1.0 ft/s	
Contraction Scour Condition	Clear-Water	
Live Bed and/or Clear Water Input Parameters		
Flow in Contracted Section:	10344 cfs	The maximum discharge calculated from the 2D model through the bridge sections under the 100-year peak flow.
Bottom Width in Contracted Section:	271.6 ft	This is the min width of the cross-section through the structure excluding the sum of the Pier 2 and 3 diameters.

Depth Prior to Scour in Contracted Section:	13.2 ft	Flow depth at Station 1123+07 feet, which is located behind the Piers 2 and 3 and provides the largest Q/W.
Results of Clear-Water Method		
Diameter of the smallest nontransportable particle in the bed material:	0.00031 ft (0.004 inches)	
Average Depth in Contracted Section after Scour:	28.2 ft	
Depth of Scour:	**15.0 ft**	

Bridge Scour Analysis: General (Contraction) Scour, 500-Year Peak Flow

Notes: This is the general (contraction) scour analysis for the proposed SR 241/2 crossing of the Yakima River under the 500-year peak flow using the Laursen contraction scour equation.

Contraction Scour

Computation Type: Clear-Water or Live-Bed Scour

Input Parameters		**Notes**
Average Depth Upstream of Contraction:	12.8 ft	Average depths at cross-sections extracted 356; 532; 881; 1152; 1410; and 1923 feet upstream of the SR 241/2 bridge upstream end were assessed to determine the scour condition.
D50:	0.00025 ft (0.003 inches)	Average D_{50} at the surface from the 3 cores.
Average Velocity Upstream:	0.7 ft/s	Average velocities at cross-sections extracted 356; 532; 881; 1152; 1410; and 1923 feet upstream of the SR 241/2 bridge upstream end were assessed to determine the scour condition.
Results of Scour Condition		
Critical velocity above which bed material of size D and smaller will be transported:	1.1 ft/s	
Contraction Scour Condition	Clear-Water	
Live Bed and/or Clear Water Input Parameters		
Flow in Contracted Section:	10967 cfs	The maximum discharge calculated from the 2D model through the bridge sections under the 100-year peak flow.
Bottom Width in Contracted Section:	271.6 ft	This is the min width of the cross-section through the structure excluding the sum of the Pier 2 and 3 diameters.
Depth Prior to Scour in Contracted Section:	15.5 ft	Flow depth at Station 1123+07 feet, which is located behind the Piers 2 and 3 and provides the largest Q/W.
Results of Clear-Water Method		
Diameter of the smallest nontransportable particle in the bed material:	0.00031 ft (0.004 inches)	
Average Depth in Contracted Section after Scour:	29.7 ft	
Depth of Scour:	**14.2 ft**	

Hydraulic Analysis Report

Project Data

Project Title: SR 241 MP 1.12 Yakima River Bridge (241/2) Replacement

Designer: A. Tsakiris

Project Date: Thursday, January 02, 2020

Project Units: U.S. Customary Units

Notes:

Bridge Scour Analysis: Piers 2 and 3, 100-Year Peak Flow

Notes: This is the pier scour analysis for Piers 2 and 3 of the proposed SR 241/2 crossing of the Yakima River under the 100-year peak flow using the HEC-18 equation.

Pier Scour

Computation Type: HEC-18

Input Parameters		**Notes**
Pier Shape:	Circular Cylinder	Per the preliminary plans provided by the WSDOT South Central Region PEO (Appendix F)
Bed Condition:	Plane Bed and Antidune Flow	Estimated for prevailing flow hydraulics.
Depth Upstream of Pier:	14.5 ft	The depth at the crossing that produces the largest pier scour.
Velocity Upstream of Pier:	2.4 ft/s	The velocity at the crossing that produces the largest pier scour.
Width of Pier:	5.0 ft	Per the preliminary plans provided by the WSDOT South Central Region PEO (Appendix F)
Angle of Attack:	0.0 Degrees	For a circular shape pier.
Result Parameters		
Froude Number Upstream:	0.11	
Correction Factor for Pier Nose Shape (K1):	1.0	
Correction Factor of Angle of Attack (K2):	1.0	
Pier Length to Pier Width (L/a):	1.0	
Correction Factor for Bed Condition (K3):	1.1	
Depth of Scour:	**6.2 ft**	

Bridge Scour Analysis: Piers 2 and 3, 500-Year Peak Flow

Notes: This is the pier scour analysis for Piers 2 and 3 of the proposed SR 241/2 crossing of the Yakima River under the 500-year peak flow using the HEC-18 equation.

Pier Scour

Computation Type: HEC-18

Input Parameters		**Notes**
Pier Shape:	Circular Cylinder	Per the preliminary plans provided by the WSDOT South Central Region PEO (Appendix F)
Bed Condition:	Plane Bed and Antidune Flow	Estimated for prevailing flow hydraulics.
Depth Upstream of Pier:	17.5 ft	The depth at the crossing that produces the largest pier scour.
Velocity Upstream of Pier:	2.0 ft/s	The velocity at the crossing that produces the largest pier scour.
Width of Pier:	5.0 ft	Per the preliminary plans provided by the WSDOT South Central Region PEO (Appendix F)
Angle of Attack:	0.0 Degrees	For a circular shape pier.
Result Parameters		
Froude Number Upstream:	0.08	
Correction Factor for Pier Nose Shape (K1):	1.0	
Correction Factor of Angle of Attack (K2):	1.0	
Pier Length to Pier Width (L/a):	1.0	
Correction Factor for Bed Condition (K3):	1.1	
Depth of Scour:	**5.9 ft**	

Hydraulic Analysis Report

Project Data

Project Title: SR 241 MP 1.12 Yakima River Bridge (241/2) Replacement

Designer: A. Tsakiris

Project Date: Thursday, January 02, 2020

Project Units: U.S. Customary Units

Notes:

Bridge Scour Analysis: Abutment Scour, 100-Year Peak Flow

Notes: This is the scour analysis for the abutments of Piers 1 and 4 of the proposed SR 241/2 crossing of the Yakima River under the 100-year peak flow using the National Cooperative Highway Research Program (NCHRP) 24-20 method.

Abutment Scour

Computation Type: NCHRP

Input Parameters

NCHRP Method

Input Parameters		**Notes**
Abutment Type:	Spill-through abutment	Based on the preliminary plans provided by the WSDOT South Central Region PEO (Appendix F)
Angle of Embankment to Flow:	60.0 Degrees	Based on the proposed conditions 2D hydraulic model velocity vectors (Appendix H)
Centerline Length of Embankment:	100.0 ft	Based on the preliminary plans provided by the WSDOT South Central Region PEO (Appendix F)
Projected Length of Embankment:	86.6 ft	Based on the preliminary plans provided by the WSDOT South Central Region PEO (Appendix F)
Width of Flood Plain:	120.0 ft	Based on the preliminary plans provided by the WSDOT South Central Region PEO (Appendix F)
Unit Discharge, Upstream in Main Channel (q_1):	5.0 cfs/ft	Unit discharge during 100-year peak flow at cross-section taken at Station 137+44 located 1410 feet upstream of the SR 241/2 proposed structure upstream end.
Unit Discharge in the Constricted Area (q_2):	37.2 cfs/ft	Unit discharge during 100-year peak flow at cross-section taken at Station 123+34 through the SR 241/2 proposed structure.
D_{50}:	0.00025 ft (0.003 inches)	Average D_{50} at the surface from the 3 cores.
Upstream Flow Depth:	8.8 ft	Flow depth during the 100-year peak flow at cross-section located 1410 feet upstream of the SR 241/2 proposed structure upstream end that produces the largest abutment scour.

Flow Depth Prior to Scour:	13.3 ft	Flow depth the during 100-year peak flow taken at the cross-section through the SR 241/2 proposed structure that produces the largest abutment scour.
Result Parameters		
q_2/q_1:	7.5	
Average Velocity Upstream:	0.8	
Critical Velocity above which Bed Material of Size D and Smaller will be Transported:	1.0 ft/s	
Scour Condition:	Clear Water	
Embankment Length/Floodplain Width Ratio:	0.72	
Scour Condition:	B	Scour condition B provides more conservative abutment scour estimate than scour condition A (see Section 12.3.1 of report).
Amplification Factor:	1.13	
Flow Depth including Contraction Scour:	29.9	
Maximum Flow Depth including Abutment Scour:	33.9	
Depth of Scour from NCHRP Method:	**20.6 ft**	

Bridge Scour Analysis: Abutment Scour, 500-Year Peak Flow

Notes: This is the scour analysis for the abutments of Piers 1 and 4 of the proposed SR 241/2 crossing of the Yakima River under the 500-year peak flow using the National Cooperative Highway Research Program (NCHRP) 24-20 method.

Abutment Scour

Computation Type: NCHRP

Input Parameters

NCHRP Method

Input Parameters		**Notes**
Abutment Type:	Spill-through abutment	Based on the preliminary plans provided by the WSDOT South Central Region PEO (Appendix F)
Angle of Embankment to Flow:	60.0 Degrees	Based on the proposed conditions 2D hydraulic model velocity vectors (Appendix H)
Centerline Length of Embankment:	100.0 ft	Based on the preliminary plans provided by the WSDOT South Central Region PEO (Appendix F)
Projected Length of Embankment:	86.6 ft	Based on the preliminary plans provided by the WSDOT South Central Region PEO (Appendix F)
Width of Flood Plain:	120.0 ft	Based on the preliminary plans provided by the WSDOT South Central Region PEO (Appendix F)
Unit Discharge, Upstream in Main Channel (q_1):	6.2 cfs/ft	Unit discharge during 500-year peak flow at cross-section taken at Station 137+44 located 1410 feet upstream of the SR 241/2 proposed structure upstream end.
Unit Discharge in the Constricted Area (q_2):	39.7 cfs/ft	Unit discharge during 500-year peak flow at cross-section taken at Station 123+34 through the SR 241/2 proposed structure.
D_{50}:	0.00025 ft (0.003 inches)	Average D_{50} at the surface from the 3 cores.
Upstream Flow Depth:	11.3 ft	Flow depth during the 500-year peak flow at cross-section located 1410 feet upstream of the SR 241/2 proposed structure upstream end that produces the largest abutment scour.
Flow Depth Prior to Scour:	15.7 ft	Flow depth during the 500-year peak flow taken at the cross-section through the SR 241/2 proposed structure that produces the largest abutment scour.
Result Parameters		
q_2/q_1:	6.4	
Average Velocity Upstream:	0.7	

Critical Velocity above which Bed Material of Size D and Smaller will be Transported:	1.1 ft/s	
Scour Condition:	Clear Water	
Embankment Length/Floodplain Width Ratio:	0.72	
Scour Condition:	B	Scour condition B provides more conservative abutment scour estimate than scour condition A (see Section 12.3.1 of report).
Amplification Factor:	1.13	
Flow Depth including Contraction Scour:	31.6	
Maximum Flow Depth including Abutment Scour:	35.8	
Depth of Scour from NCHRP Method:	**20.1 ft**	

Appendix J – Rock Revetment and Filter Sizing Calculations

Hydraulic Analysis Report

Project Data

Project Title: SR 241 MP 1.12 Yakima River Bridge (241/2) Replacement

Designer: A. Tsakiris

Project Date: Thursday, January 16, 2020

Project Units: U.S. Customary Units

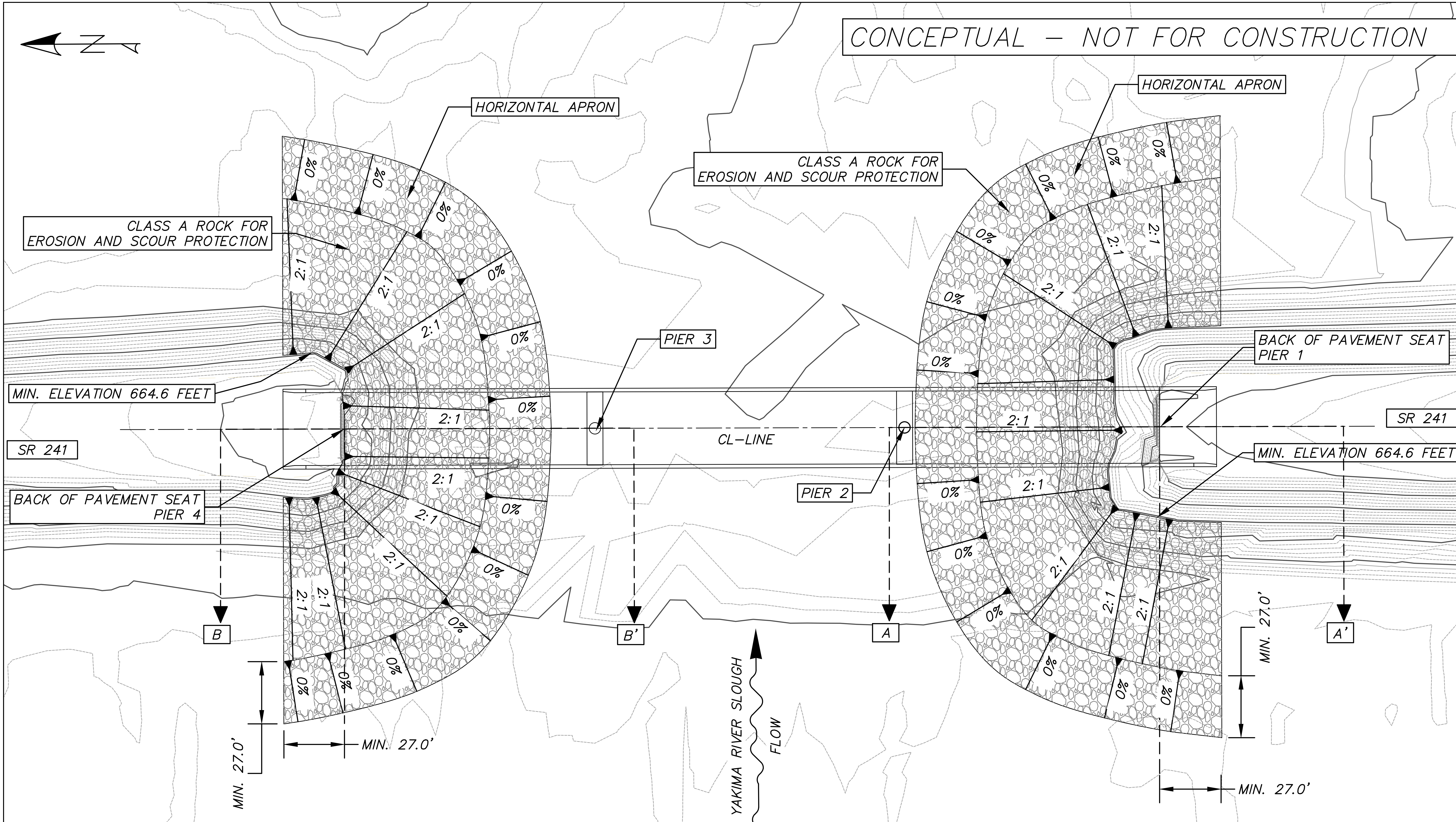
Notes:

Riprap Analysis: Riprap Analysis

Notes: This is the calculation for the rock revetment size for the scour countermeasure at the abutment Piers 1 and 4 of the proposed bridge at the 241/2 crossing of the Yakima River.

Input Parameters

Input Parameters		**Notes**
Riprap Type:	Abutment/ Guide Bank	The structure is an abutment The water will spill through the abutment
Set-back Length:	0.0 ft	The set-back length is the distance from the near edge of the main channel to the toe of abutment
Main Channel Average Flow Depth:	13.2 ft	
Flow Depth at Toe of Abutment:	15.5 ft	
Total Discharge:	10344 cfs	Calculations will use either total or overbank discharges.
Overbank Discharge:	0	
Total Bridge Area:	4364 ft^2	
Setback Area:	0 ft^2	
Maximum Channel Velocity:	2.4	
Specific Gravity of Riprap:	2.65	
Result Parameters		
Set-back ratio:	0.0	
Characteristic Velocity:	2.3 ft/s	
Froude Number at the Abutment Toe:	0.11	
Abutment Coefficient:	0.9	
Computed D_{50}:	**1.1 in**	



WASHINGTON STATE DEPARTMENT OF TRANSPORTATION

nhc northwest hydraulic consultants
711 capitol way south, suite 607
olympia, washington 98501
phone: (360) 584–9810

LEGEND

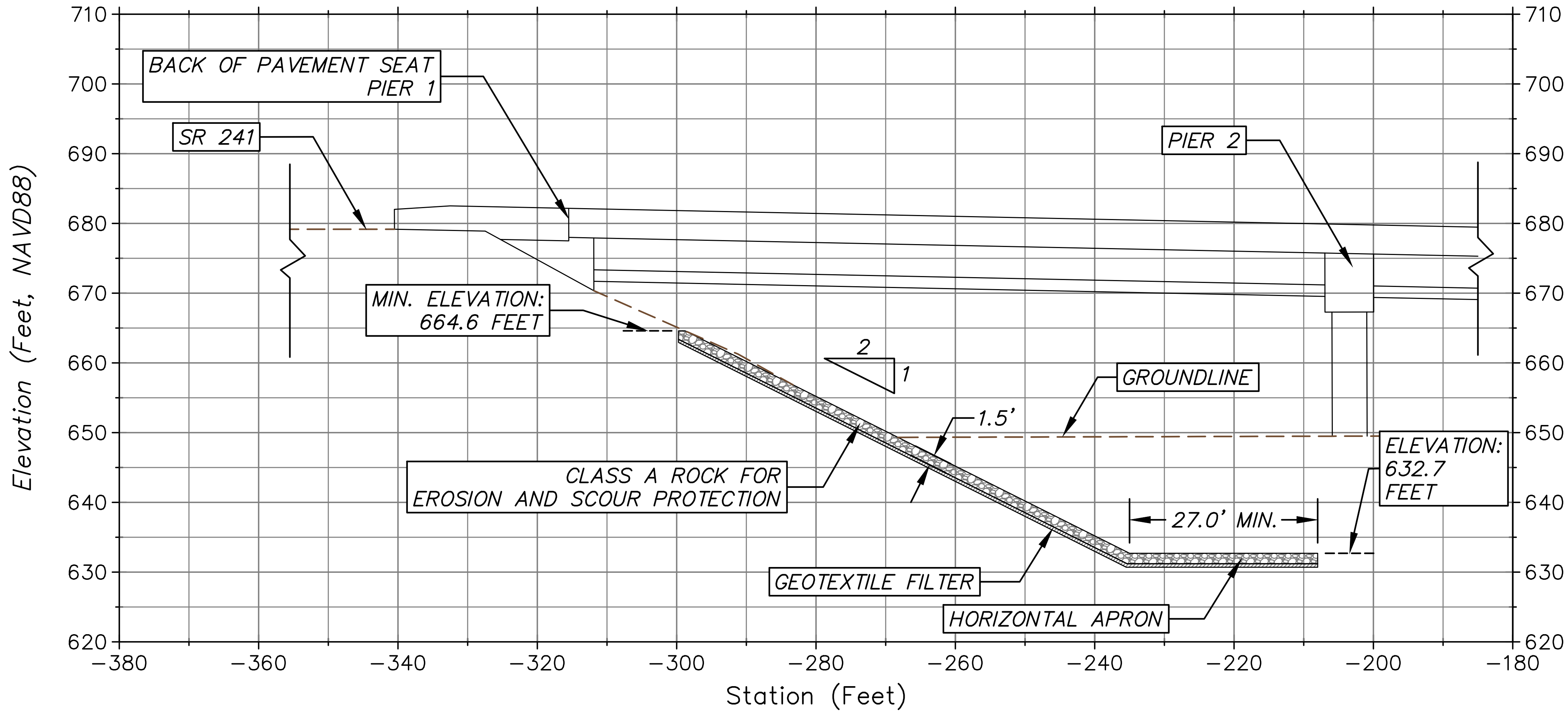
CLASS A ROCK FOR EROSION AND SCOUR PROTECTION

0 40 80 Feet

Job: 2001436
Rev:
Drft:
Chkd:
Date: 24Mar20

SR 241 MP 1.12 YAKIMA RIVER BRIDGE (241/2) REPLACEMENT

CONCEPTUAL SCOUR COUNTERMEASURE PLAN VIEW



CONCEPTUAL – NOT FOR CONSTRUCTION

WASHINGTON STATE DEPARTMENT OF TRANSPORTATION

nhc
northwest hydraulic consultants
711 capitol way south, suite 607
olympia, washington 98501
phone: (360) 584–9810

LEGEND

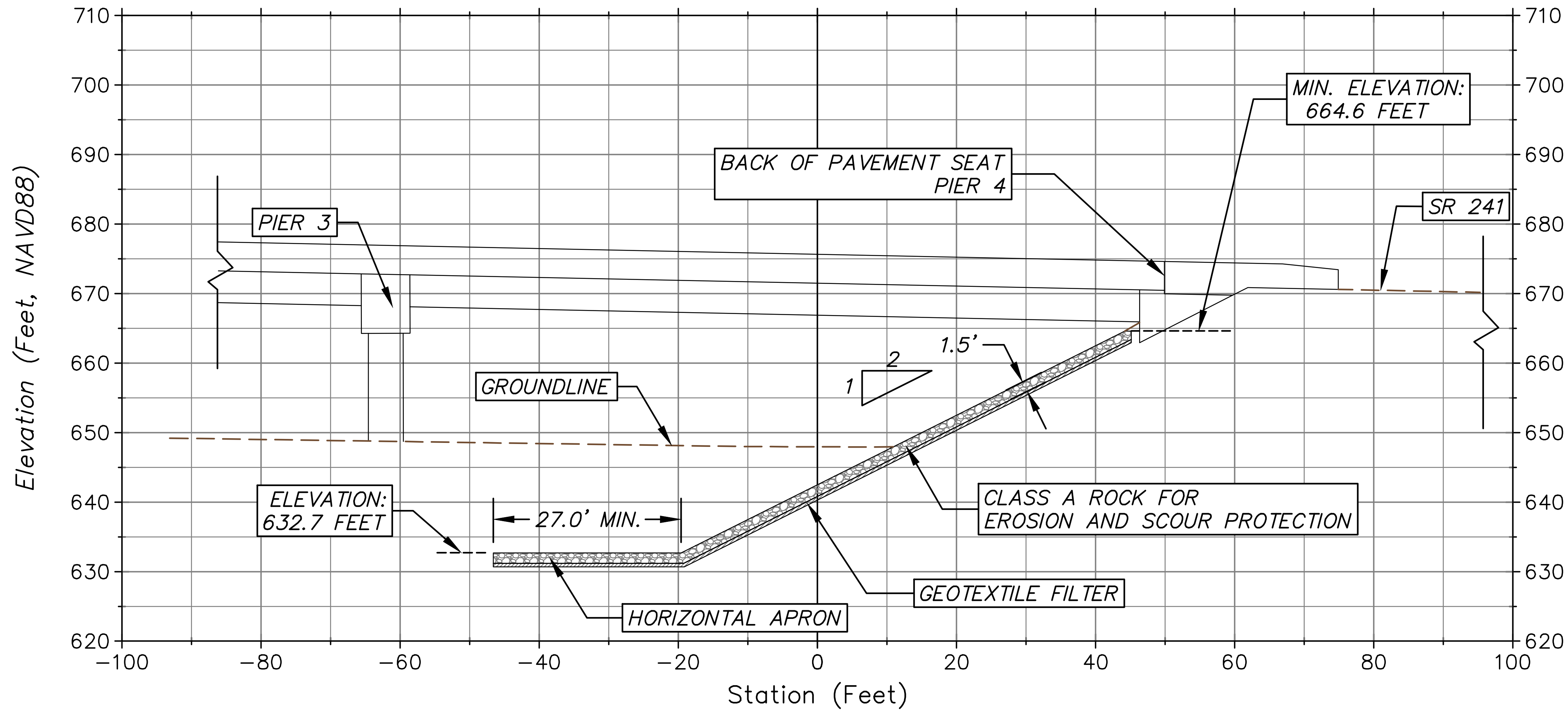
CLASS A ROCK FOR EROSION AND SCOUR PROTECTION

GEOTEXTILE FILTER

Job: 2001436
Rev:
Drft:
Chkd:
Date: 24Mar20

SR 241 MP 1.12 YAKIMA RIVER BRIDGE (241/2) REPLACEMENT

CONCEPTUAL SCOUR COUNTERMEASURE
TYPICAL SECTION A-A'



CONCEPTUAL – NOT FOR CONSTRUCTION

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LEGEND
CLASS A ROCK FOR EROSION AND SCOUR PROTECTION
GEOTEXTILE FILTER

Job: 2001436
Rev:
Drft:
Chkd:
Date: 21Feb20

SR 241 MP 1.12 YAKIMA RIVER BRIDGE (241/2) REPLACEMENT

CONCEPTUAL SCOUR COUNTERMEASURE
TYPICAL SECTION B-B'

Appendix K – FEMA Region X "No-Rise" Certification

ENGINEERING "NO-RISE" CERTIFICATION

This is to certify that I am a duly qualified engineer licensed to practice in the State of Washington.

It is to further certify that the attached technical data supports the fact that proposed SR 241/2 Yakima River Bridge will
(Name of Development)
not impact the 100-year flood elevations, floodway elevations and floodway widths on Yakima River at published sections
(Name of Stream)
in the Flood Insurance Study for Yakima County,
(Name of Community)
dated June 16, 2016 and will not impact the 100-year flood elevations, floodway elevations, and floodway widths at unpublished cross-sections in the vicinity of the proposed development.

Attached are the following documents that support my findings:

SR 241 MP 1.12 Yakima River Bridge (241/2) Replacement: Hydraulics and Scour Analysis Report

(Date) 5/5/20

(Signature)

Julie Heilman

2809 Rudkin Road

Union Gap, WA 98903

(Address)

(WSDOT State Hydraulic Engineer)

(Seal)

JULIE HEILMAN
STATE OF WASHINGTON
41819
REGISTERED
PROFESSIONAL ENGINEER
Julie Heilman