MEMORANDUM

TO:	Steve Johnson Alexander Valley Citizens League	Date: Job No:	May 23, 2019 2018029.1
FROM:	N. Bobby Zermeño, PE		
PROJECT:	Asti Bridge Project over the Russian River Bridge Replacement Conceptual Study Memorandum		

GENERAL

In recent years areas throughout the State of California have been devastated by wild fires. In 2017, the Pocket Fire consumed over 17,000 acres of land destroying or damaging a total of eight structures and threatening countless others in the communities of Geyserville and Asti in Sonoma County. During that particular fire, we understand that residents in the community of Asti on the east side of the Russian River could potentially have been left stranded had the temporary bridge at the Asti Crossing not been in place. Without that bridge, the nearest all weather crossing of the Russian River is located approximately five miles to the north at Crocker Road in the town of Cloverdale. If a fire was to cut off access to that northern bridge, the Asti residents would be trapped without an all-weather bridge in place at the Asti crossing.

Currently secondary access is provided by a low water crossing of the Russian River along Washington School Road which is reconstructed each year by County of Sonoma road maintenance crews. The low water crossing is open to vehicular traffic between June 15th and October 15th as allowed by the California Department of Fish and Wildlife. This low water crossing consists of granular fill approaches and a two span railcar bridge measuring approximately 60 feet in length. The railcar bridge is supported on permanent reinforced concrete abutments and a reinforced concrete pier wall. The County is required to annually obtain all necessary permits for the low water crossing, including a streambed alteration agreement from the California Department of Fish and Wildlife. The cost to the County for permitting, construction, and removal of the low water crossing is approximately $160,000 to $200,000 each year.

The purpose of this conceptual study is to provide scoping recommendations for replacing the low water crossing with an all-weather bridge crossing of the Russian River along the existing Washington School Road alignment. The scope of this study includes conceptual level bridge engineering, preparation of a preliminary hydraulic memorandum, conceptual recommendations for the replacement bridge type, length and width, and a preliminary engineer’s estimate of probable construction cost.

HYDRAULICS

Avila and Associates completed a preliminary Hydrology and Hydraulic Technical Memorandum (see Attachment 2) summarizing the results of their preliminary HEC-RAS analysis used to determine the most appropriate bridge length based on impacts to the 100-year water surface elevation. Since the proposed crossing is located in a FEMA defined floodway, the new bridge cannot cause any increase to the 100-year water surface elevation. An increase of the water surface elevation affecting any insurable structures would require the project's owner to flood proof, relocated, elevate, or demolish the impacted structures.

The preliminary hydraulic analysis completed by Avila and Associates consisted of quantifying the impact to the 100-year water surface elevation for various bridge lengths. They determined that a 500 ft. long structure resulted in an increase of 0.1 ft. to the 100-year water surface elevation due to roadway fill being placed within the limits of the 100-year flood event. An 1,100 ft. long bridge resulted in a decrease of roughly 0.1 ft. to the 100-year water surface elevation since the approach roadway fill is located outside of the floodplain. Therefore, in order to avoid impacts to the 100-year water surface elevation Avila & Associates recommended that the proposed bridge length measure 1,100 ft.

BRIDGE DESIGN CRITERIA

The following is a discussion of specific design criteria and constraints that were considered in the development of the proposed structure recommendations.

Structure Design Standards

The following standards will be used for the design of the new structure and the development of the Final PS&E document:

- AASHTO LRFD Bridge Design Specifications, Sixth Edition, 2012 with California Amendments, January 2014.
  - Dead Load: Tributary dead loads due to structure and attachments self-weight including provision for 35 psf. future wearing surface. No provisions for future utilities have been provided.
  - Live Load: HL93 and Permit Design Live Load with up to 4 feet of equivalent soil height at abutment walls and up to 5 feet of equivalent soil height at wingwalls to approximate the effects of horizontal earth pressure against these components due to live load surcharge
  - Durability: No special durability measures are required.
- Caltrans Division of Engineering (DES) engineering publications including Bridge Design Aids (BDA), Bridge Design Details (BDD), Bridge Design Practice (BDP), Bridge Memo to Designers (MTD), and Bridge Standard Detail Sheets (XS Sheets)
- Caltrans 2018 Standard Specifications and Revised Standard Specifications (RSS)
- Caltrans 2018 Standard Plans and associated Revised Standard Plans (RSP)

Bridge Geometry and Use

In the vicinity of the proposed project, Washington School Road currently functions as a low water crossing and is classified as a major rural collector conveying primarily vehicular traffic. Based on traffic volume data maintained by the County, Washington School Road has an ADT of 737 vehicles per day. The proposed bridge geometry has been established based on the AASHTO's *A Policy on Geometric Design of Highways and Streets (6th Edition)* as well as the preliminary Hydrology and Hydraulic Technical Memorandum provided by Avila and Associates.

<u>Bridge Width</u>
The overall width of the new bridge is 31 ft. 6 in. and accommodates two 11 ft. travel lanes with Concrete Barrier Type 80 and 3 ft. wide shoulders along each edge of deck. In an attempt to minimize construction cost of the project the possibility of using a single lane bridge was investigated; however, the County informed us that any bridge constructed will need to meet AASHTO minimum width requirements based on the ADT and roadway classification.

<u>Bridge Length</u>
The proposed bridge measures a total of 1,100 ft. in length consisting of 115 ft. end spans and six 145 ft. interior spans. The bridge length was set to in accordance with the preliminary hydraulic analysis aiming to prevent any impact to the existing water surface elevation upstream of the structure by locating abutment fill slopes outside the limits of the 100-year flood event with the only obstructions to flow being the proposed piers.

Alignment

At the time of completing this study, Cornerstone received direction from the Alexander Valley Citizens League to scope the replacement bridge along the existing Washington School Road low water crossing. Due to the length of structure required to avoid impacts to the 100-year water surface elevation, a portion of the proposed structure will be on a curved alignment. As part of any future phases of this project, Cornerstone recommends that an alignment study be completed to evaluate and determine the optimal alignment for the new bridge crossing.

Aesthetics

The bridge is located in a rural area surrounded by vineyards and is anticipated to accommodate a very low ADT. Therefore, no special aesthetic provisions have been included in the design at this time.

Barrier Type

Concrete Barrier Type 80 is provided along each edge of deck, per Caltrans Standard Plan RSP B11-60. Type 80 barriers were chosen to provide an open spandrel barrier to assist in reducing the narrow appearance of the structure for motorists and bicyclists when traveling over the structure.

Bike Facilities

Based on our correspondence with the County of Sonoma, we understand that Asti Road is planned to accommodate a Class II Bikeway facility in the future; however, there are no plans to install bikeway facilities along River Road. A Class II Bikeway facility provides a striped lane for one-way bike travel on a street or highway and be a minimum of 4 feet wide. Since a Class II

Bikeway is not planned along River Road, the County recommended that we assume Washington School Road will need to accommodate a Class III Bikeway facility. A Class III Bikeway is a signed shared roadway that provides for shared use with pedestrians or motor vehicle traffic, typically on lower volume roadways. Furthermore, the County requested that shoulders be provided along the full length of the bridge for use by bicyclists. Since bicyclists are anticipated to use the facility tubular bicycle railing has also been added to the Type 80 concrete barriers.

Clearances

Caltrans Office of Special Funded Projects Information and Procedures Guide, Section 2-4 "Hydraulics Report", sufficient freeboard shall be provided above the 50-year water surface elevation (design flood) to pass anticipated drift. For PSR or PR reports completed prior to conducting a drift evaluation, Caltrans ordinarily permits a minimum freeboard of 0.6 m or 2 ft. over the 50-year flood be assumed. In addition, the 100-year flood must also be conveyed within the channel below the soffit of the structure. The current bridge alternatives currently under consideration have been paid out to provide more than the minimum 2 ft. of freeboard above the 50-year water surface elevation. Each alternative will also pass the 100-year water surface elevation.

Corrosion

We are unaware of any corrosive foundation soils that may affect the construction of the proposed bridge as a geotechnical field investigation has yet to be completed. No provisions have been included in the bridge cost estimate to account for mitigation of corrosive foundation soils.

Constructability

Due to the unpredictable nature of storm events, in channel construction activities should be limited to the dry season between the months of May through October. Additionally, since the bridge is located along a route with a low ADT in a rural area, construction staging will not be considered. It is also anticipated that the bridge can be constructed in a single construction season. Heavy equipment will be required within Ash Slough during erection of falsework, installation of drilled shafts, and excavation and backfill operations.

Datum

The vertical datum to be used in the completion of this memorandum is NAVD 88.

Deck Protection

Per Caltrans Memos to Designers 8-2 Attachment 2, the project is located in a Non-Freeze-Thaw area. This refers to mild climates where frost is rare, or moderate climates where frost or light freezing occurs, but chains are seldom used. Additionally, salting of the deck is rare. Therefore, the design and construction guidelines given for Non-Freeze-Thaw areas in Caltrans Memos to Designers 8-2 Attachment 1 will be implemented in the design of the replacement structure.

Falsework

Falsework will be required in the river channel during the construction of the superstructure for each of the proposed bridge alternatives. The area surrounding the proposed bridge is open and largely undeveloped allowing for conventional falsework construction to be employed. All required environmental studies and permits should account for falsework temporarily placed in the river channel.

Bridge Foundations

At this time a geotechnical field investigation has not been completed for the proposed bridge. However, it is anticipated that the bridge will be supported on deep pile foundations consisting of large diameter cast-in-drilled hole concrete piles or large diameter cast-in-steel shell concrete piles.

Hazardous Materials

We are unaware of any hazardous materials that may affect the construction of the proposed bridge. No provisions have been included in the project cost estimate to account for disposal of such materials.

Permits

At this time we are unaware of any environmental or regulatory agency permit requirements that would influence the recommended bridge layout or type.

Removal of Existing Bridge

The roadway is expected to remain closed throughout the duration of construction of the proposed bridge. The existing bridge substructure will need to be completely removed prior to the beginning of construction.

Right-of-Way

It is anticipated that right-of-way acquisition will be required as part of this project; however, the cost of land acquisition is considered outside the scope of this memorandum.

Seismic Design

Seismic design of the bridge will be based on Caltrans Seismic Design Criteria (SDC) version 1.7. A site specific Acceleration Response Spectrum (ARS) curve has been developed and is included in Appendix D.

Utilities

There are not currently any known utilities in the vicinity of the proposed project. However, utility mapping will be completed as part of the survey operation and preparation of a project base map as part of future phases of this project.

SUMMARY OF BRIDGE ALTERNATIVES CONSIDERED

Alternative 1 –Multi-Span ACROW Bridge

Alternative 1 consists of constructing a multi-span ACROW Bridge for the superstructure supported on single column piers and seat type abutments. ACROW Bridge is a prefabricated modular steel bridge manufacturer. In the state of California, these bridges are most typically used in temporary applications such as during construction to maintain vehicular traffic along an adjacent alignment while the permanent bridge is constructed or in emergency situations such as along SR 140 following the Ferguson landslide when two ACROW Bridge trusses were installed detour traffic around the slide.

Based on recent correspondence with Caltrans during the February ACEC/Caltrans Division of Engineering Services Structures Liaison Committee meeting, Caltrans stated that they do not use ACROW Bridges for permanent applications. Furthermore, based on our correspondence with the County they would not permit the use of an ACROW Bridge as they do not have the capacity for the additional maintenance that they require in comparison to precast or cast-in-place concrete structure. Lastly, since it's been assumed that the proposed alignment is to follow the existing low water crossing resulting in a portion of the bridge ending up on a horizontal curve which is not easily accommodated with a modular steel structure. For these reasons, an ACROW Bridge is not recommended.

Figure 1 – ACROW Bridge used to Maintain Vehicular Traffic during Construction

Alternative 2 –Multi-Span Two Lane Cast-in-Place Post Tensioned Concrete Box Girder Bridge

Alternative 2 consists of replacing the existing low water crossing with an eight span cast-in-place post tensioned concrete box girder bridge accommodating two lanes of traffic supported on large diameter cast-in-drilled-hole concrete piles at the piers and seat type abutments. The proposed bridge measures 1,100 ft. in length with 115 ft. end spans and 145 ft. interior spans. The depth of the proposed box girder superstructure is 6 ft., which provides a depth-to-span ratio of 0.041. This depth-to-span ratio is consistent with the guidelines contained in AASHTO LRFD Bridge Design Specifications, 6th Edition Table 2.5.2.6.3-1 and as shown on page 10-26 of Caltrans Bridge Design Aids.

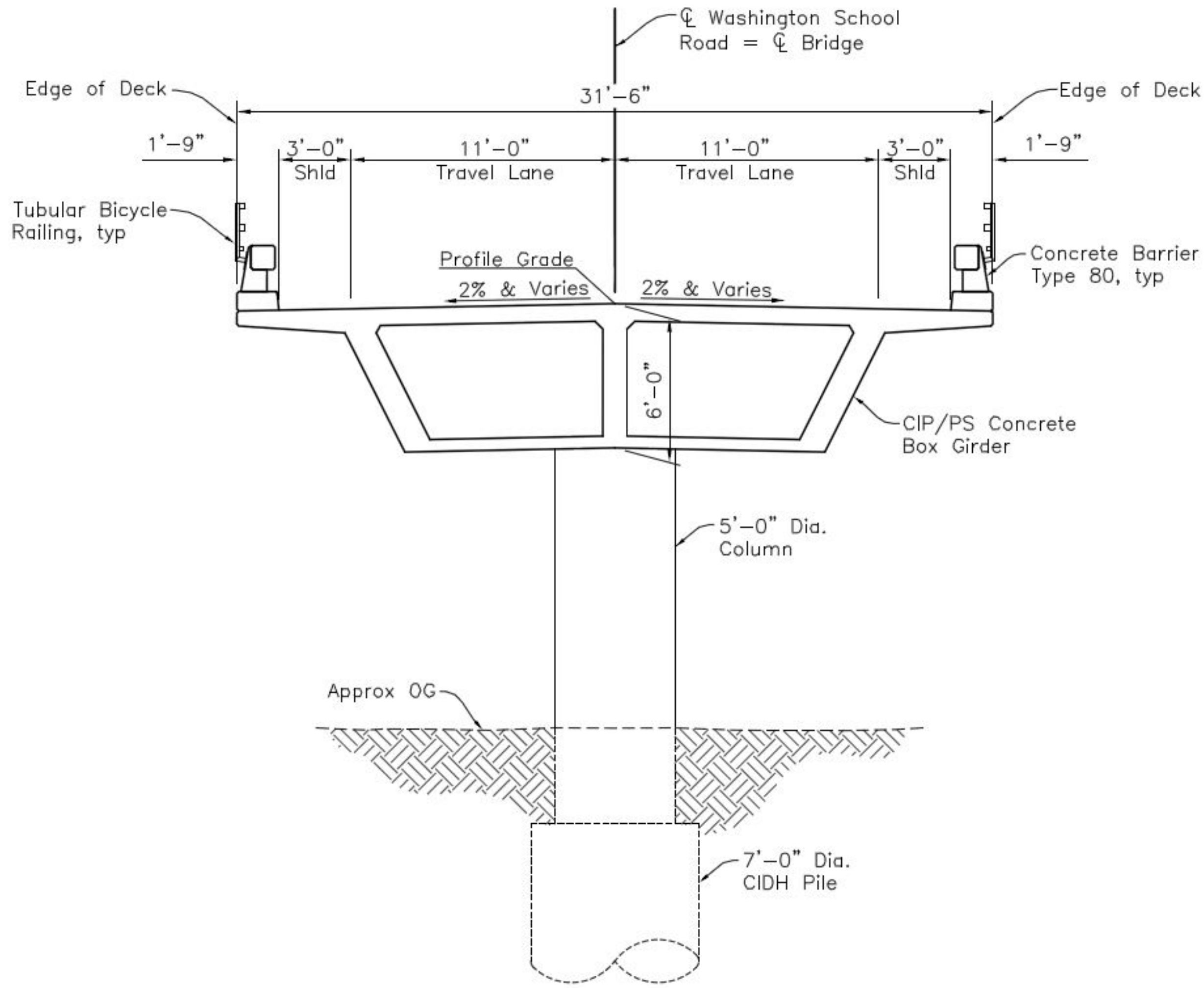


Figure 2 – Two Lane CIP/PS Concrete Box Girder Typical Section

Advantages of a CIP/PS superstructure include its relatively low cost, long span lengths, relatively thin superstructure depth, ease of maintenance, familiarity with this type of construction among a variety of contractors, and closed soffit box girder superstructures have been observed to perform better in seismic events as compared to precast bridges, steel girder bridges, and modular truss bridges. Moreover, cast-in-place superstructures able to accommodate profile grades consisting of a mix of vertical curves and tangent sections, varying cross slopes, and horizontal curves.

In addition to the proposed bridge, retaining walls are anticipated to be required along the western bridge approach fill embankments. The existing roadway is being raised approximately 5 to 8 ft. in order to provide adequate freeboard below the proposed bridge soffit. The retaining walls are anticipated to be used to minimize impacts to the existing drainage basin part of the Chateau Souverain Asti Winery as well as to minimize fill placed in the adjacent river channel. Furthermore, at this time it is assumed that a minimum of approximately 500 ft. of approach roadway work will be required. The approach roadway is assumed to extend from the end of existing pavement along Washington School Road the start of the proposed bridge as well as from the end of bridge to River Road.

Preliminary Structure Construction Cost Estimate

The construction cost estimate below is based on industry guidelines, Caltrans Bridge Design Aids estimating charts and Comparative Bridge Costs, as well as previous Cornerstone projects. The construction costs below do not include costs for utilities (casings, carriers, conductors, venting, testing), right-of-way costs, permits, roadway, environmental mitigation, and contaminated/hazardous material disposal. A 10% Mobilization and 30% Contingency were added to the sum of the unit prices to determine the total construction cost. The proposed cost should be used for preliminary planning purposes only.

The preliminary structural construction cost estimate for Alternative 2 is $13.2 million.

	Bridge	**Retaining Walls**
Structure Depth (ft) =	6	--
Length (ft) =	1100	317
Width (ft)/Height (ft) =	31.5	10.6
Area (ft^2) =	34650	3367
Cost/sq ft including: 10% Mobilization 30% Contingency	$360	$210
Construction Cost =	$12,474,000.00	$706,973.40
Exist Bridge Removal =	$30,000.00	--
Individual Cost =	$12,504,000.00	$706,973.40
Combined Structural Construction Cost Estimate =		$13,210,973.40

Figure 3 – Alternative 2 Preliminary Structural Cost Estimate

Alternative 3 – Multi-Span Single Lane Cast-in-Place Post Tensioned Concrete Box Girder Bridge

Alternative 3 consists of replacing the existing low water crossing with an eight span cast-in-place post tensioned concrete box girder bridge accommodating a single lane of traffic supported on large diameter cast-in-drilled-hole concrete piles at the piers and seat type abutments. The proposed bridge length and substructure support configuration remains unchanged from Alternative 2 with the total length measuring 1,100 ft. consisting of 115 ft. end spans and 145 ft. interior spans. The depth of the proposed box girder superstructure remains unchanged from the two lane alternative at 6 ft., resulting in a depth-to-span ratio of 0.041.

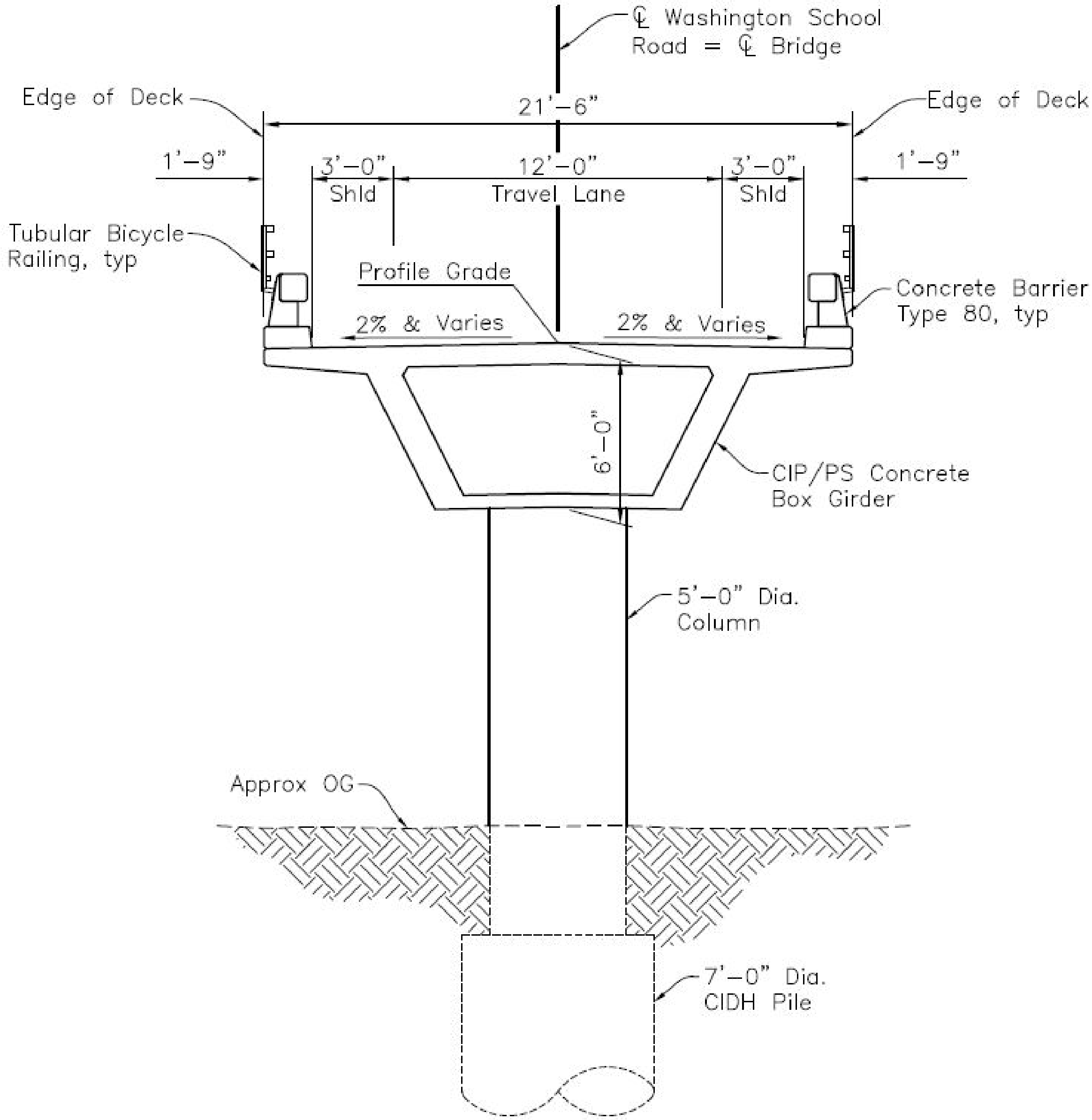


Figure 4 – Single Lane CIP/PS Concrete Box Girder Typical Section

While the County has indicated that a single lane structure will not be an allowed replacement alternative on this particular project since it does not comply with minimum traveled widths presented in AASHTO's *A Policy on Geometric Design of Highways and Streets (6th Edition)*, we understand that it is of particular interest to the Alexander Valley Citizens League and have elected to include it as a potential alternative.

The proposed limits of retaining walls and approach roadway work described as part of Alternative 2 is will be required as part of this alternative as well.

Preliminary Structure Construction Cost Estimate

The construction cost estimate below is based on industry guidelines, Caltrans Bridge Design Aids estimating charts and Comparative Bridge Costs, as well as previous Cornerstone projects. The construction costs below do not include costs for utilities (casings, carriers, conductors, venting, testing), right-of-way costs, permits, roadway, environmental mitigation, and contaminated/hazardous material disposal. A 10% Mobilization and 30% Contingency were added to the sum of the unit prices to determine the total construction cost. The proposed cost should be used for preliminary planning purposes only.

The preliminary structural construction cost estimate for Alternative 3 is $10.2 million.

	Bridge	Retaining Walls
Structure Depth (ft) =	6	--
Length (ft) =	1100	317
Width (ft)/Height (ft) =	21.5	10.6
Area (ft^2) =	23650	3367
Cost/sq ft including:		
10% Mobilization		
30% Contingency	$400	$210
Construction Cost =	$9,460,000.00	$706,973.40
Exist Bridge Removal =	$30,000.00	--
Individual Cost =	$9,490,000.00	$706,973.40
Combined Structural Construction Cost Estimate =		$10,196,973.40

Figure 5 – Alternative 3 Preliminary Structural Cost Estimate

CONCLUSION AND MOST PROMISING ALTERNATIVE

At this time, the most promising alternative and our recommendation for use in scoping the project moving forward in is Alternative 2, the multi-span cast-in-place post tensioned concrete box girder accommodating two vehicular travel lanes in compliance with AASHTO minimums.

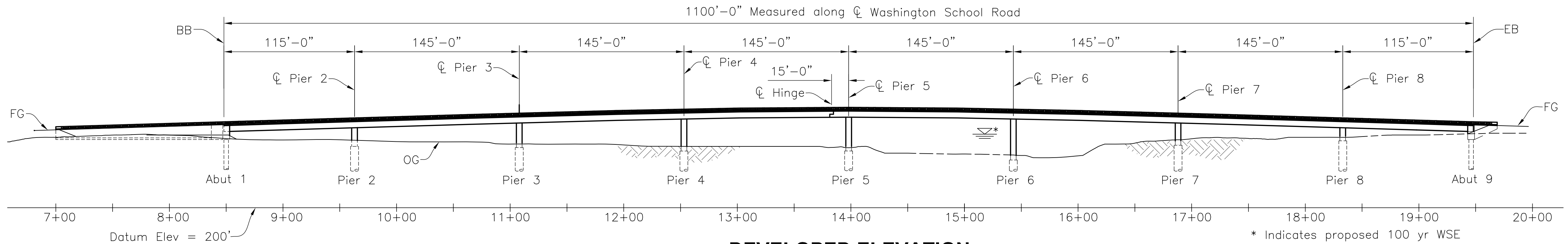
If you have any questions or concerns, please call.

End memo.

Attachments:

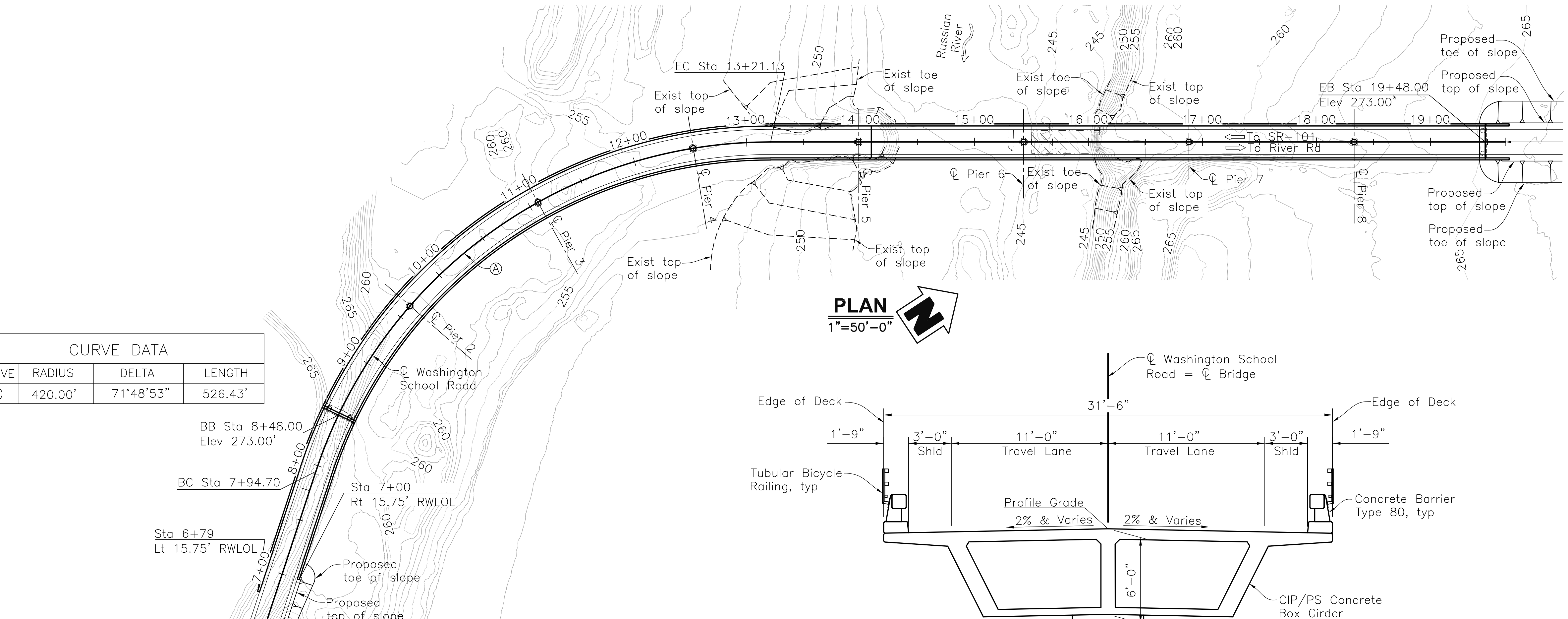
- Attachment 1 – General Plan for Two Lane Multi-Span CIP/PS Concrete Box Girder
- Attachment 2 – Aerial View of Proposed Bridge Layout
- Attachment 3 – Hydrology & Hydraulics Analysis for the Replacement of the Russian River Summer Crossing over Russian River (Bridge No. 20C0504) Technical Memorandum

Attachment 1 – General Plan for Two Lane Multi-Span CIP/PS Concrete Box Girder Bridge



DEVELOPED ELEVATION

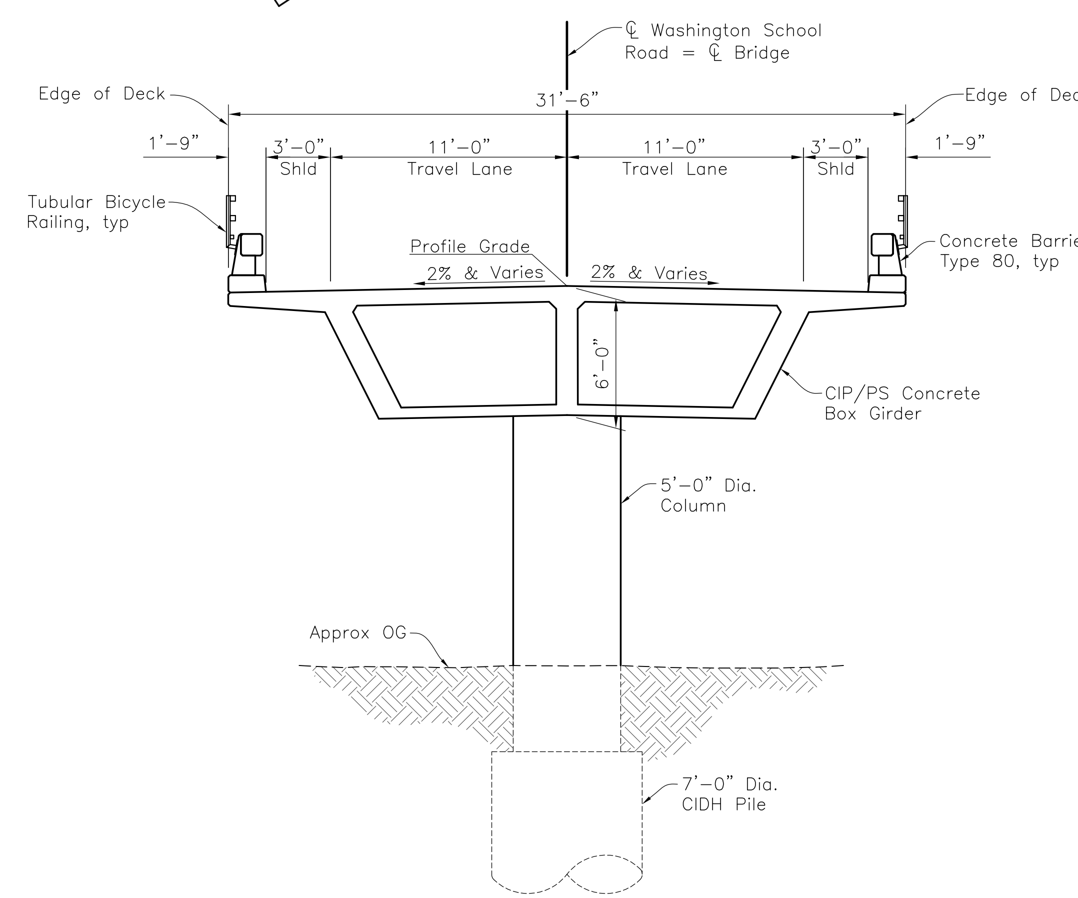
1"=50'–0"



PLAN

1"=50'–0"

CURVE DATA			
CURVE	RADIUS	DELTA	LENGTH
A	420.00'	71°48'53"	526.43'



TYPICAL SECTION

1/4"=1'–0"

Legend:

(hatched)	Exist Bridge to be Removed
(solid line)	Indicates New Construction
(dash-dot line)	Indicates Existing Bridge

Conceptual Cost Estimate

Date of Estimate	=	2/15/19
Structure Depth	=	6'–0"
Length	=	1,100'–0"
Width	=	31'–6"
Area	=	34,650 SF
Cost /sq ft including:		
10% Mobilization		
30% Contingency	=	$360
Cost New Bridge	=	$12,474,000
Exist Bridge Removal	=	$30,000
Total Cost	=	$12,504,000

NOT FOR CONSTRUCTION

DESIGNED BY: NRZ | DRAWN BY: TZW | CHECKED BY: | DATE:01/30/19

REV. | DATE | DESCRIPTION | BY

CORNERSTONE structural engineering group
986 W Alluvial Ave - Suite 201
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GENERAL PLAN SHEET No. 1

ASTI BRIDGE AT RUSSIAN RIVER

CALIFORNIA

ASTI

SHEET NUMBER S1 OF 2 SHEETS

DRAWING NO. 2018029

Attachment 2 – Aerial View of Proposed Bridge Layout

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ASTI BRIDGE AT RUSSIAN RIVER

ASTI | SONOMA COUNTY | CALIFORNIA

AERIAL VIEW OF PROPOSED BRIDGE LAYOUT

EXHIBIT 1

JOB #: 2018029

DATE: 04/10/2019

Attachment 3 – Hydrology & Hydraulics Analysis for the Replacement of the Russian River Summer Crossing over Russian River (Bridge No. 20C0504) Technical Memorandum

Technical Memorandum

To: Bobby Zermeno, Project Manager, CSEG

From: Cathy Avila, PE, Principal, Avila and Associates

Date: May 23, 2019

RE: **Hydrology and Hydraulic Analysis for the Replacement of the Russian River Summer Crossing over Russian River (Bridge # 20C0504), Sonoma County, California**

INTRODUCTION

This memo presents the preliminary results of the hydraulic analysis for the replacement of Russian River Summer Crossing over the Russian River (Br # 20C0504) with an all weather crossing. The two replacement options include a 500 ft long bridge and a 1,100 ft long bridge. The existing bridge is located in Asti, CA approximately 4 miles southeast of Cloverdale, CA as shown in Figure 1 and Figure 2. The datum elevation used for this study is NAVD-88[1].

Figure 1: Location Map

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[1] Sonoma County. 2016. "Sonoma County Vegetation Mapping and LiDAR Program: Technical Data Report." February.

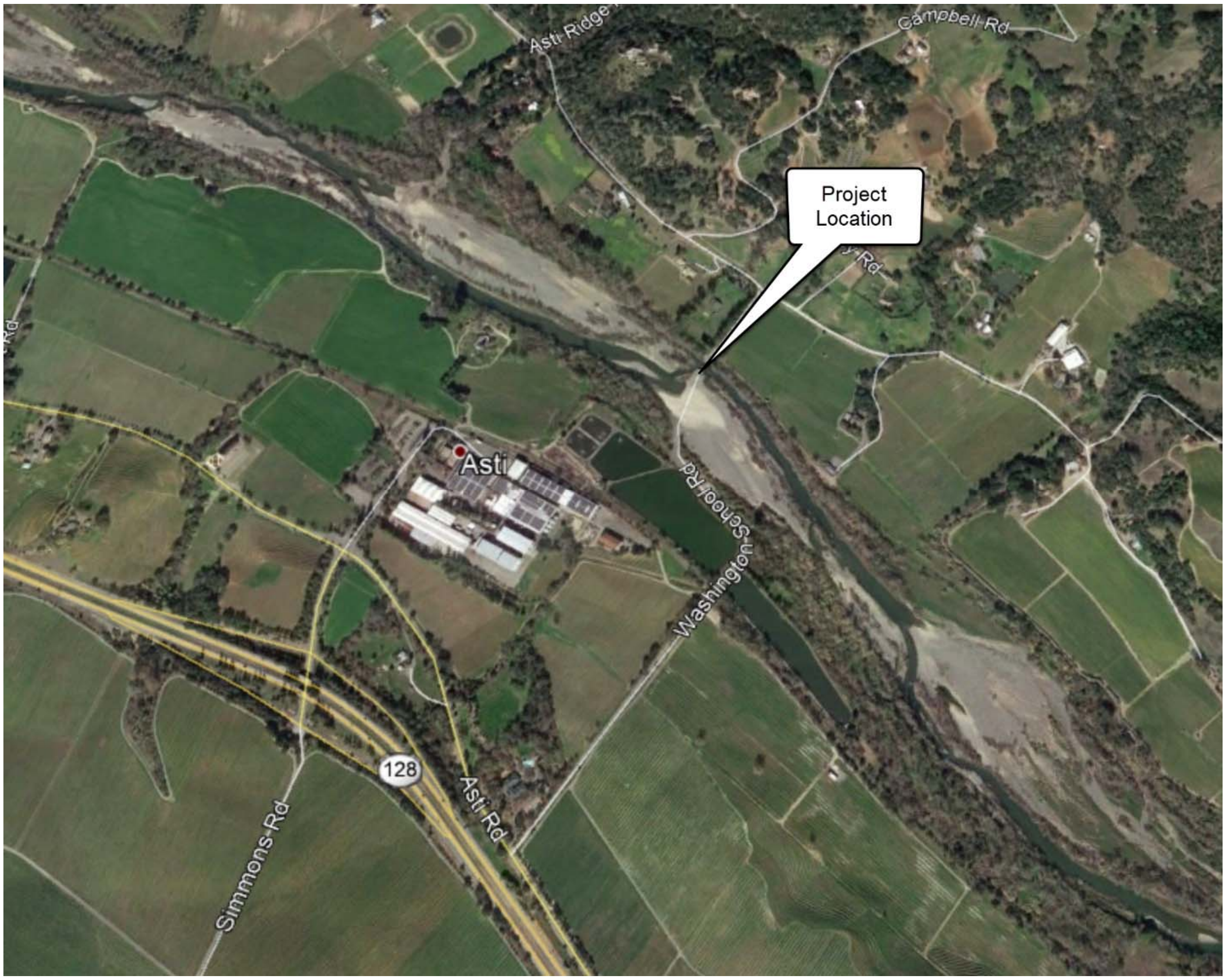

Figure 2. Zoomed in view of project location map.

As shown in the FIRMette below (Figure 3), the project is located within a FEMA floodway. According to 44 CFR Section 60.3 (d) (3) of the National Flood Insurance Program (NFIP) regulations states that a community shall *"prohibit encroachments, including fill, new construction, substantial improvements, and other developments within the adopted regulatory floodway unless it has been demonstrated through hydrologic and hydraulic analyses performed in accordance with standard engineering practice that the proposed encroachment would not result in any increase in flood levels within the community during the occurrence of the base (100-year) flood discharge."* If the water surface elevation is increased and affects any structures, it is the project owner's responsibility to floodproof, relocate, elevate, or demolish (FRED) the impacted structures.

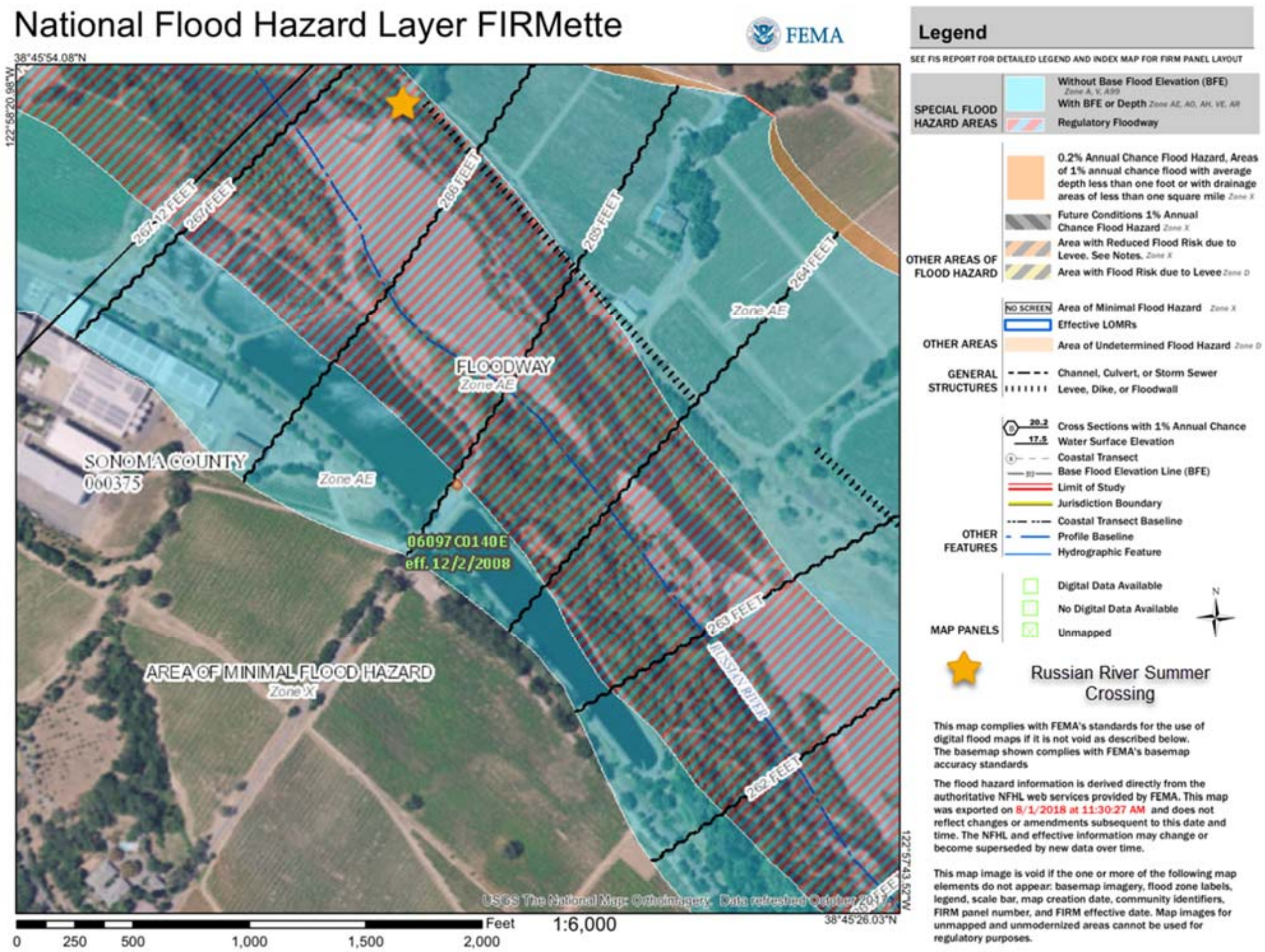

Figure 3. FEMA FIRMette of the project location effective 12/2/2008

Avila and Associates reviewed the pertinent bridge maintenance records for the existing bridge to review the typical impacts to bridges along this reach. Details of the bridge and a summary of the maintenance records are shown in Table 1.

Table 1: Existing bridge information and summary of maintenance records

	Russian River Summer Xing-Asti
Bridge Number	20C0504
Bridge Length (ft)	60
Span Lengths (ft)	2 @ 28 ft
Bridge Type	Two span simply supported and removable steel girders (10) with ARMCO corrugated decking and precast concrete seat abutments with short monolithic wingwalls all founded on steel H-piles
Debris Challenges	n/a
Cross Sections Available for	1993, 1999, 2001, 2006, 2011, 2012
NBIS Item 113 (scour) code	U (unknown foundations)
ELI Flag 361 Condition State[2]	2
ELI Flag 220/6000 (Pile Cap or Footing RC/Scour) Condition State[3]	2
Pier Type	Precast concrete pier wall founded on steel H-piles
Year Built	1992
Year Widened	n/a
Scour Challenges	2001[4], 2003[5], 2005[6], 2006[7], 2007[8], 2009[9], 2011[10], 2012[11], 2013[12], 2014[13], 2015[14], 2016[15], 2017[16]

[2] In 2013 prior to change in element inspection methodology.
[3] In 2017 after change in element inspection methodology.
[4] Submerged steel piles under Pier 2 are exposed approx. 1.6 meters more than what was indicated in the 1999 section. The piles under the abutments are exposed 1-2 meters. The piles at all supports are exposed up to 2.5 meters.
[5] Undermining of abutments and Pier 2 were visually evident, piles supporting Pier 2 exposed and a section of the most upstream pile supporting the included debris barrier of Pier 2 was missing. Piles supporting the abutments exposed at least 1 meter.
[6] Same as 2003.
[7] Channel has degraded since 1993 by 0.9 m in span 1 to 0.6 in span 2. All supporting steel piles at Abutment 1, Pier 2, and Abutment 3 were exposed ranging 1.5m to 2.0m.
[8] Piles supporting Pier 2 exposed up to 1.3 meters (11 piles visible). Upstream section of the pile supporting the inclined debris barrier of Pier 2 was missing. The piles supporting both abutments are exposed up to 1 meter (4 piles visible at Abutment 1 and 5 piles visible at Abutment 2).
[9] Same as 2007 with the addition that the channel has degraded 0.3 meters at Pier 2 only and 5 piles are exposed at each abutment.
[10] Same as 2009.
[11] Same as 2011.
[12] Five piles at each abutment exposed up to 4 feet. All 11 piles visible at Pier 2 and exposed up to 5 feet.
[13] Five piles exposed at Abutment 1 up to 2 feet. Six piles exposed at Abutment 3 up to 5 feet. The piles supporting Pier 2 are exposed by up to 7.5 feet.
[14] Same as 2014.
[15] Two of the upstream piles at Abutment 1 are exposed up to 2 feet. The piles supporting Pier 2 are exposed up to 2 feet. Six of the piles under Abutment 3 are exposed up to 5 feet. Channel has aggraded around Pier 2 approx. 3 to 5 feet. Appears the channel was regraded since 2015 inspection.
[16] Same as 2016.

HYDROLOGY

The Asti Summer Crossing is approximately 3.7 miles upstream of the confluence with Gill Creek on the Russian River. A FEMA Flood Insurance Study (FIS) determined the 50- and 100-year discharges for the Russian River upstream of the confluence with Gill Creek and these discharges were used for the hydraulic analysis as shown in Table 2.

Table 2. Discharges used for analysis (cfs)

	Design	Base
Frequency (years)	50	100
Discharge (cubic feet per second)	67,000	76,000

For design purposes, a second approach to determining the discharges will be necessary. See Appendix A for a summary of the FIS study.

HYDRAULICS

Previous Analysis

Avila and Associates received HEC-2 analysis from FEMA which was completed in 1979. After recreating and reviewing the HEC-2 model in HEC-RAS, the HEC-2 information was determined to be unusable as the existing conditions model. The bridge locations and cross sections in the HEC-2 model could not be referenced to current conditions and the Russian River Summer Crossing was not included in the 1979 analysis. Therefore, a new 2D HEC-RAS model was created for the existing condition as described below.

Updated Analysis

Hydraulic parameters (water surface elevations and velocities) were obtained from the U.S. Army Corps of Engineers HEC-RAS (Hydraulic Engineering Center River Analysis System) version 5.0.5. A 2D hydraulic analysis was performed using Digital Elevation Model (DEM) information obtained from Sonoma County as shown in Figure 4.

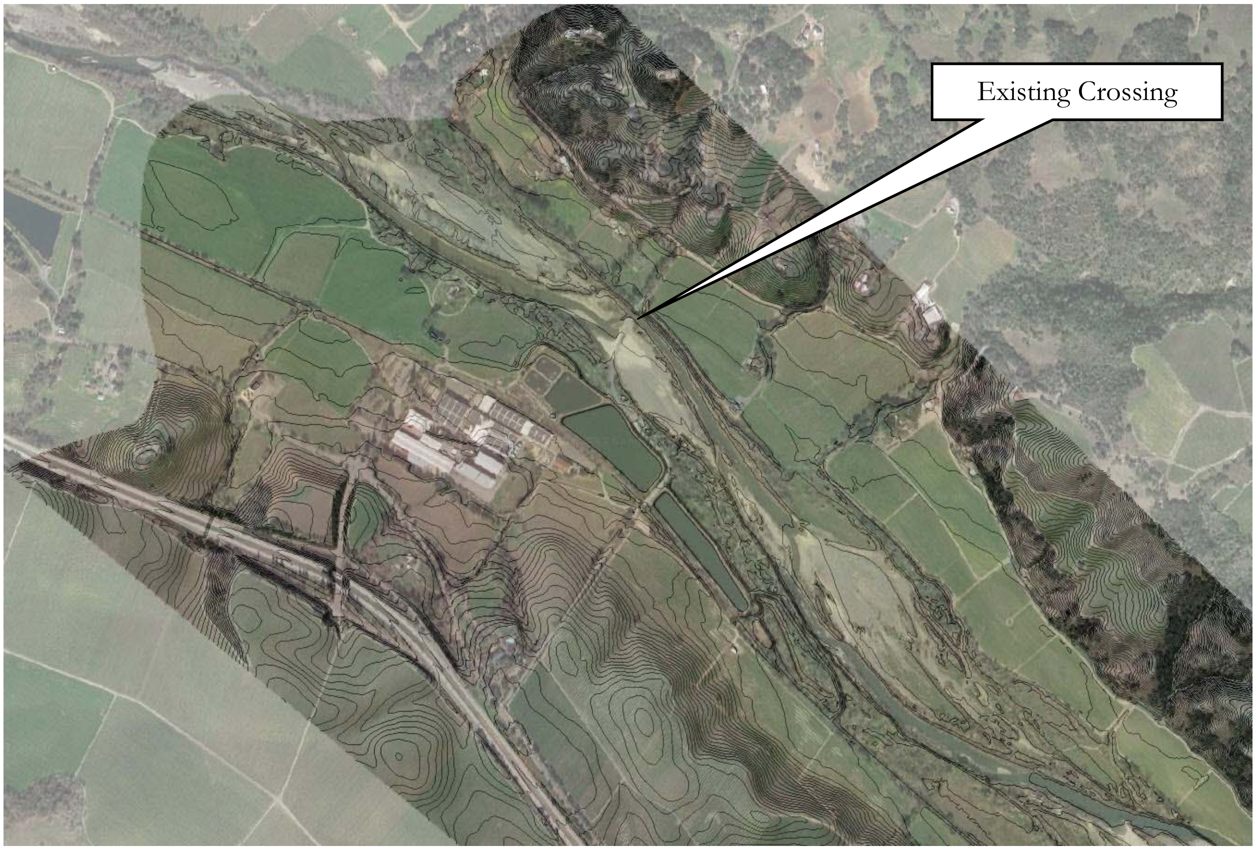

Figure 4. DEM used for 2D hydraulic analysis (5 ft contours shown).

A 2D flow area using a 30 ft x 30 ft grid was used for the analysis as shown in Figure 5.

Figure 5. 2D Flow Area used for analysis.

A close up of the DEM at the existing crossing is shown in Figure 6. It appears that a portion of the existing roadway was washed out. For the existing condition analysis, a surface was created using Autocad Civil 3D that approximates the pre-washout condition. The surface was converted to a DEM and combined with the original DEM as shown in Figure 7. The existing bridge was modeled as a double box culvert with inside dimensions matching the clear space dimensions shown in as-built drawings contained in the bridge inspection reports as shown in Figure 8. The soffit elevation of the culverts was approximated to be 253.5 by subtracting the deck thickness shown in the as-built drawings from the DEM roadway elevation at the north approach as shown in Figure 9.

Figure 6. Close up of DEM at the existing crossing (2 ft contours shown).

Figure 7. DEM with restored roadway (approximate) for existing condition analysis.

Figure 8. Existing bridge modeled as double box culvert (plan view).

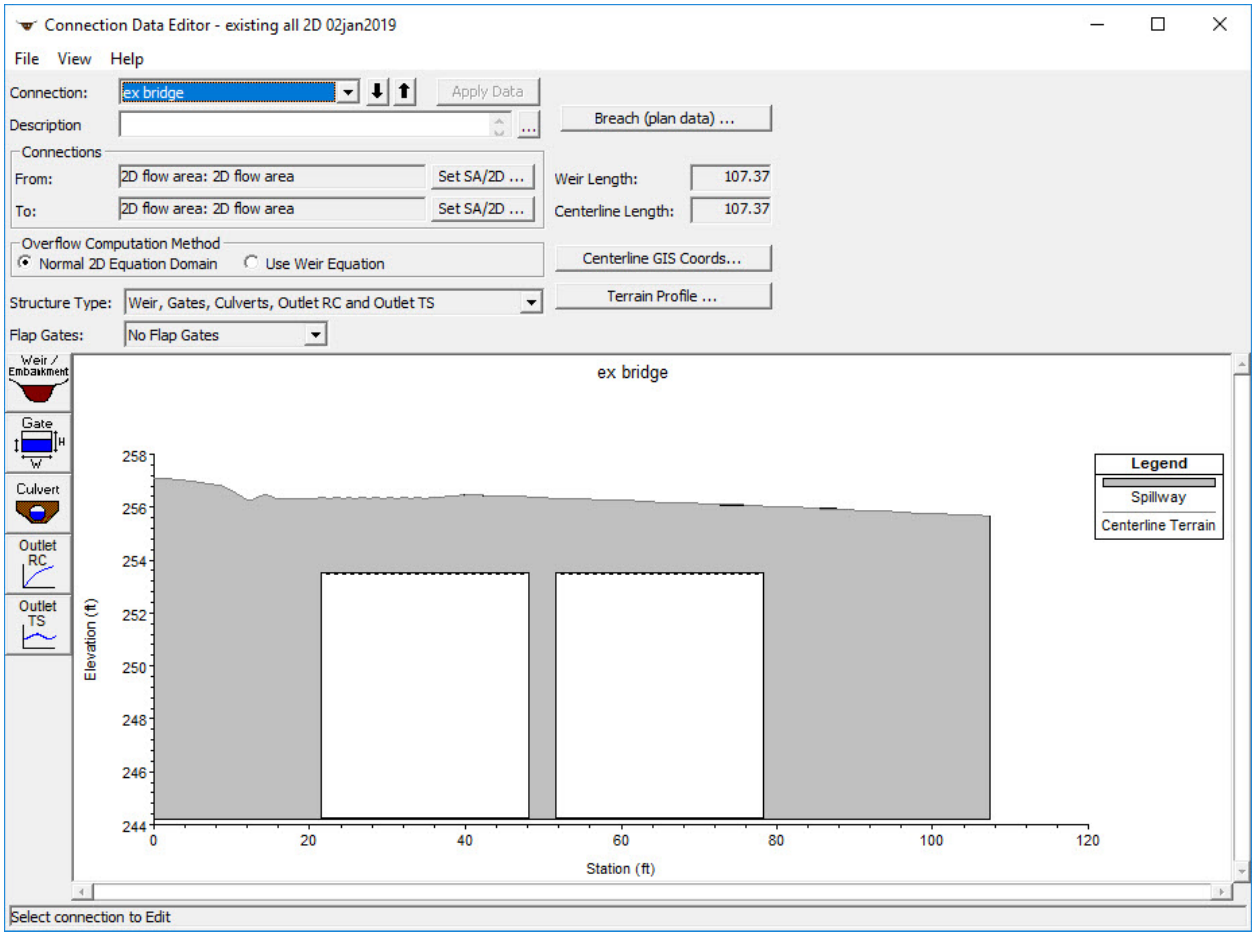

Figure 9. Existing bridge modeled as double box culvert (profile view).

For the proposed condition analyses, surfaces of the assumed finish grade of the roadway approaches were constructed using Civil 3D. The abutments were represented by a vertical face in the surfaces. Similarly, individual surfaces of the piers were constructed assuming 18 ft long by 6 ft wide pier walls with round ends. The elevation of the top of the piers was set above the computed maximum water surface elevation taken from the existing condition analysis results. The roadway approach and pier surfaces were converted to DEM's and combined with the original DEM (without the restored roadway) and used for the proposed condition analyses. The resulting DEM for the proposed 500 ft long bridge option is shown in Figure 10.

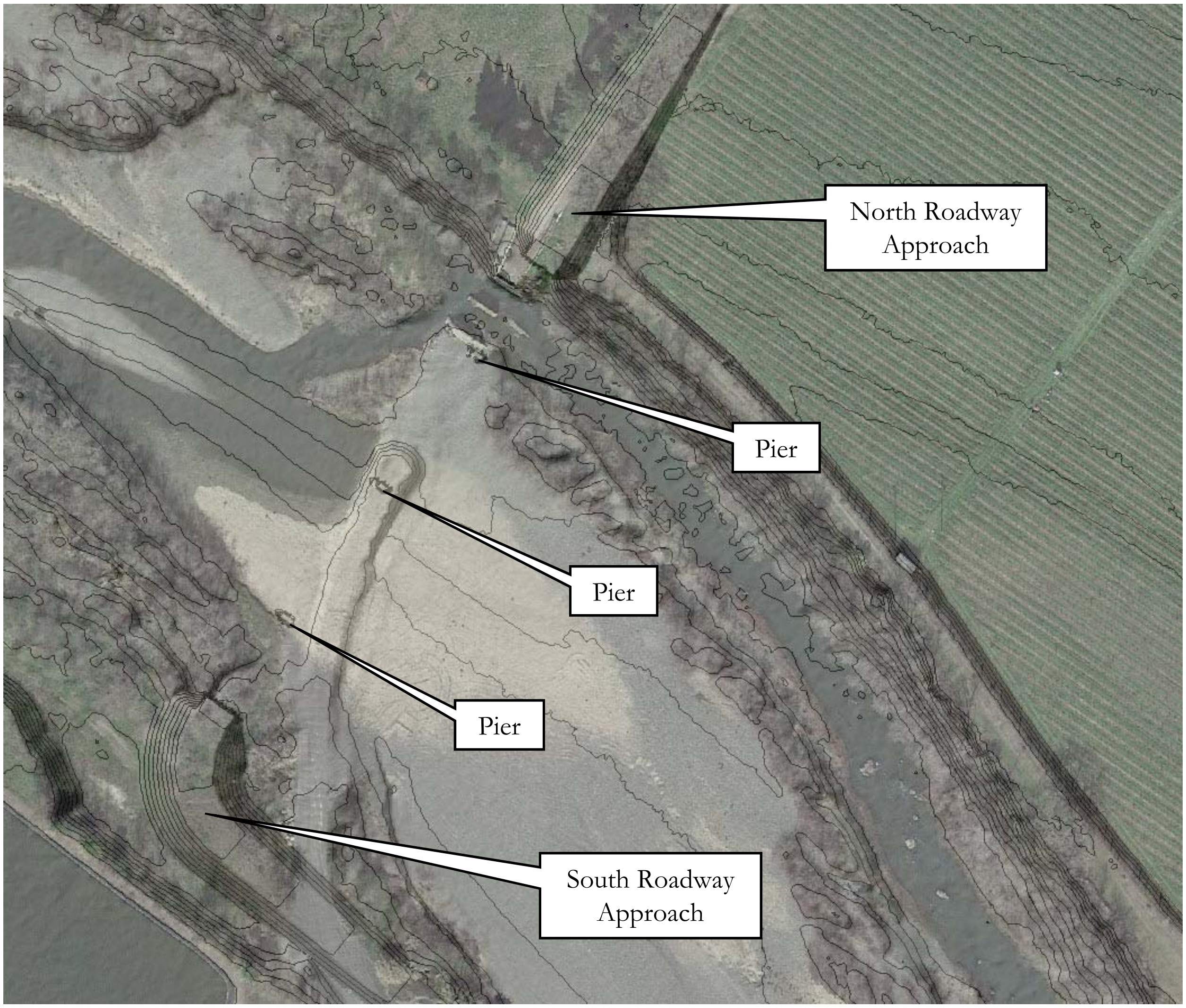

Figure 10. DEM used for proposed 500 ft long bridge.

Land use within the 2D flow area was determined from Google Satellite imagery and manning's n-value regions were created using the following n-values; 0.10 for commercial and residential areas, 0.065 for areas with heavy vegetation (used as the default n-value for the 2D flow area geometry), 0.04 for areas with medium vegetation, and 0.035 for areas with light vegetation and the channel bottom.

A hypothetical flow hydrograph was used as the upstream boundary condition for the 2D hydraulic analyses as shown in Figure 11. A normal depth with an energy grade line slope of 0.004 ft/ft was used as the downstream boundary condition and is based on the approximate slope of the channel per the DEM.

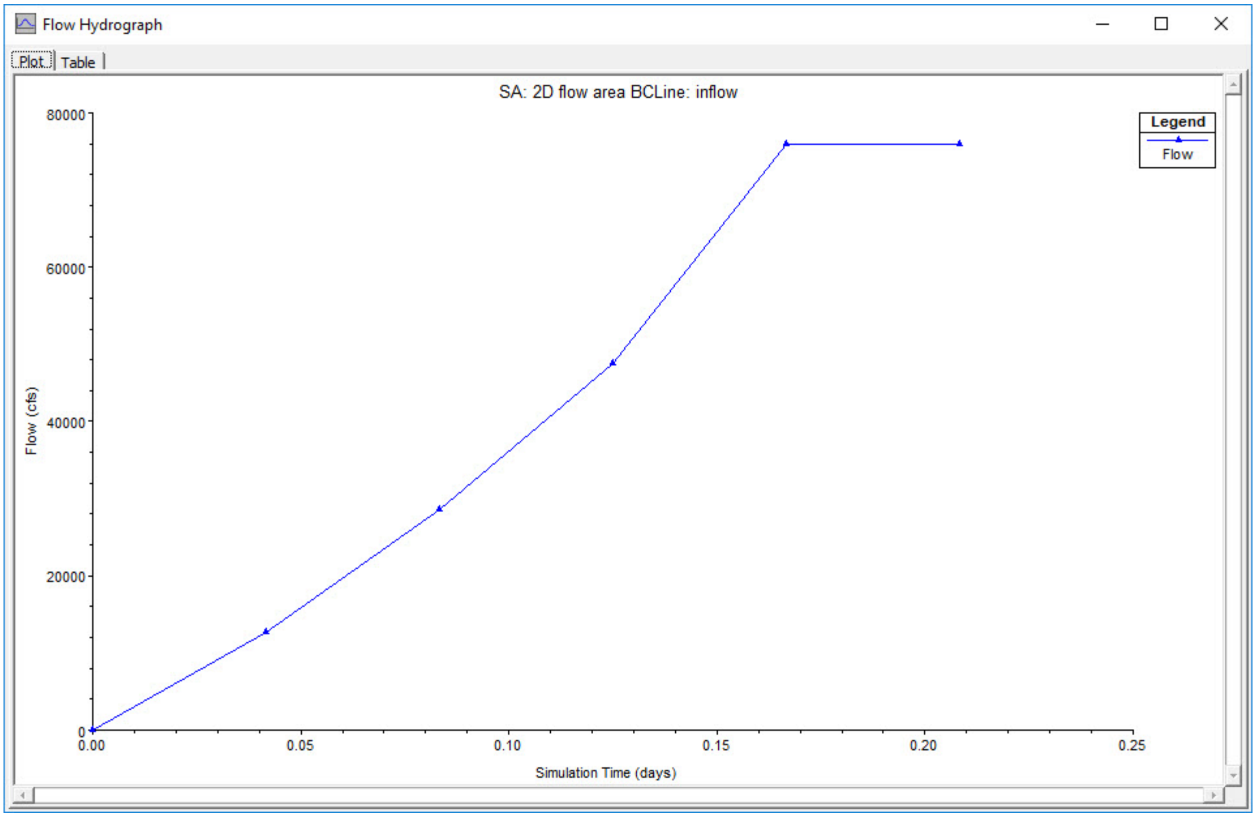

Figure 11. Hypothetical flow hydrograph used for analyses (peak = 76,000 cfs).

Other parameters used in the 2D hydraulic analyses were:

- Simulation time of 5 hours
- Time interval of 1 second
- Diffusion Wave equation set

RESULTS

Existing Conditions

Under existing conditions, the flow in the Russian River flow is split upstream of the bridge and overtops the eastern roadway as shown in Figure 12.

Figure 12. Flow splits upstream of bridge under existing conditions

The maximum water surface elevation (WSE) at the existing bridge is 264.9 feet as shown in Figure 13.

Figure 13. Water surface elevation results for existing conditions

The water velocities are highest within the channel (reaching approximately 17 fps in the southeastern main channel) and immediately after the flow splits at the roadway embankment (approximately 10 fps). The southeastern overbanks are flooded with relatively stagnant water as shown in Figure 14. The water surface elevation in the region is more consistent near 260 feet and velocities are below 2 fps. This indicates the water in the overbanks is not only due to the overtopping of the roadway, but is also caused by backwater from downstream.

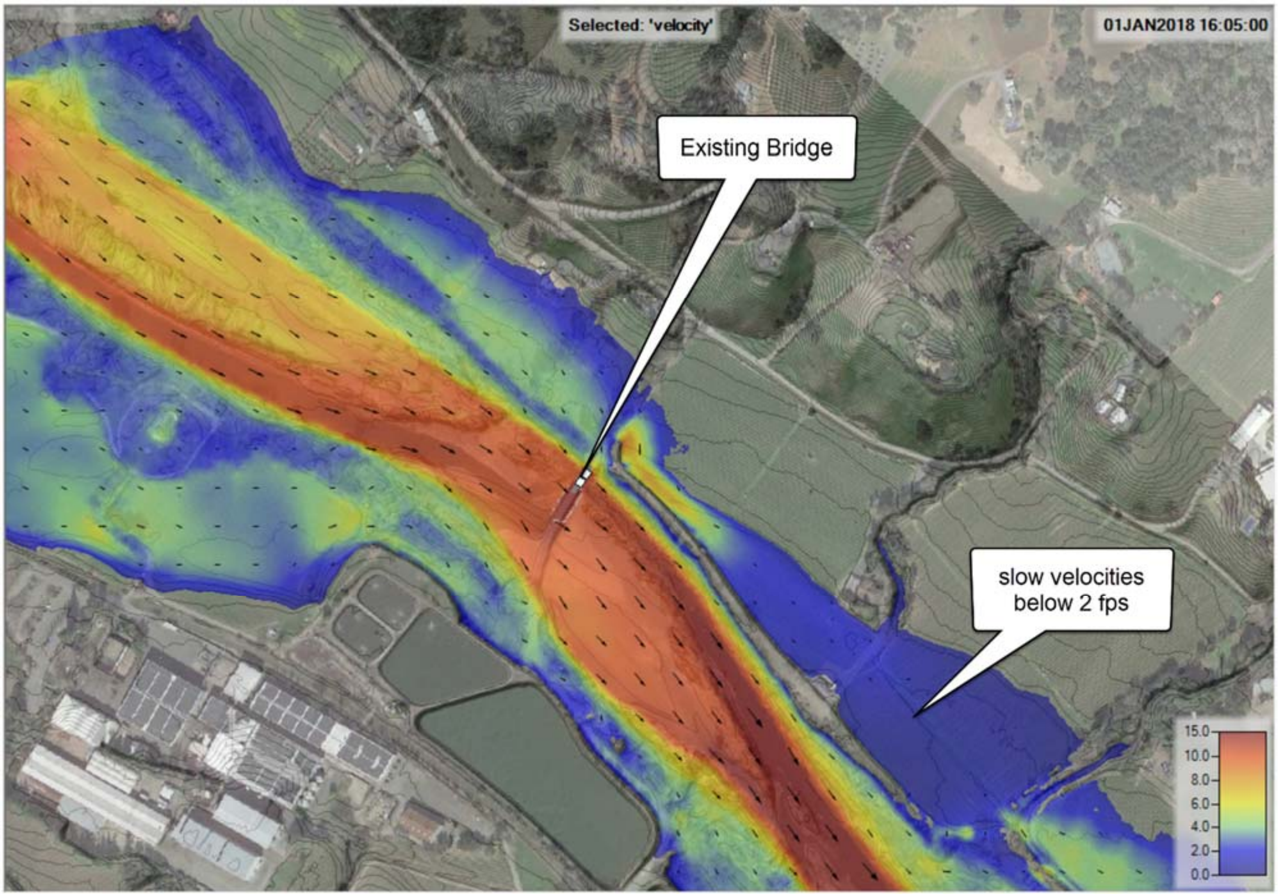

Figure 14. Velocity results (with vectors) for the existing condition

Proposed Conditions 500-ft Long Bridge

The new approach roadway for the 500-ft long bridge blocks the flow that overtops the roadway under existing conditions (Figure 15). This results in more water flowing below the bridge and a maximum WSE at the bridge of 265 ft, which is a WSE increase of 0.1 ft.

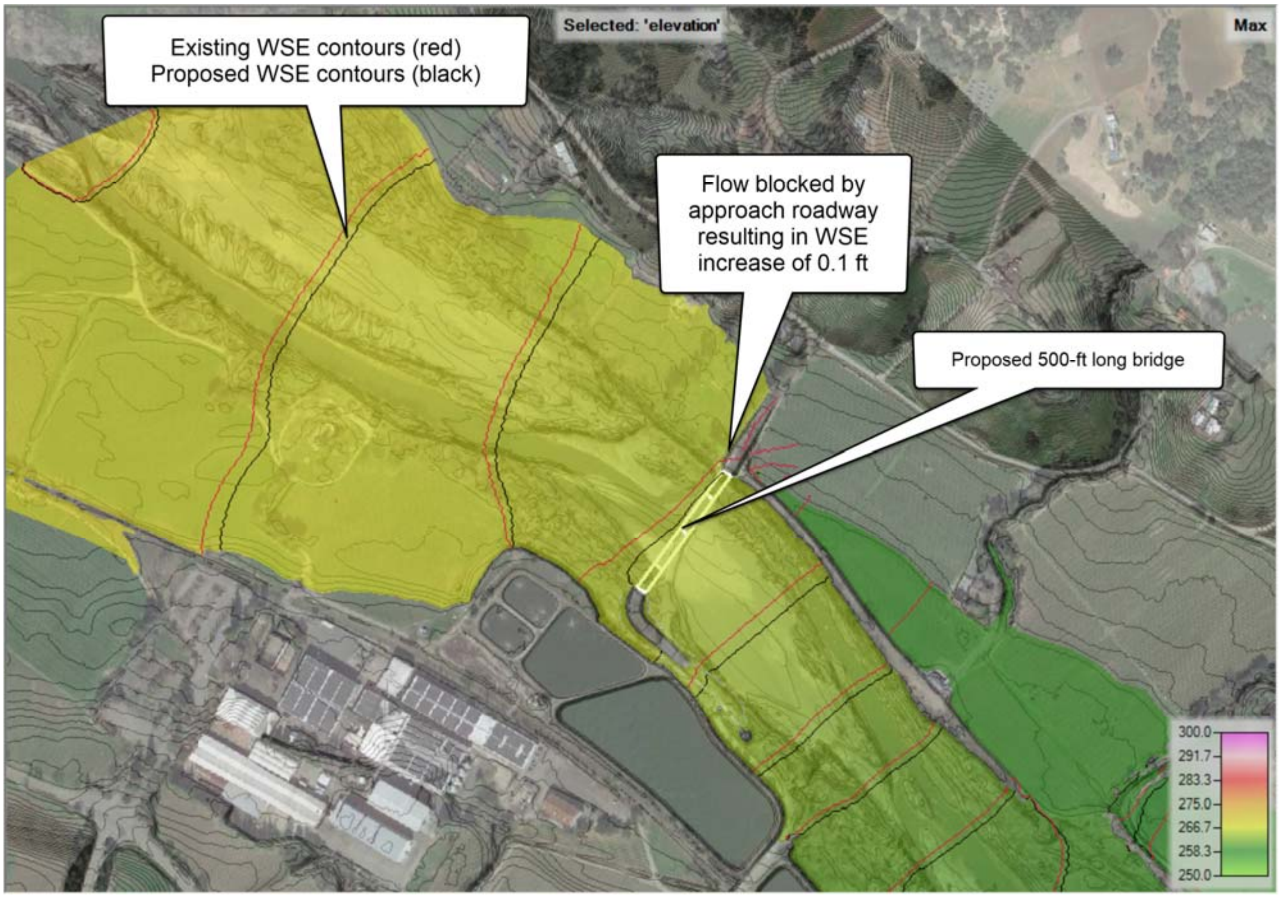

Figure 15. Water surface elevation results for proposed 500-ft long bridge

Under the 500-ft long proposed conditions channel velocities do not differ significantly from existing conditions (Figure 16). Due to backwater from downstream of the bridge, water is still present in the overbanks; however, the velocities are below 1 fps.

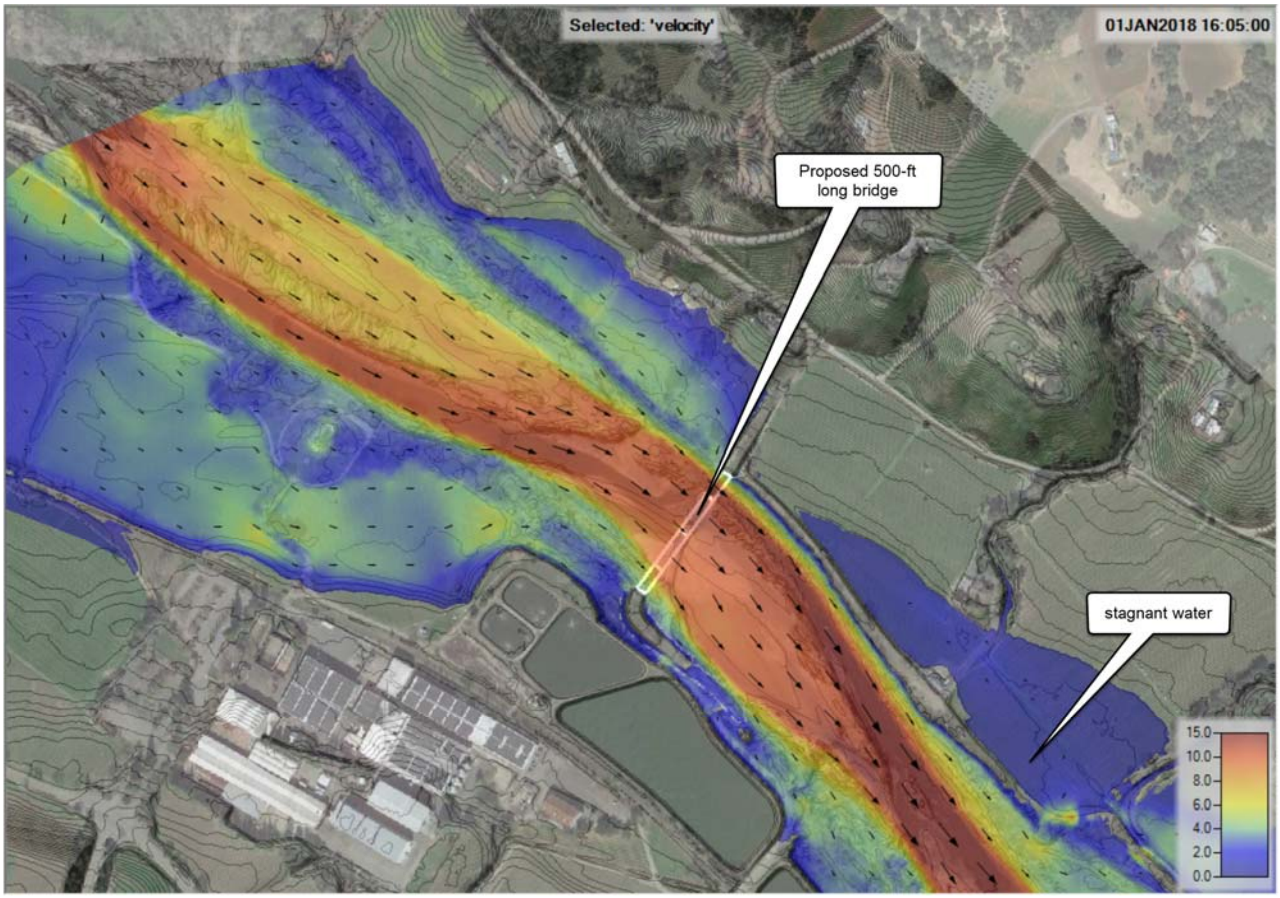

Figure 16. Velocity results (with vectors) for proposed 500-ft long bridge

Proposed Conditions 1,100-ft Long Bridge

With the longer bridge alternative, the elevated approach roadway is set back from the main channel, allowing the flow to go under the bridge and overtop the eastern bank similarly to existing conditions. The increase in waterway, results in a 0.1 ft decrease in WSE at the bridge with a proposed WSE of 264.8. A comparison of existing and proposed WSEs is included in Figure 17.

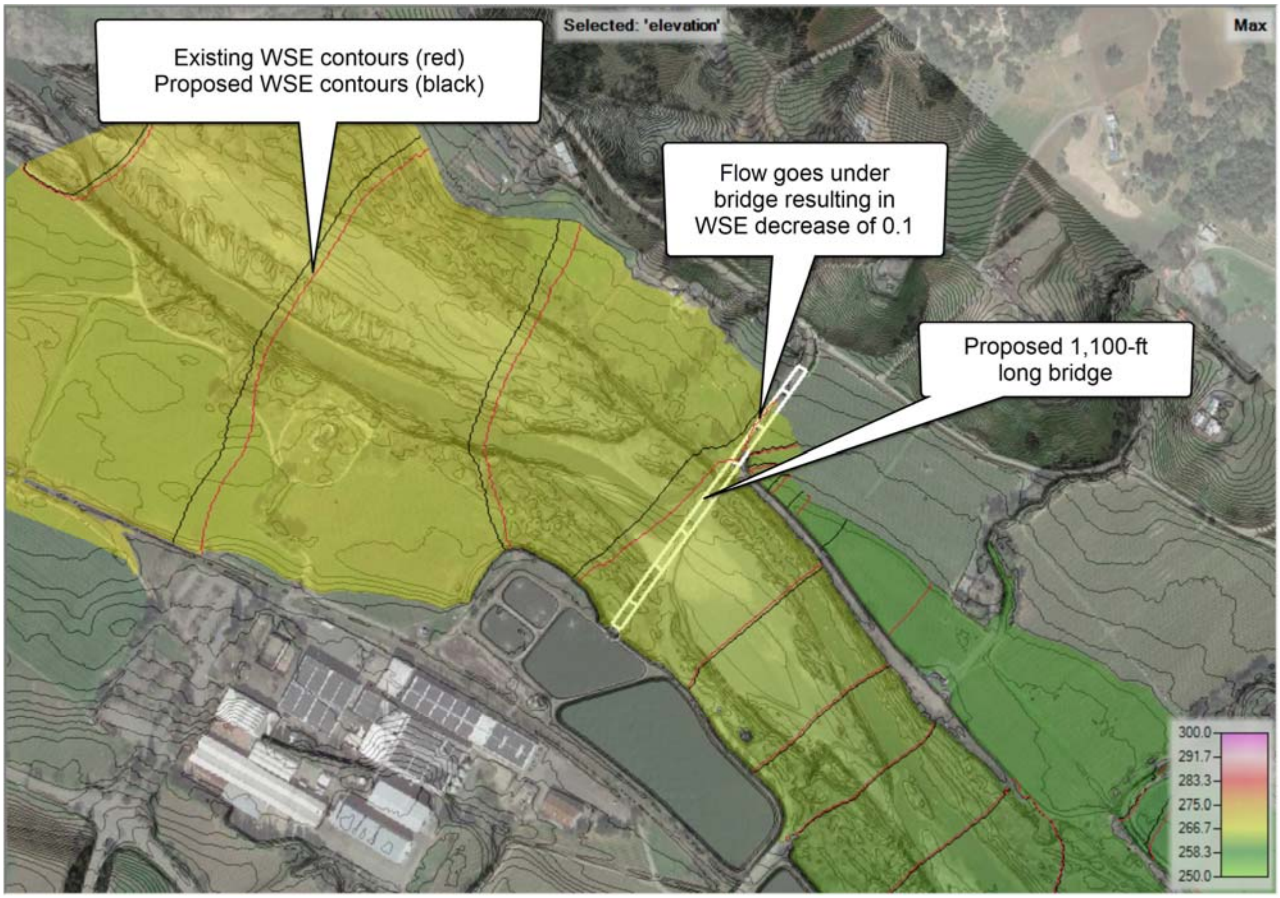

Figure 17. Water surface elevation results for proposed 1,100-ft long bridge

Velocities with the 1,100 ft long bridge are not significantly different than existing conditions. Channel velocities reach 17 fps, velocities in the overbanks are maximum 9 fps just south of the existing roadway embankment (approximately 1fps less than existing conditions), and remain at 2 fps in the more stagnant, backwater area. Proposed velocities are shown in Figure 18. It is worth noting that, as modeled, the approach roadway for a straight 1,100 ft long bridge is not feasible for roadway design, however it is hydraulically representative of the proposed bridge and suitable for this stage of analysis.

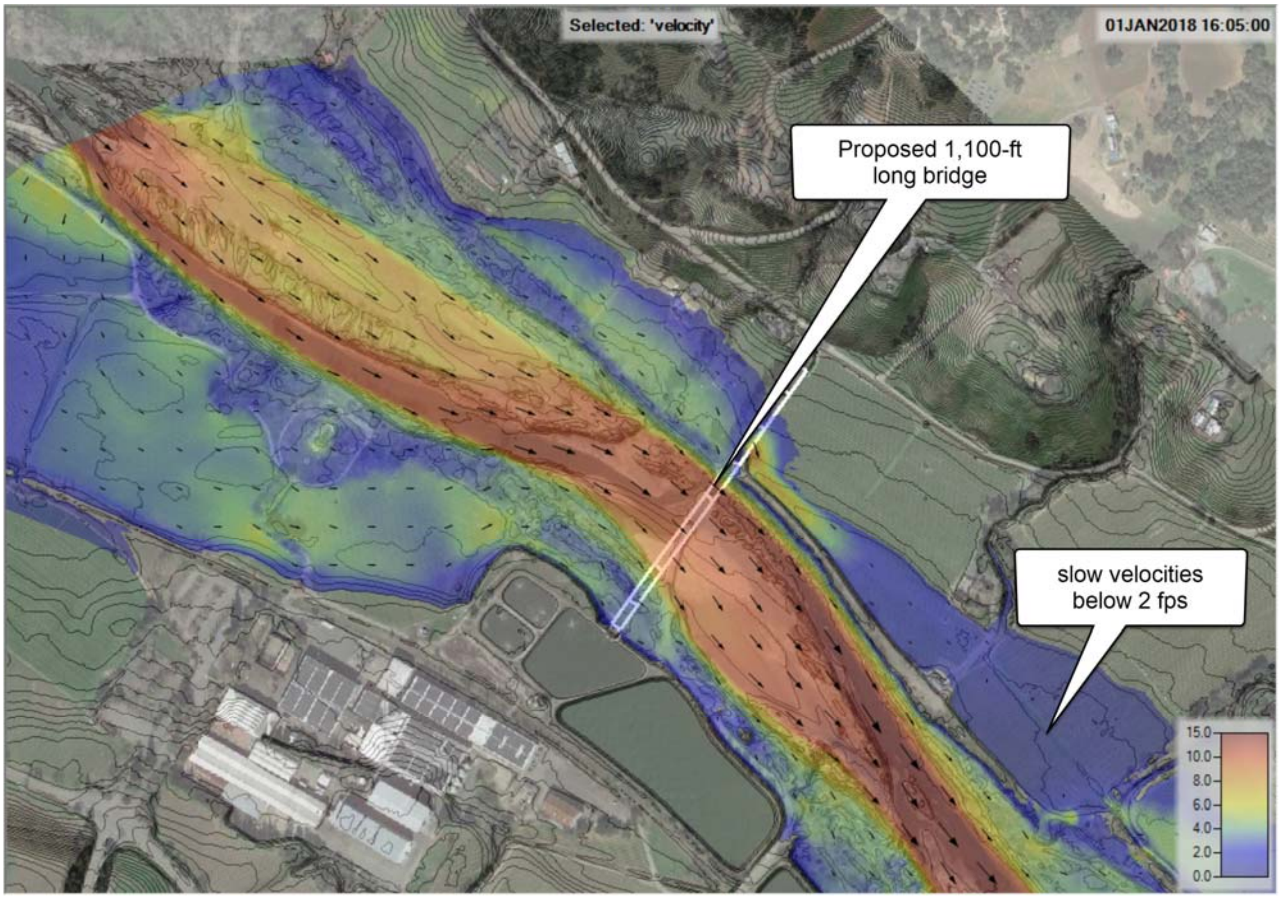

Figure 18. Velocity results (with vectors) for proposed 1,100-ft long bridge

CONCLUSIONS

This Technical Memorandum was prepared to analyze two bridge alternatives for the replacement of the Russian River Summer Crossing in Asti, CA. Because the project is located in a FEMA floodway, the new bridge cannot cause any water surface elevation increase.

The first alternative was a 500-ft long bridge with an elevated northeastern approach roadway. In this case, the approach roadway blocks the flow that overtops the roadway in existing conditions, resulting in a water surface elevation increase of 0.1 ft. The second alternative was a 1,100 ft long bridge. This alternative ensures no roadway fill blocks the channel, and allows the existing flow to pass under the bridge. This results in a water surface elevation 0.1 ft lower than existing conditions near the bridge. However, a different bridge configuration (perhaps curved) would need to be modeled to determine a feasible bridge configuration that provides a hydraulic opening similar to the 1100-ft long bridge shown in Figure 18. With more detailed geometry and modelling, it is expected an approximately 1,100 ft long hydraulic opening could show no significant impact on the Russian River at this location.

APPENDICES

APPENDIX A- HYDROLOGY

The 50- and 100-year discharges were determined from the FEMA FIS study for Sonoma County revised in March 2017. The Asti bridge is approximately 3.7 miles upstream of the confluence with Gill Creek on the Russian River. The corresponding basin area and discharges are in the table below.

Table 4. Summary of Discharges (continued)

Flooding Source and Location	Drainage Area (Square miles)	Peak Discharges (Cubic Feet per Second)			
		10-percent	2-percent	1-percent	0.2-percent
RUSSIAN RIVER (continued)					
Upstream of confluence of Maacama Canal	707	51,000	73,000	82,000	115,000
Upstream of confluence of Sausal Creek	686	50,000	71,000	81,000	111,000
Upstream of confluence of Lytton Creek	678	50,000	70,000	80,000	110,000
Upstream of confluence of Miller Creek	654	48,000	68,000	79,000	106,000
Upstream of confluence of Gill Creek	642	47,000	67,000	76,000	105,000
Upstream of confluence of Big Sulphur Creek	520	46,000	58,000	73,000	100,000
Upstream of confluence of Oat Valley Creek	502	40,000	56,000	64,000	85,000