

FLOODPLAIN AND BRIDGE SCOUR STUDY FOR TEMESCAL WASH AT THE NEW TEMESCAL CANYON ROAD BRIDGE AND ROADWAY PROJECT

FEDERAL AID PROJECT NO. BRLO 5074 (015)

Submitted to:



CALIFORNIA DEPARTMENT OF TRANSPORTATION, DISTRICT 8

464 W. 4th Street
San Bernardino, CA 92401

Prepared for:



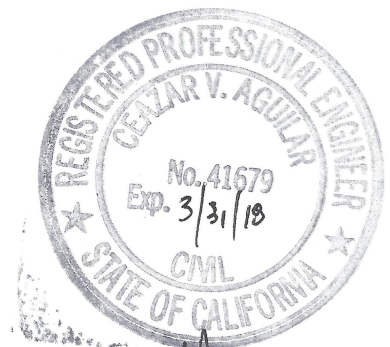
CITY OF LAKE ELSINORE

130 South Main St.
Lake Elsinore, CA 92530
(951) 674-3124

Prepared by:



2155 Chicago Avenue, Suite 301
Riverside, CA 92507
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A handwritten signature in black ink, appearing to be 'C. Aguilar', written over the bottom right portion of the professional engineer seal.

November 14, 2016

Memorandum

*Flex your power!
Be energy efficient!*

To: SEAN YEUNG, Chief
Local Assistance

Date: January 26, 2016

Attn: ALBERT VERGEL DE DIOS
Local Assistance Engineer

File: 08-RIV-0-LE
Temescal Canyon Road
@ Temescal Wash
Bridge No. 56C0050
HBP Replacement

From: **JIM DECICCO** 
Senior Bridge Engineer
Office of Special Funded Projects, Structures Local Assistance
& Structure Contract Management
Program/Project & Resource Management
Division of Engineering Services

Subject: Review of Bridge Type Selection Report

The Bridge Type Selection Report dated November 23, 2016 has been reviewed for the City of Lake Elsinore bridge replacement project. The following summarizes Structures Local Assistance commentary on issues related to the City's planned project.

1. Structures Local Assistance has reviewed the Bridge Type Selection Report. We have no comments.
2. The Office of Structure Hydraulics & Hydrology has reviewed the Floodplain and Bridge Scour Study dated November 14, 2016, which is Appendix F in the Bridge Type Selection Report. They have no comments.
3. The Office of Geotechnical Design South has previously reviewed the Preliminary Foundation Report, which is Appendix E in the Bridge Type Selection Report, dated August 26, 2016. The comments were sent November 22, 2016.
4. The estimated construction cost for the structural portion of the project appears reasonable and should be considered acceptable.

If you have any questions, please contact me at (916) 227-8500.

c: file

From: Jeon, Jongkoo@DOT [<mailto:jongkoo.jeon@dot.ca.gov>]
Sent: Tuesday, February 28, 2017 1:09 PM
To: Sathis <sathiss@groupdelta.com>
Cc: Islam, Mohammed@DOT <mohammed.islam@dot.ca.gov>; Vergel De Dios, Alberto C@DOT <albert.vergel.de.dios@dot.ca.gov>
Subject: RE: DRAFT Responses to Review Comments (Temescal Canyon Road Bridge) - 56C0050

Hello Sathi,

We (GS) reviewed your draft responses for Temescal Canyon Bridge Project, and we are okay with it without any comments.
Thank you.

From: Vergel De Dios, Alberto C@DOT
Sent: Tuesday, February 28, 2017 8:06 AM
To: Jeon, Jongkoo@DOT <jongkoo.jeon@dot.ca.gov>
Cc: Islam, Mohammed@DOT <mohammed.islam@dot.ca.gov>
Subject: RE: DRAFT Responses to Review Comments (Temescal Canyon Road Bridge) - 56C0050

That would be great, if possible, copy me to know progress of review.

Alberto Vergel de Dios P.E.
Transportation Engineer -Civil
Local Assistance
MS 760
(909) 806-3944

From: Jeon, Jongkoo@DOT
Sent: Friday, February 24, 2017 11:26 AM
To: Vergel De Dios, Alberto C@DOT <albert.vergel.de.dios@dot.ca.gov>
Cc: Islam, Mohammed@DOT <mohammed.islam@dot.ca.gov>
Subject: FW: DRAFT Responses to Review Comments (Temescal Canyon Road Bridge) - 56C0050

Hello Albert,

We (GS) are asked to review consultant's responses regarding our comments. Because this request is not from you, I want to get your opinion before proceeding it if it's okay to review it and directly send back our reviews to Group Delta. Please let us know.
Thank you.

JASON E. UHLEY
General Manager-Chief Engineer



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RIVERSIDE COUNTY FLOOD CONTROL AND WATER CONSERVATION DISTRICT

October 31, 2016

Mr. Jason Simpson
City of Lake Elsinore
130 South Main Street
Lake Elsinore, CA 92530

Dear Mr. Simpson:

Re: MR 295 Floodplain and Bridge Scour Study
for Temescal Wash at the New Temescal
Canyon Road Bridge and Roadway Project in
the City of Lake Elsinore, California
MS 163
Account No. 137-0-3-90181
Plan Check No. 4

The District received the following items for review from the City of Lake Elsinore on October 28, 2016 and prepared by Aguilar Consulting Inc.:

- Floodplain and bridge scour study for Temescal Wash at the new Temescal Canyon Road Bridge and Roadway Project within the city of Lake Elsinore, CA dated October 20, 2016 (submitted October 28, 2016).
- CD containing a HEC-RAS model for the existing and proposed conditions.

The District has completed Plan Check No. 4 for the subject project and offers no additional comments.

The District is aware that this floodplain and bridge scour study report was prepared in support of the Highway Bridge Program (HBP) Project Approval/Environmental Document phase (PAED phase). The District's review of the floodplain and bridge scour study report is solely a planning level review and in no way implies approval or sponsorship of the new road alignment, grading, final design and structural integrity of the new bridge. We recommend that detailed design plans consider appropriate sized channel conveyance in order to maintain adequate conveyance capacity through the skewed bridge. The report shall be updated to reflect the changes to assure that the bridge clearance, scour requirement, and overall safety are met.

The following comments from previous reviews remain as advisory and shall be considered in the final report.

1. The proposed bridge and road leading to it will be located within the effective Federal Emergency Management Agency (FEMA) floodway. The preliminary plans and model show grading and fill within the effective floodway. A hydraulic analysis to show "no rise" in the water surface elevation will need to be included with the CLOMR package.
2. FEMA requires Endangered Species Act (ESA) compliance for any grading or fill within a floodplain. Documentation will need to be included with the CLOMR package.
3. Per Pages 108 and 109 of the 2014 Flood Insurance Study (FIS), Temescal Wash debris potential is listed as high. Bridge clearance allowance or freeboard will be determined based the water surface elevation generated from the bulked flow rate (1.5xQ₁₀₀) (per Page 47 of the FIS).

October 31, 2016

-2-

Mr. Jason Simpson

Re: MR 295 Floodplain and Bridge Scour Study
for Temescal Wash at the New Temescal
Canyon Road Bridge and Roadway Project in
the City of Lake Elsinore, California
MS 163
Account No. 137-0-3-90181
Plan Check No. 4

4. Future CLOMR submittal to FEMA might require submittal of an effective model, duplicate effective model, corrective duplicate effective model, existing condition model, and proposed conditions model, no rise certificate, and a floodway analysis.

If you have any questions or concerns, you may contact Hilal Elhaddad at 951.955.8255 or me at 951.955.1265.

Very truly yours,



DEBORAH DE CHAMBEAU
Engineering Project Manager

c: Aguilar Consulting, Inc.
Attn: Ceazar V. Aguilar

HAE:mcv
P8208348

**FLOODPLAIN AND BRIDGE SCOUR STUDY FOR TEMESCAL WASH AT THE
NEW TEMESCAL CANYON ROAD BRIDGE AND ROADWAY PROJECT
LAKE ELSINORE, CALIFORNIA**

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EXHIBITS

EXHIBIT A:	100-YEAR FLOODPLAIN EXHIBIT FOR TEMESCAL WASH BASED ON EXISTING CONDITION IN THE VICINITY OF THE EXISTING TEMESCAL CANYON ROAD BRIDGE
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EXHIBIT C:	PROPOSED ROADWAY GEOMETRIC APPROVAL DRAWING (GAD) FOR TEMESCAL CANYON ROAD

ATTACHMENT

- RIVERSIDE COUNTY FLOOD CONTROL AND WATER CONSERVATION DISTRICT (RCFC & WCD) APPROVAL LETTER DATED OCTOBER 31, 2016

ENCLOSURE

- DIGITAL CD CONTAINING TEMESCAL CANYON ROAD BRIDGE HEC-RAS CALCULATIONS FOR TEMESCAL WASH BASED ON EXISTING AND PROPOSED CONDITIONS, FEMA HEC-2 FILES FOR THE TEMESCAL WASH IN THE VICINITY OF TEMESCAL CANYON ROAD, AND DIGITAL PDF OF THE STUDY (INSIDE THE REPORT BINDER)

**FLOODPLAIN AND BRIDGE SCOUR STUDY FOR TEMESCAL WASH AT THE
NEW TEMESCAL CANYON ROAD BRIDGE AND ROADWAY PROJECT
LAKE ELSINORE, CALIFORNIA**

I. EXECUTIVE SUMMARY

The City of Lake Elsinore proposes to construct a new bridge and roadway for Temescal Canyon Road at Temescal Wash under the Federal Highway Administration (FHWA) Highway Bridge Program (HBP). The new bridge will be located approximately 1,200 feet west of the existing bridge while the new roadway will follow an east-west alignment, roughly 3,540 feet in length, that will extend from Lake Street to the existing Temescal Canyon Road to the northwest. The existing bridge and roadway will be abandoned in place and will serve as a temporary trail until such time as the Alberhill Villages Specific Plan is developed.

The floodplain and bridge scour study report was prepared in support of the HBP Project Approval/Environmental Document phase (PAED phase). Upon completion of the PAED phase and Caltrans approval, the City of Lake Elsinore will proceed with the Plans, Specifications, & Estimates phase (PS&E phase – final design) of the project.

The project site is generally bounded by I-15 to the north, Lake Street to the east, Pacific Clay Products facility to the south, and Bernard Street to the west. As part of the HBP requirement, Caltrans, which provides funding program management and oversight on behalf of FHWA, requires that the bridge structure adequately convey safe passage of the 100-year flow with adequate clearance (freeboard) and the bridge abutments be protected from scour resulting from a 100-year flood. Additionally, Caltrans requires that the pier/bent foundation be protected from scour based on the 200-year flood event as required by FHWA.

The “Floodplain and Bridge Scour Study for Temescal Wash at the New Temescal Canyon Road Bridge and Roadway Project” was prepared in order to establish the existing or baseline and proposed or with-project 100-year floodplain conditions and to evaluate the channel stability characteristics of the Temescal Wash in the vicinity of the proposed bridge and roadway. The results of the existing or baseline study will be the basis for determining the required mitigation measures in conjunction with the proposed or with-project study condition.

The 1991 Federal Emergency Management Agency (FEMA) Flood Insurance Study (FIS) for Riverside County was used to determine the peak discharge of 10,400 CFS for the 100-year return period in the vicinity of the new Temescal Canyon Road Bridge and Roadway Project (Ref. 1).

The hydraulic models for Temescal Wash were developed using FEMA’s HEC-2 Model (subsequently converted to HEC-RAS) and the project aerial topographic map with 1-foot contour intervals developed by KWC Engineers (2015). Geo-RAS was used to develop the new stream cross sections for Temescal Wash within the ArcView GIS. The HEC-RAS computer software program, version 4.1.0, was used to compute the hydraulic variables for the channels under peak flow conditions for floods of 100-year and 200-year frequencies

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including bulked flow rates. Both Geo-RAS and HEC-RAS are products of the Hydrologic Engineering Center (HEC) of the US Army Corps of Engineers.

For the most part, Manning's N-values of 0.070 and 0.055 were assigned for the stream bed and channel overbanks, respectively, throughout the length of the study reach for the existing and proposed conditions. These Manning's N-values were derived by FEMA from the 2014 FIS and were verified based on aerial map and field review of the reaches to be modeled. Contraction and expansion coefficients of 0.3 and 0.5, respectively, were used for the bridge and values of 0.1 and 0.3, respectively, were used elsewhere.

For the existing and proposed (with-project) conditions, average flow velocities under the 100-year flood condition within the study reach range from 2.05 feet per second to 11.66 feet per second and 2.34 feet per second to 11.84 feet per second, respectively.

The existing bridge at Temescal Canyon Road at the location of Temescal Wash was determined to be significantly under capacity based upon the 100-year flood flow of 10,400 CFS. The proposed bridge will be designed to fully convey the 100-year flow with adequate bridge clearance.

The total local scour at the bridge structure is equal to a combination of two scour components; abutment scour and pier/bent scour. Abutment scour was determined to be 6.5 feet while the pier/bent scour was calculated to be 13.3 feet. The long-term scour was determined to be 2.2 feet over the project 75-year life cycle of the bridge. The bridge abutments will be protected against scour by lining the channel side slopes with concrete and extending a concrete cutoff wall to the scour depth of 11.2 feet (9.0 feet of general scour per RCFC & WCD's requirement + 2.2 feet of long-term scour). On the other hand, the bridge piers/bents will be designed based on the total scour value of 24.5 feet, which is the combination of the local pier scour of 13.3 feet, general scour of 9.0 feet per RCFC & WCD's requirement, and long-term scour of 2.2 feet.

II. INTRODUCTION

This report was prepared to establish the existing or baseline and proposed or with-project 100-year floodplain conditions and to evaluate the channel stability characteristics of the Temescal Wash in the vicinity of the proposed Temescal Canyon Road bridge and roadway project in the City of Lake Elsinore. The results of the "existing or baseline condition" study will be the basis for determining the required mitigation measures in conjunction with the "proposed or with-project" condition.

A. Existing or Baseline Condition

The existing Temescal Canyon Road and Bridge Crossing project is generally bounded by I-15 to the north, Lake Street to the east, Pacific Clay Products facility to the south, and Bernard Street to the west in the City of Lake Elsinore (see Figure 1, next page). Temescal Canyon Road is currently a 2-lane roadway (one lane in each direction). The existing 23-foot wide Temescal Canyon Road Bridge has been rated by Caltrans as "Functionally

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Obsolete” (FO) with a low Sufficiency Rating (SR) of 68.5. Additionally, the existing bridge structure does not provide adequate conveyance for the 100-year flow. It is considerably undersized and causes flood waters to backup and overtop the bridge deck and its roadway approaches. The existing bridge structure is also located on a sharp curved alignment at the west approach for the eastbound traffic, which can only accommodate a safe design speed of 30 to 40 miles per hour (MPH). The narrow bridge with 10-foot traveled lanes further reduces the safe speed to less than 30 MPH, which is not acceptable to the traffic operation standpoint as Temescal Canyon Road serves as a “Major Road” requiring a design speed of 55 MPH for flat terrain per the City’s General Plan.

Temescal Wash runs through the project area from east-to-west and it consists of a low flow channel with broad overbank floodplain areas. The low-flow channel is heavily vegetated with shrubs, and Willow and Eucalyptus trees while the overbank floodplain area is peppered with shrubs and small Willows trees (see Photo Nos. 1 through 5 on pages 21 and 22).

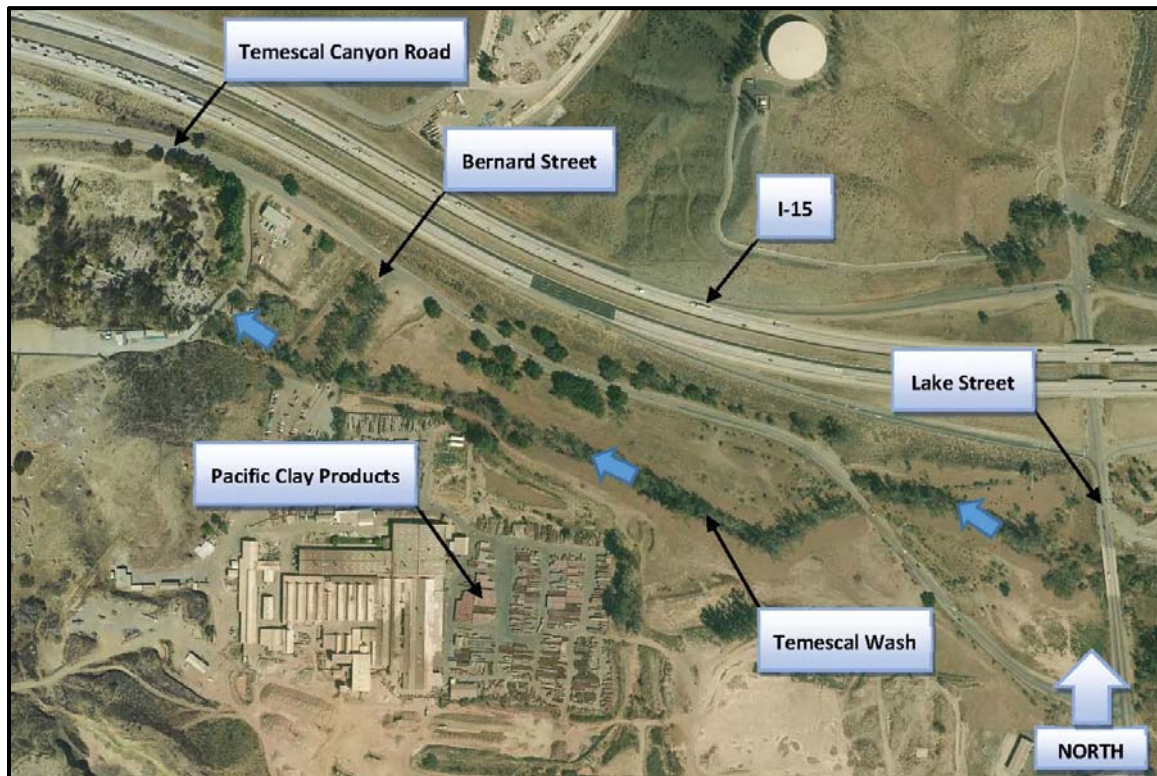


Figure 1: Project Location Map

B. Proposed or With-Project Condition

The type of superstructure for the proposed bridge is tentatively selected as a continuous cast-in-place (CIP) post-tensioned concrete box girder. The structure will be supported by two reinforced concrete seat type abutments, and 2 sets of pier/bent columns (four 5-foot

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diameter columns per pier/bent set). All pier/bent columns will be supported on driven steel H piles (Figure 2a). The bridge will consist of a total of three spans.

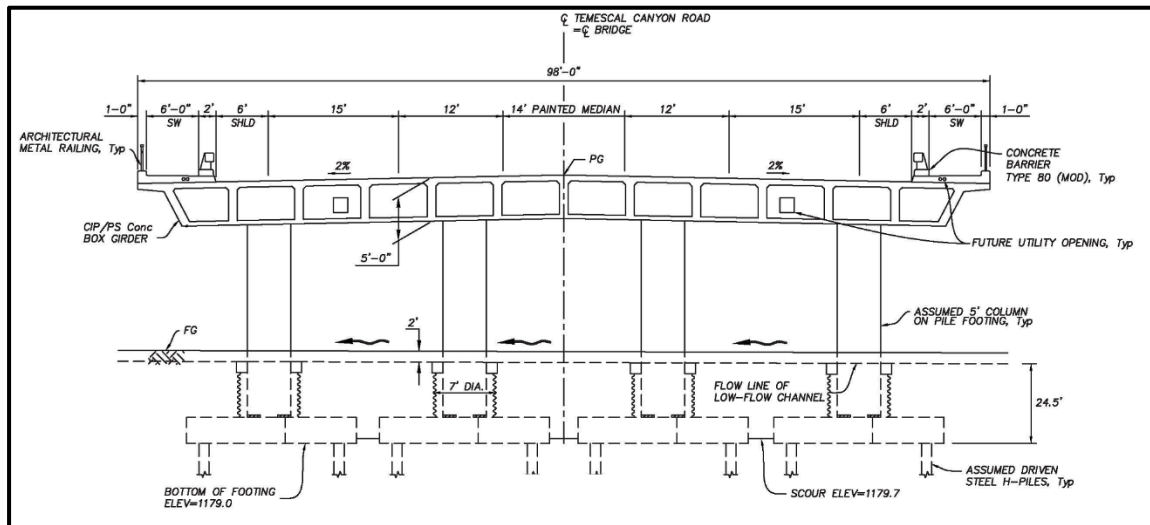


Figure 2a: Typical Section of Proposed Temescal Canyon Road Bridge

The proposed bridge is 98-feet wide (with a curb-to-curb width of 80 feet), 306 feet long, and a structure depth of 5 feet. The bridge will be striped with a 14-foot painted median, two 12-foot inside lanes, two 15-foot outside lanes, two 6-foot shoulders that can accommodate a Class II bike lane, and two 6-foot sidewalks separated from vehicular traffic with a concrete barrier, which is necessary due to a posted speed limit greater than 45 MPH (see Figure 2a). This bridge and approximately 200 feet of the roadway, northwest and southeast of the bridge, will be constructed using HBP and local funding.

The realigned road from the bridge to Lake Street going southeast will conform to the City's standard for a "Major Highway" with a right-of-way width of 100 feet. The ultimate standard roadway section will consist of a painted 14-foot median, two 12-foot inside lanes, two 15-foot outside lanes, two 6-foot shoulders, and two 10-foot parkways that can accommodate a 6-foot wide sidewalk. The roadway will connect to Lake Street approximately 180 feet south of the current intersection, which conforms to the location detailed in the City's General Plan Circulation Element (see Figure 2b, next page). This segment of the roadway from approximately 200 feet southeast of the bridge to Lake Street will be constructed in conjunction with the Alberhill Villages Specific Plan (AVSP). In the interim, AVSP will construct a 2-lane roadway that will include a 696-foot roadway transition.

The project also includes an 850-foot roadway transition from the bridge to the existing 2-lane Temescal Canyon Road to the northwest. This roadway segment, from approximately 200 feet northeast of the bridge to the existing Temescal Canyon Road, will be constructed using local funding.

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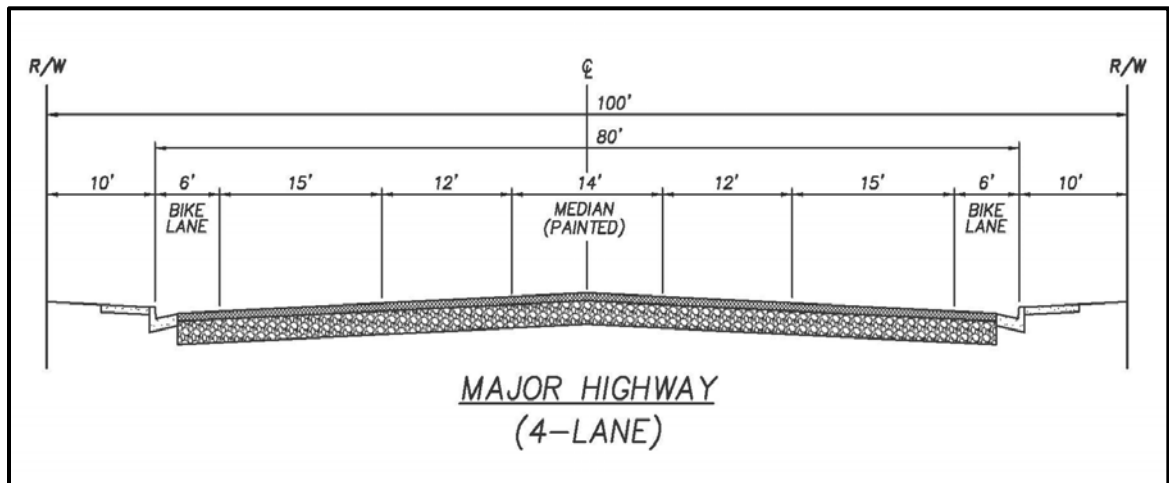


Figure 2b: Typical Section of Ultimate Temescal Canyon Road

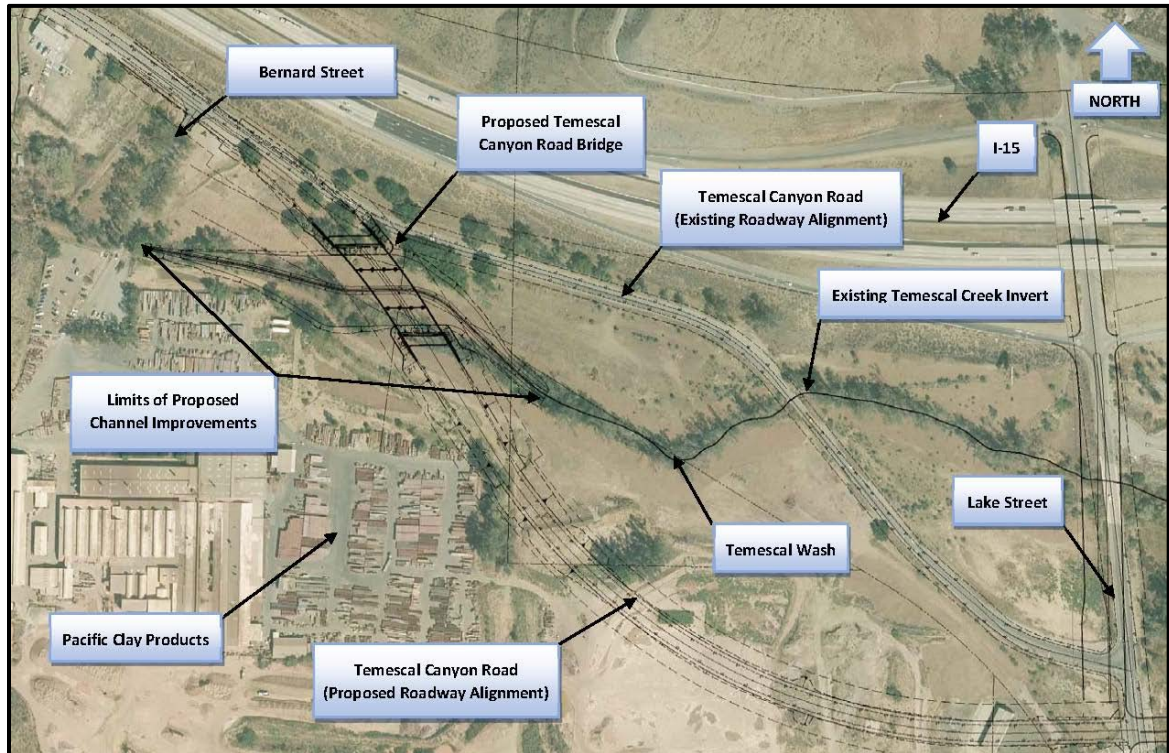


Figure 3: Proposed Alignment for the New Temescal Canyon Road

The project will include minimal drainage improvements within Temescal Wash. Activities will include minor re-grading of the creek in the vicinity of the bridge and construction of concrete slope protection and cutoff wall to protect the bridge abutments from scour. An 850-foot segment of the existing low flow channel (404 Jurisdictional Delineation) will be relocated to convey low flows through the proposed bridge. The relocated low-flow channel will extend approximately 560 feet downstream of the proposed bridge. It will also extend approximately 510 feet upstream of the proposed

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bridge. The relocated low-flow channel will be restored to replicate the bio-resource of the existing low-flow channel.

C. Study Scope

The scope of this study includes the following:

1. Determination of the 100-year design flow rate for the study.
2. Development of the 100-year flood plain model for the existing (baseline) and proposed (with-project) conditions utilizing the HEC-RAS software computer program.
3. Evaluation of the channel bed (general scour) and local (pier/bent) scour depths for the existing and proposed conditions under the 100-year and 200-year flood events, respectively.
4. Qualitative evaluation of long-term scour or aggradation.
5. Evaluation of project impacts and determination of drainage mitigation measures.
6. Preparation of the floodplain study analysis report.

III. PROJECT SITE AND DRAINAGE AREA OVERVIEW

The new Temescal Canyon Road Bridge and Roadway Project is located in the City of Lake Elsinore, Riverside County, California. The proposed bridge crossing is located approximately 3.3 miles upstream of the Lee Lake Dam and approximately 2,100 feet downstream of the Lake Street Bridge Crossing.

The major watercourse located within the project area is Temescal Wash. It serves as the natural flood conveyance system for the flows discharging from Elsinore lake in the city of Lake Elsinore and the local mountains. It traverses approximately 29 miles in a northwesterly direction through west Riverside County, where it confluences with the Santa Ana River at Prado Dam.

Within the study reach, Temescal Wash is a broad, flat floodplain averaging 300 feet in width, with a low-flow channel that's approximately 6 feet wide and 2 to 3 feet deep. The gradient of the wash is flat, ranging from 0.003 percent to 0.009 percent.

Review of the Federal Emergency Management Agency (FEMA) floodplain map dated August 28, 2008 (see Figure 4) indicates that the project site is mapped within a regulatory floodway and also mapped as Zone AE, which means that the area is subject to inundation by the 1-percent-annual-chance flood event with Base Flood Elevations (BFEs). The existing condition HEC-RAS model was developed using FEMA's HEC-2 Model for Temescal Wash, which is included on the digital CD enclosure.

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The floodway analysis is not included in this study report for the reason that a separate floodplain/floodway analysis will be performed in conjunction with the Conditional Letter of Map Revision (CLOMR) application to FEMA during the PS&E phase of this Highway Bridge Program.

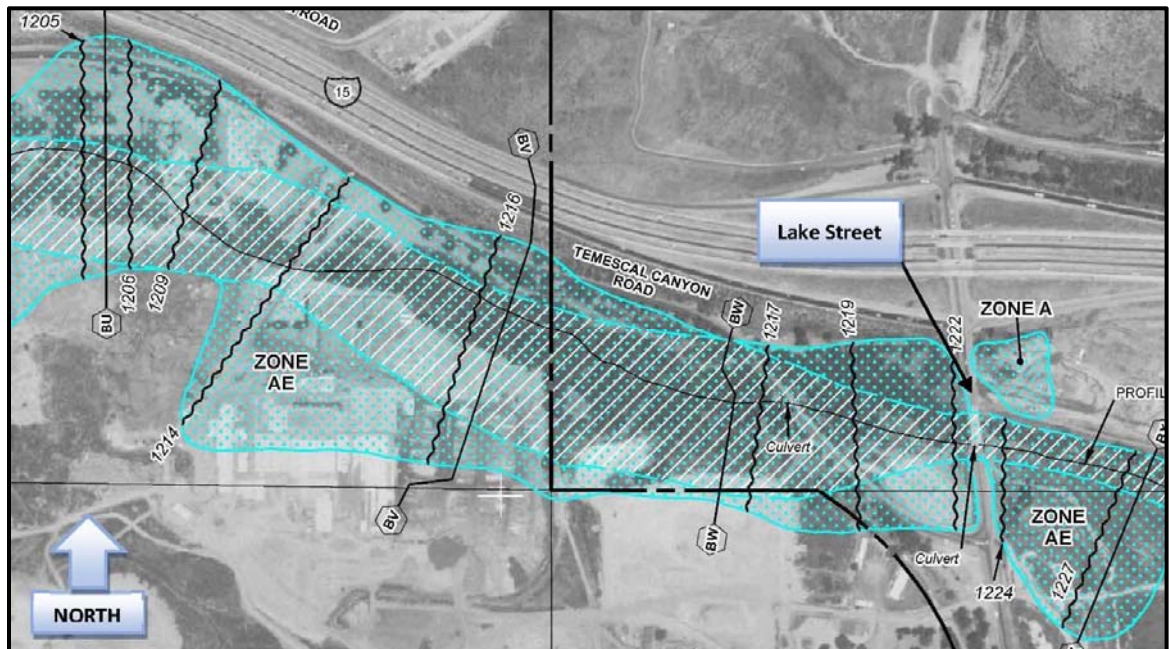


Figure 4 – Federal Insurance Rate Map Number 06065C2007G

IV. HYDROLOGY

The 100-year peak discharge for the Temescal Wash in the vicinity of the project reach is 10,400 CFS as published in the FEMA 1991 FIS (see Ref. 1). The 200-year flow is determined to be 19,032 CFS based on the flood discharge-frequency curve developed by the USACOE-LAD for the Santa Ana River Basin (see Ref. 5).

V. HYDRAULIC ANALYSIS

Hydraulic models of the Temescal Wash study reach were developed using the existing FEMA HEC-2 Model for Temescal Wash (was subsequently converted to HEC-RAS) and project aerial topographic map with 1-foot contour intervals provided by KWC Engineers (December 2015). There were 18 sections used in the “existing condition” analysis spanning a total reach length of 4,334 feet. The sections include the existing Temescal Canyon Road Bridge and Lake Street Bridge. These FEMA sections were developed based on the National Geodetic Vertical Datum 1929 (NGVD 29). In order to convert these sections to the North American Vertical Datum 1988 (NAVD 88), an elevation conversion factor of 2.51 feet (per FEMA) was added to the “Y” coordinates. Stations 108500 and 109400 were modified to reflect the current topographic characteristics using the project aerial topographic map. The elevations of the low-flow channel at Stations 109465, 109466, 109491, 109492, and 109572 were also revised to reflect the current flow line

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elevation as shown on the project aerial topographic map. Two sections were added in the model, Stations 108111 and 108773, to better define the hydraulic characteristics near the proposed bridge location. Geo-RAS was used to develop the cross sections for Stations 108111, 108500, 108773, and 109400 within the ArcView GIS. These sections were developed based on the current project design aerial topographic map.

HEC-RAS was used to compute the hydraulic variables for the channels under peak flow condition for the 100-year and 200-year frequency storm events including the bulked flow rate conditions (1.2, 1.35, and 1.5 bulking factors). Since the stream reach is flat, sub-critical flow regime was used for the hydraulic model, which is consistent with FEMA original HEC-2 model. In order to account for areas of the wash that are considered “ineffective”, ineffective flow boundaries were modeled.

Both Geo-RAS and HEC-RAS (Version 4.1.0) are products of the Hydrologic Engineering Center (HEC) of the US Army Corps of Engineers.

The limits of the HEC-RAS study are shown in Figure 5 (proposed condition). The downstream limit is defined by HEC-RAS Station 107700 (located approximately 679 feet downstream or west of the proposed Temescal Canyon Road Bridge, and just upstream of Bernard Street) while the upstream limit is defined by HEC-RAS Station 112034, located approximately 3,710 feet upstream or east of the proposed Temescal Canyon Road Bridge). Station 112034 is approximately 1,641 feet upstream of east of the existing Lake Street Bridge. The downstream boundary condition or hydraulic control for the downstream end of the model was determined using a water surface elevation of 1211.45 (NGVD 29) or 1213.96 (NAVD 88), which was obtained from the FEMA-FIS (see Ref. 1). The centerline HEC-RAS Station for the proposed Temescal Canyon Road Bridge is 108324.

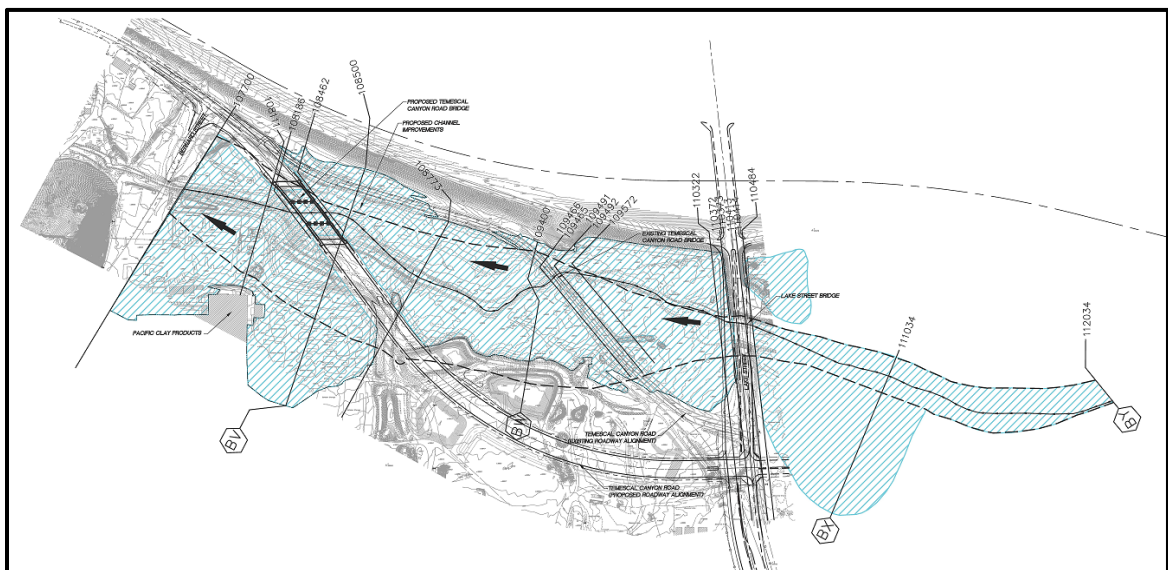


Figure 5: HEC-RAS Study Limits

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For the most part, Manning's N-values of 0.070 and 0.055 were assigned for the stream bed and channel overbanks, respectively, throughout the length of the study reach for the existing and proposed conditions. These Manning's N-values were derived by FEMA and were verified based on aerial map and field review of the reaches to be modeled, considering the various components that contribute to flow resistance – i.e. bed material size, irregularity, vegetation type and density, etc. It should be noted that there is some uncertainty in assigning Manning's N-values along natural streams. In reality, the values can change during the event being modeled, due to bedform development, changes in flow depth, loss of vegetation, and changes in geometry. The Manning's N-values assigned for this study are considered reasonable for purposes of this study, but are by no means exact. The locations of the cross-sections used in the hydraulic models used for this study are shown on Exhibits A and B. The HEC-RAS cross sections are shown in Appendix D and E. Contraction and expansion coefficients of 0.3 and 0.5, respectively, were used for the bridge and values of 0.1 and 0.3, respectively, were used elsewhere.

The results of the 100-year HEC-RAS calculations for the existing condition are shown in Table 1, with elevations based on NAVD 88 (page 24). Under the proposed condition, 100-year HEC-RAS calculations are shown in Table 2 (page 25). The tables provide results for the cross sections located in the wash that are potentially affected by the proposed bridge. The tables include hydraulic elements such as river stations, flow line elevations, 100-year water surface elevations, average flow velocities, top width, etc. A comparative analysis was prepared to evaluate the changes to the 100-year hydraulic data between the existing and proposed conditions. The results are shown in Table 3 and it shows changes to the channel flow line elevations, water surface elevations, and average flow velocities (page 26).

Per the FEMA-FIS, Temescal Wash is susceptible to a high debris potential. In order to account for debris that could potentially clog the bridge opening, debris bulking factors of 1.2, 1.35, and 1.5 were applied to the 100-year peak discharge and 1-foot of debris was added to each side of the piers to determine the impact of bulked flows to the proposed bridge clearance. The results of the analysis are discussed under "Bridge Clearance Allowances or Freeboard".

A. Existing or Baseline Condition

The channel characteristics of the Temescal Wash are uniform over the extent of the study reach. The channel profile obtained from the hydraulic model is illustrated in Figure 6 (next page). Channel slopes range from 0.3 to 0.9 percent throughout the study reach.

The water surface profile for the 100-year event under the existing condition is illustrated in Figure 6. It varies from elevations 1213.96 to 1230.88 within the study reach. The flow depths range from 6.59 feet to 12.85 feet. The flow depth is the difference between the water surface elevation and the invert elevation at any given cross section. From Figure 6, it is evident that the existing Temescal Canyon Road Bridge is overtopped during the 100-year flood.

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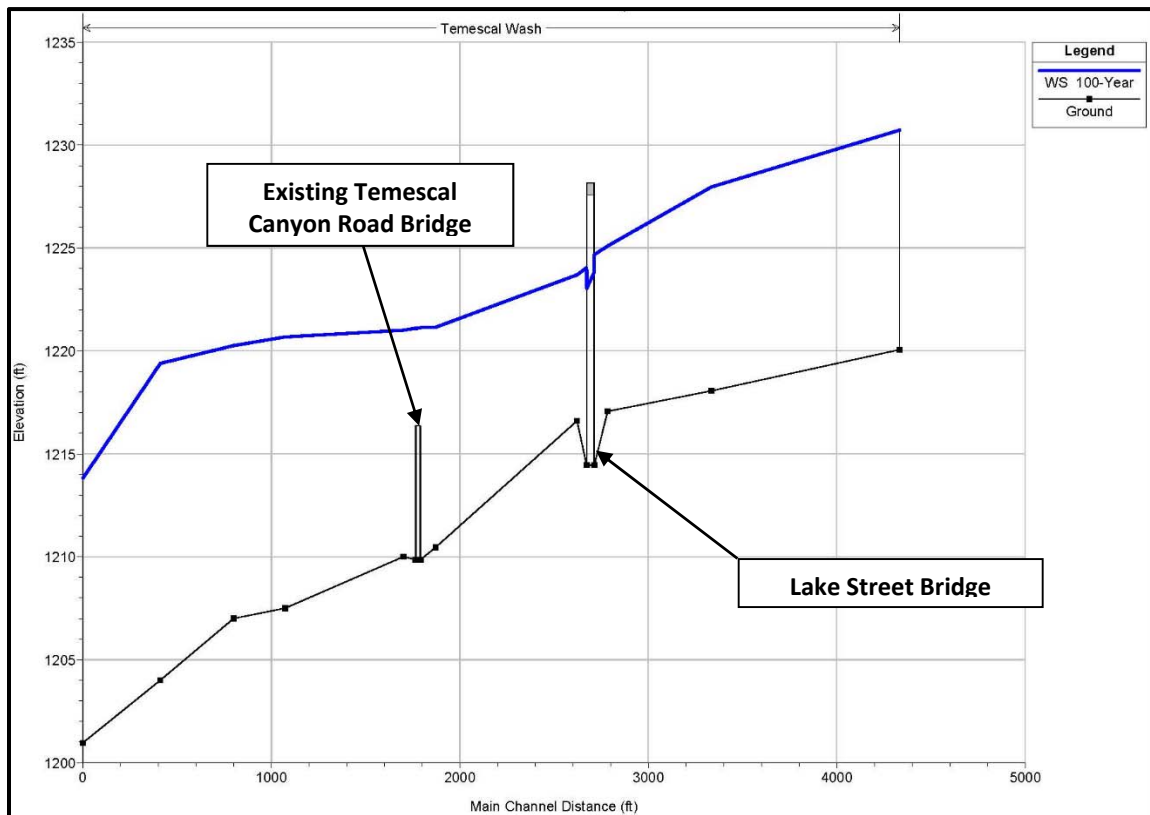


Figure 6: Temescal Wash 100-Year Flood Profile (Existing Condition)

In general, channel average flow velocities increase with increasing flow rate or channel slope, and tend to be higher in the channelized portion of a study reach, particularly in those areas with a defined low-flow section. The channel average flow velocity under the 100-year peak flood condition is shown in Figure 7 (next page). In the vicinity of the existing Temescal Canyon Road bridge, the average flow velocities are low, varying from 2.05 feet per second to 4.04 feet per second. Elsewhere within the study reach, the average flow velocities range from 2.55 feet per second to 11.66 feet per second.

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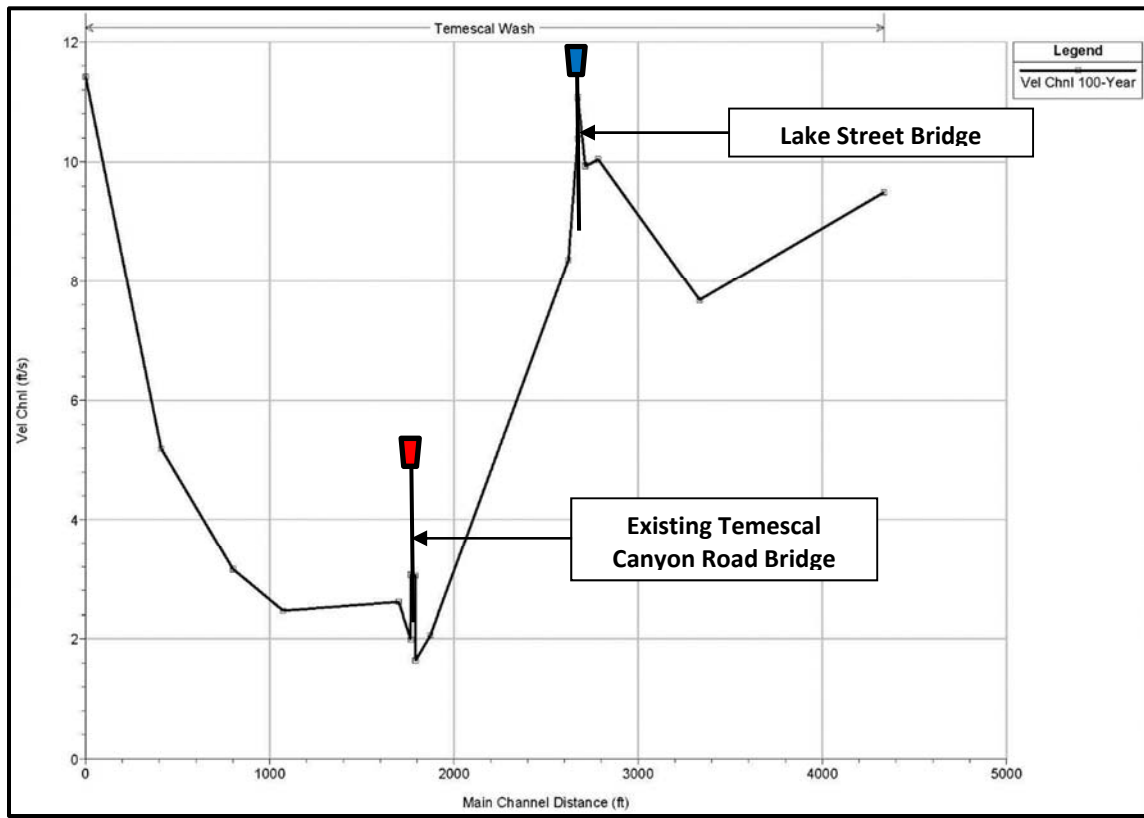


Figure 7: Temescal Wash 100-Year Average Flow Velocities (Existing Condition)

Flow top width for Temescal Wash under the 100-year peak flow condition is shown in Figure 8 (next page). Under this flow condition, the top width narrows and expands through the study reach from a minimum of 94 feet to a maximum of 1,222 feet.

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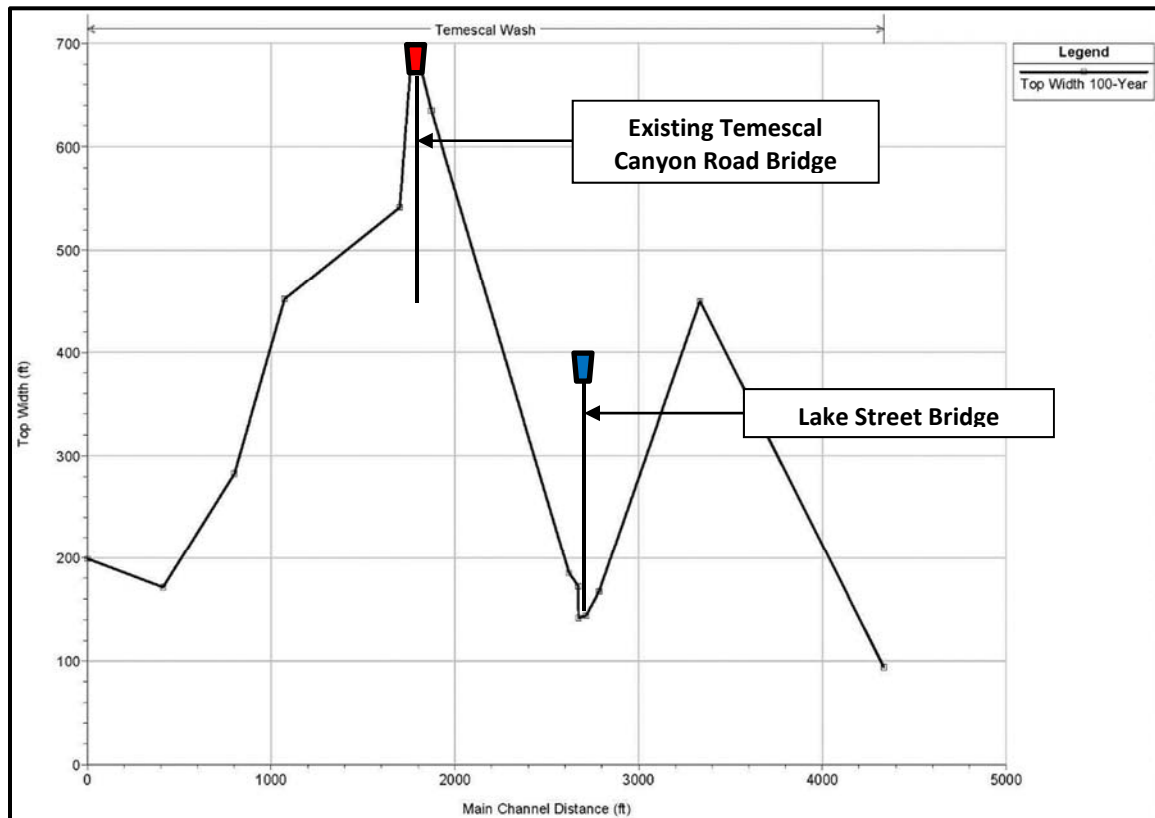


Figure 8: Temescal Wash 100-Year Flow Top Width (Existing Condition)

B. Proposed or With-Project Condition

A hydraulic model for the proposed or with-project condition was developed by modifying and/or inserting cross-sections into the existing or pre-project condition model to represent the geometries of the proposed earthen channel and bridge structure. These sections are Stations 108111, 108186 (downstream face of the bridge), 108324 (bridge centerline), 108462 (upstream face of the bridge), and 108500.

As shown in Figure 9 (next page), the 100-year water surface elevations under the proposed condition are lower for the majority of the study reach, from just downstream of the proposed bridge (Station 108111) up to Station 111034 (upstream of the existing Lake Street bridge). The water surface elevations decreased due to lower channel invert and improved hydraulic efficiency effected by the proposed bridge and proposed channel improvements near the downstream end of the study reach.

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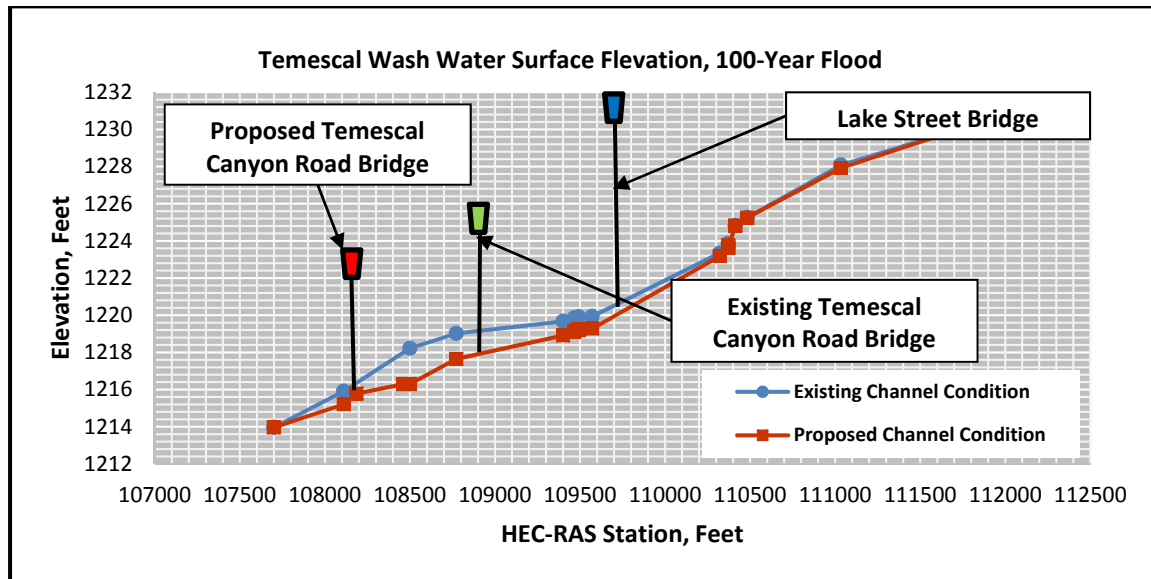


Figure 9: Temescal Wash Water Surface Elevations, 100-Year Flood Event

Under the proposed condition, average flow velocities show a slight increase from the proposed bridge upstream to Lake Street Bridge, ranging from 0.01 feet per second to 1.92 feet per second. At Station 108111 (downstream of the proposed bridge), the average flow velocity slightly decreased by 1.90 feet per second as illustrated in Figure 10.

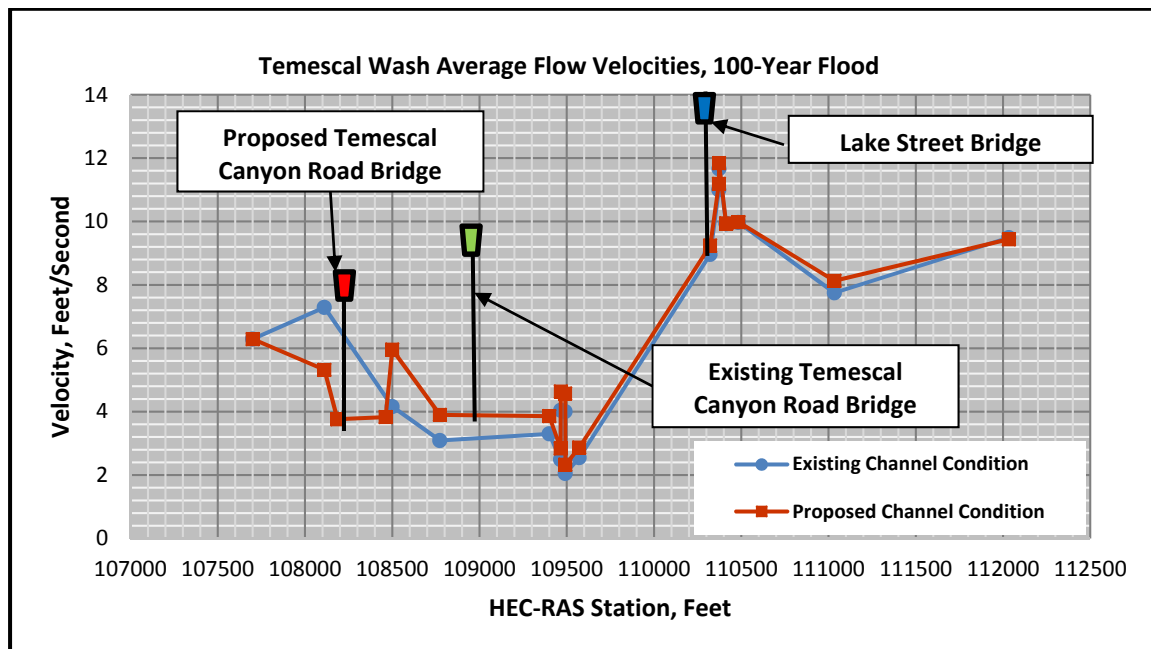


Figure 10: Temescal Wash Average Flow Velocities, 100-Year Flood Event

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Bridge Clearance Allowance or Freeboard for the Proposed or With-Project Condition

As shown in Table 4, under the 100-year and proposed conditions, a bridge clearance allowance or freeboard of 3.16 feet is provided at the upstream face or northeast corner of the bridge. On the other hand, the bridge clearance allowance at the downstream face or northwest corner of the bridge is 3.45 feet as shown in Table 5.

**TABLE 4: BRIDGE CLEARANCE ALLOWANCE OR FREEBOARD
(UPSTREAM FACE OF BRIDGE)**

Bridge	Bridge Soffit Elevation	100-Year Water Surface Elevation	Bridge Clearance (Feet)
Temescal Canyon Road Bridge	1219.47	1216.31	3.16

**TABLE 5: BRIDGE CLEARANCE ALLOWANCE OR FREEBOARD
(DOWNSTREAM FACE OF BRIDGE)**

Bridge	Bridge Soffit Elevation	100-Year Water Surface Elevation	Bridge Clearance (Feet)
Temescal Canyon Road Bridge	1219.23	1215.78	3.45

Debris loading of 1-foot was added to each side of the pier as well as bulking factors of 1.2, 1.35, and 1.5 to the 100-year peak discharge to evaluate the impacts of potential debris flows to the bridge clearance allowance. Based on the results of the analysis, it was determined that under the 1.2 bulked flow condition, the bridge clearance allowances are 2.38 feet (1219.47 – 1217.09) and 2.77 feet (1219.23 – 1216.46) at the upstream face and downstream face of the bridge, respectively. For the 1.35 bulked flow condition, the bridge clearance allowances are 1.83 feet (1219.47 – 1217.64) at the upstream face and 2.29 feet (1219.23 – 1216.94) at the downstream face while for the 1.5 bulked flow condition, the bridge clearance allowances are 1.30 feet (1219.47 – 1218.17) at the upstream face and 1.82 feet (1219.23 – 1217.41) at the downstream face.

VI. SCOUR ANALYSIS

Potential bridge scour was computed using the procedures outlined in the Federal Highway Administration (FHWA) publications HEC-18 (Ref. 4). Abutment scour was analyzed using the 100-year flood discharge of 10,400 CFS while local pier/bent scour and contraction scour were determined based on the 200-year flow of 19,032 CFS as required by FHWA.

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The total local scour at the bridge structure is equal to a combination of three scour components; abutment scour, contraction scour, and pier/bent scour. On the other hand, the total scour is determined to be the sum of the total **local** scour and long-term scour. A description of each scour component is provided in the following discussions.

1. Abutment Scour Analysis

Abutment scour depends on the interaction of the overbank flow obstructed by the abutment, the roadway approach, and the flow in the main channel at the abutment. Abutment scour for this study was calculated using the NCHRP 24-20 Scour Approach. It is expressed as:

$$Y_s = Y_{\max} - Y_o; Y_{\max} = \alpha_A Y_c; Y_c = Y_1 (q_{2c}/q_1)^{6/7}; \text{ where,}$$

Y_s = Scour Depth (feet)

$Y_{\max}$ = Channel Flow Depth including live-bed contraction scour (feet)

Y_c = Channel Flow Depth including live-bed contraction scour (feet)

Y_1 = Bridge Flow Depth (14.31 Ft per HEC-RAS)

$Y_{\text{ROB \& LOB}}$ = Abutment Flow Depth at Left Overbank or Abutment (14.31 feet just upstream of bridge {HEC-RAS model}) minus 3 feet

q_c = Channel Unit discharge (14.31 Ft X 3.92 FPS = 44 ft²/s)

$q_a (\text{ROB})$ = Right Abutment Area Unit discharge (11.31 Ft X 3.92 FPS = 44 ft²/s)

$q_a (\text{LOB})$ = Left Abutment Area Unit discharge (11.31 Ft X 3.92 FPS = 44 ft²/s)

α_A = Taken from Figure 8.10 of the HEC-18 Manual (1.19 for both banks)

Q = 100-year Flow Rate (10,400 CFS)

SBR = Setback Ratio (used to determine unit discharges q_c and q_a based on SBR less than 5)

V = Flow Velocity thru Bridge (3.92 FPS per HEC-RAS)

ROB = Right Overbank

LOB = Left Overbank

As shown in Table 6 below, the results of the analysis indicate that approximately 6.5 feet of scour can be expected at the north and south bridge abutment.

**TABLE 6: ABUTMENT SCOUR CALCULATION
RESULTS FOR PROPOSED TEMESCAL CANYON ROAD BRIDGE**

Location	Y_s	$Y_{\max}$	Y_c
Bridge Abutment	6.5	20.8	17.5

2. Contraction Scour Analysis

Contraction scour at the bridge generally occurs when the flow area of a river at flood stage is reduced by a bridge. Additionally, it occurs when overbank flow is forced back to the channel by roadway embankments at the approaches to a bridge. Contraction

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scour was determined using the Live Bed Contraction Equation. The Live Bed Contraction Equation is expressed as:

$$Y_2 = Y_1 (W_1/W_2)^{K_1}; \quad Y_s = Y_2 - Y_o; \text{ where,}$$

Y_s = Scour Depth (feet)

Y_1 = Average Flow Depth in the Upstream Channel Section (per HEC-RAS)

Y_2 = Average Depth in the Contracted Section

K_1 = Bed Material Transport Characteristic (mostly suspended material)

W_1 = Bottom Width of the Upstream Main Channel that is Transporting Bed Material

W_2 = Bottom width of Main Channel in Contracted Section Less Pier Width

Y_o = Existing Depth in the Contracted Section before Scour

As shown in Table 7, the results of the analysis indicate that approximately 1.0 foot of scour can be expected at the piers.

**TABLE 7: CONTRACTION SCOUR CALCULATION
RESULTS FOR PROPOSED TEMESCAL CANYON ROAD BRIDGE**

Location	Y_s	Y_2	Y_1	Y_o	W_1	W_2	K_1
Piers	1.0	18.25	17.29	17.29	185	171	0.69

3. Local (Pier/Bent) Scour Analysis

The potential local scour that may occur at the piers/bents as flows accelerate through the bridge could undermine the stability of the bridge. The local pier/bent scour was estimated using the HEC-18 (CSU) Equation published by the Federal Highway Administration in April 2012. The pier/bent scour analysis was performed based on the 200-year flood event as required by FHWA.

The HEC-18 (CSU) Equation is expressed as:

$$Y_s = Y_1 2.0 K_1 K_2 K_3 (a/Y_1)^{0.65} Fr_1^{0.43} \text{ where,}$$

Y_s = Scour Depth (feet)

Y_1 = Flow Depth directly Upstream of Pier (feet)

Y_2 = Adjusted Flow Depth directly Upstream of Pier due to General Scour (feet)

K_1 = Correction Factor for Pier Nose Shape (Dimensionless Unit)

K_2 = Correction Factor for Angle of Attack of Flow (Dimensionless Unit)

K_3 = Correction Factor for Bed Condition (Dimensionless Unit)

a = Pier Width (feet)

Fr_1 = Froude Number Directly Upstream of Pier = $V_1/(gY_1)^{0.5}$

V_1 = Maximum Mean Flow Velocity at Pier (feet/sec)

V_2 = Adjusted Maximum Mean Flow Velocity at Pier due to General Scour (feet/sec)

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g = Acceleration of Gravity (32.2 feet/sec²)

The results of the analysis are presented in Table 8 and it indicates that the maximum local scour depth at the piers/bents is 13.3 feet.

**TABLE 8: LOCAL (PIER/BENT) SCOUR CALCULATION
RESULTS FOR PROPOSED TEMESCAL CANYON ROAD BRIDGE**

Condition	Y_s	a	L	Y_1/Y_2	K_1	K_2	K_3	F_r	V_2	g
Simple Pier/Bent	13.3	9.00	7.0	17.29	1.0	1.0	1.1	0.234	5.52	32.2

4. Long-Term Scour Analysis

Long-term scour (bed degradation) is associated with lowering of the streambed over a significant reach of the river and over an extended period of time (usually 50 to 100 years or more). It is generally caused by physiological changes in the river such as long-term sediment supply imbalance associated with gravel mining operation. Drastic changes in the hydrological condition of the river system could also be a contributing factor. For this study, the long-term scour was evaluated qualitatively by comparing the changes in the overall river bed elevation using the following aerial topographic maps:

- Riverside County Flood Control District's 1969 Line Topo Map with 4-foot contour intervals (NGVD 1929):
 - Section 15, T5S and R5W
 - Section 16, T5S and R5W
- Riverside County Flood Control District's 2009 Orthophoto Map with 4-foot contour intervals (NAVD 1988):
 - Section 15, T5S and R5W
 - Section 16, T5S and R5W
- Project design aerial topographic map dated 2015 with 1-foot contour intervals (NAVD 1988)

The reach of Temescal Wash that was evaluated extends from Bernard Street culvert (formerly Larson Road) to Lake Street bridge. The results of the qualitative analysis are outlined below:

- Section 16 (Bernard Street culvert, formerly Larson Road):
 - No appreciable change in elevations in the overbank area of Temescal Wash is apparent. However, the flowline elevation of the wash shown on the 1969 line topo map at the upstream side of the culvert is 1199.5 (NGVD 1929) or 1201.86 (NAVD 1988) while the 2009 orthophoto map shows it to be approximately elevation 1204.0. Due to heavy and dense vegetation existing in the 2009 orthophoto map, it is feasible that elevation 1204.0 does not reflect the true flow line elevation of the wash. The project design topo

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map (2015) shows elevation 1200.6 at roughly the same location. This could mean that a channel degradation of approximately 1.26 feet has occurred from 1969 to 2015, a period of 46 years, which translates to a long-term degradation rate of 0.03 feet per year.

- Section 15 (existing Temescal Canyon Road Bridge):
 - The flowline elevation of the wash shown on the 1969 line topo map is 1208.8 (NGVD 1929) or 1211.16 (NAVD 1988) while the 2009 orthophoto map shows it to be approximately elevation 1212.0. Again, due to heavy and dense vegetation existing in the 2009 orthophoto map, it is feasible that elevation 1212.0 does not reflect the true flow line elevation of the wash. The project design topo map (2015) shows elevation 1210.0 at roughly the same location in the wash. This could mean that a channel degradation of approximately 1.16 feet has occurred from 1969 to 2015, a period of 46 years, which translates to a long-term degradation rate of 0.03 feet per year.
- Based on a degradation rate of 0.03 feet per year, it was determined that a long-term scour depth of 2.2 feet is appropriate to use based upon a project life cycle of 75 years.
- Since the minimum flow line elevation of the low-flow channel is 1201.76 (downstream face of the bridge), the long-term scour elevation is determined to be 1199.56 (1201.76 – 2.2).

Total Scour

The total scour at the proposed piers will be the sum of the local (pier) scour based on the 200-year flow as required by FHWA and long-term scour. The summation of the total scour depth potential at the piers is 16.5 feet, as shown in Table 9. At the abutments of the proposed bridge, a combination of long-term scour and abutment scour was applied, yielding a total scour potential of 8.7 feet, as shown in Table 9.

TABLE 9: TOTAL SCOUR DEPTH RECOMMENDATIONS

Scour Element	Piers	Abutment
Long-term Scour (feet)	2.2	2.2
Abutment Scour (feet)	N/A	6.5
Contraction Scour(feet)	1.0	N/A
Pier Scour (feet)	13.3	N/A
Total Scour (feet)	16.5	8.7

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Caltrans Scour Data Table

According to Caltrans, structures over waterways are designed for site-specific hydraulic and hydrological conditions. Scour calculations consider the final design at each support. Over time, channel conditions change causing scour or channel degradation at bridge substructure elements. Addition of the Scour Data Table on the Foundation Plan (and Bridge Hydraulics Report) will assist in the future evaluation of changed conditions by providing hydraulic information about the original design. The Scour Data Table indicates the long-term scour and short-term scour values in support of the bridge foundation design as shown in Table 10.

TABLE 10: CALTRANS SCOUR DATA TABLE

Support Number	Long Term (Degradation and Contraction) Scour Elevation	Short Term (Local) Scour Depth (feet)
Abutment 1	N/A	N/A
Bent 2	1199.56	16.5
Bent 3	1199.56	16.5
Abutment 4	N/A	N/A

RCFC & WCD Scour Design Requirement (Local Agency Requirement)

The floodplain and bridge hydraulics/scour study report was initially submitted to RCFC & WCD for review on March 16, 2016. Revised reports were subsequently submitted on August 5, 2016 and October 20, 2016. RCFC & WCD approved the study report on October 31, 2016 (see Attachment).

RCFC & WCD requires bridge scour to be determined based on the following scour components:

- Long-term Scour
- Local Pier Scour
- General Scour (RCFC & WCD views general scour as inclusive of abutment and contraction scour)

While the long-term scour and local pier scour were determined the same way as described in this report, general scour was determined using the Los Angeles County Flood Control District's Toe-Down Depth Versus Flow Velocity Chart (Ref. 3). Based on the maximum average flow velocity of 3.92 feet per second at the proposed bridge location, the scour depth is determined to be 6 feet for "Straight Reaches" and 9 feet for "Curved Reach". Since the channel is on a curve, a general scour of 9 feet is used in this study as shown in Table 11.

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Cut-Off Depths

Velocities	Straight Reaches	*Curved Reach
0 - 6 f.p.s.	6-ft.	9-ft.
6 - 10 f.p.s.	8-ft.	12-ft.
10 - 15 f.p.s.	10-ft.	15-ft.
15 - 18 f.p.s.	12.5 ft.	18-ft.
18 - 20 f.p.s.	14 ft.	21-ft.

**TABLE 11: GENERAL SCOUR CALCULATION RESULTS FOR
PROPOSED TEMESCAL CANYON ROAD BRIDGE USING THE
LOS ANGELES COUNTY FLOOD CONTROL DISTRICT'S TOE-DOWN
DEPTH VERSUS FLOW VELOCITY CHART**

Location	Average Flow Velocity (FPS)	Maximum Scour Depth (Feet)	Minimum Low-Flow Channel Elevation at D/S Face of Bridge (Feet)	Maximum Scour Depth Elevation (Feet)
Abutment Cutoff Walls	3.92	9.0	1201.76	1192.76

The total scour at the proposed piers per RCFC & WCD's design requirement is the sum of the local (pier) scour based on the 200-year flow as required by FHWA, general scour, and long-term scour. Therefore, the total scour depth potential at the piers is 24.5 feet, as shown in Table 12.

At the abutments of the proposed bridge, a combination of long-term scour and general scour was applied, yielding a total scour potential of 11.2 feet.

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**TABLE 12: TOTAL SCOUR DEPTH RECOMMENDATIONS BASED ON RCFC
& WCD'S DESIGN REQUIREMENTS**

Scour Element	Piers	Abutment
Long-term Scour (feet)	2.2	2.2
General Scour (feet)	9.0	9.0
Pier Scour (feet)	13.3	N/A
Total Scour (feet)	24.5	11.2

Since RCFC & WCD's scour values are greater than the results shown using Caltrans' methodology, the bridge pier and abutment foundations will be designed based on the scour values shown in Table 12. Caltrans Scour Data Table is therefore revised to reflect the more conservative values (see Table 13).

**TABLE 13: CALTRANS SCOUR DATA TABLE BASED ON RCFC & WCD'S
DESIGN REQUIREMENTS**

Support Number	Long Term (Degradation and Contraction) Scour Elevation	Short Term (Local) Scour Depth (feet)
Abutment 1	N/A	N/A
Bent 2	1199.56	22.3
Bent 3	1199.56	22.3
Abutment 4	N/A	N/A

VII. SUMMARY AND RECOMMENDATIONS

Under the existing condition, the Temescal Canyon Road Bridge was determined to be inadequate for conveying the 100-year storm flow of 10,400 CFS. Flood flows are expected to overtop the existing bridge during this major flood event. The flow depths range from 6.59 feet to 12.85 feet while the average flow velocities range from approximately 2.05 to over 11.66 feet per second. For the proposed condition, the construction of the new bridge with a higher profile and graded channel will provide additional flow capacity needed to convey the 100-year flow of 10,400 CFS. Due to the lower channel invert and improved hydraulic efficiency effected by the proposed bridge and proposed channel improvements, the 100-year water surface elevations are lower for the majority of the study reach, from just downstream of the proposed bridge (Station 108111) up to the existing Lake Street bridge (Station 110373). Average flow velocities within the project limits range from over 2.34 to 11.84 feet per second.

Adequate bridge clearance allowance or freeboard is provided to convey the 100-year flow of 10,400 CFS as well as the bulked flows of 1.2, 1.35, and 1.5.

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A bridge clearance allowance of 3.16 feet is provided at the upstream face or northeast corner of the bridge while at the downstream face or northwest corner of the bridge, 3.45 feet of bridge clearance allowance is provided.

Under bulked flow conditions of 1.2, the bridge clearance allowances are 2.38 feet (1219.47 – 1217.09) and 2.77 feet (1219.23 – 1216.46) at the upstream face and downstream face of the bridge. For the 1.35 bulked flow, the bridge clearance allowances are 1.83 feet (1219.47 – 1217.67) at the upstream face and 2.29 feet (1219.23 – 1216.94) at the downstream face while for the 1.5 bulked flow, the bridge clearance allowances are 1.30 feet (1219.47 – 1218.17) at the upstream face and 1.82 feet (1219.23 – 1217.41) at the downstream face.

In order to protect the proposed bridge abutments from scour, concrete channel lining is proposed on the channel side slopes with cutoff walls extended to the scour depth of 11.2 feet. The bridge pier/bent will be designed based on the total scour depth of 24.5 feet (sum of maximum local pier scour of 13.3 feet, general scour of 9.0 feet and long-term scour of 2.2 feet – see Table 8).

Per Caltrans Scour Table 9, the long-term scour elevation is 1199.56 (1201.76 {low-flow channel flow line} – 2.2 feet) and the total short-term (local) scour depth is 22.3 feet (9.0 feet {General Scour} + 13.3 feet {Local Pier Scour}).

VIII. REFERENCES

1. Federal Emergency Management Agency Flood Insurance Study for Riverside County, California (1991 and 2014).
2. KWC Engineers (February 2014), “Preliminary Hydrologic Analysis for Alberhill Villages Specific Plan in the City of Lake Elsinore, County of Riverside, California”.
3. Los Angeles County Flood Control District (March 1982), “Design Hydraulic Manual”.
4. U.S. Department of Transportation, Federal Highway Administration (April 2012), “Evaluating Scour at Bridges, Fifth Edition, Publication No. FHWA-HIF-12-003, Hydraulic Engineering Circular No. 18”.
5. U.S. Army Corps of Engineers – Los Angeles District (August 1977), “Hydrology for Review Report for Flood Control and Related Purposes, Mission Zanja, San Timoteo, Temescal and Wilson Creeks, Santa Ana River Basin and Orange County, California”.

IX. PROJECT PHOTOGRAPHS



PHOTO #1: Looking westerly at the Existing Temescal Canyon Road near Bernard St.



PHOTO #2: Low-flow channel downstream of the Existing Temescal Canyon Road



PHOTO #3: Low-flow channel and floodplain overbank area near Pacific Clay Products looking downstream



PHOTO #4: Typical floodplain overbank area



PHOTO #5: Typical floodplain overbank area to the left and low-flow channel to the right



PHOTO #6: Low-flow channel downstream of the Existing Temescal Canyon Road



PHOTO #7: Bernard Street Bridge at Temescal Wash



PHOTO #8: Lake Street looking north at location of the proposed tie-in of Temescal Canyon Road



**PHOTO #9: Existing Temescal Canyon Road Bridge
looking east**



**PHOTO #10: Existing Temescal Canyon Road Bridge
looking west**



**PHOTO #11: Lake Street Bridge looking north
(Image taken from Google Earth)**

LIST OF TABLES

Table 1: 100-Year Hydraulics for the Temescal Canyon Road Bridge (Existing Condition)

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Temescal Wash	112034	100-Year	8,300	1220.21	1230.88	0.00	1232.28	0.003740	9.49	875.05	94.01	0.55
Temescal Wash	111034	100-Year	8,300	1218.21	1228.08	1225.48	1228.82	0.002616	7.75	1447.81	772.39	0.46
Temescal Wash	110484	100-Year	10,400	1217.21	1225.26	1223.80	1226.72	0.005067	9.97	1089.43	799.66	0.64
Temescal Wash	110414	100-Year	10,400	1214.61	1224.82	1222.89	1226.35	0.005175	9.93	1047.60	477.62	0.65
Temescal Wash	110413	100-Year	10,400	1214.61	1224.82	1222.89	1226.35	0.001296	9.93	1047.04	477.32	0.65
Temescal Wash	110393	Lake Street Bridge										
Temescal Wash	110373	100-Year	10,400	1214.61	1223.73	1222.89	1225.84	0.002141	11.66	892.16	392.54	0.82
Temescal Wash	110372	100-Year	10,400	1214.61	1223.86	1223.15	1225.70	0.016791	11.00	959.94	402.14	0.76
Temescal Wash	110322	100-Year	10,400	1216.75	1223.34	1222.20	1224.93	0.010937	8.96	1056.77	785.62	0.62
Temescal Wash	109572	100-Year	10,400	1210.61	1219.93	0.00	1220.05	0.000802	2.55	3833.91	617.75	0.17
Temescal Wash	109492	100-Year	10,400	1210.01	1219.91	0.00	1220.00	0.000382	2.05	4342.25	678.96	0.12
Temescal Wash	109491	100-Year	10,400	1210.01	1219.87	1216.00	1220.00	0.000674	4.00	4055.39	678.61	0.23
Temescal Wash	109478.5	Existing Temescal Canyon Road Bridge										
Temescal Wash	109466	100-Year	10,400	1210.01	1219.82	0.00	1219.95	0.000692	4.04	4020.28	678.09	0.24
Temescal Wash	109465	100-Year	10,400	1210.01	1219.84	0.00	1219.93	0.000775	2.49	4294.87	678.26	0.15
Temescal Wash	109400	100-Year	10,400	1210.00	1219.67	1215.98	1219.84	0.001522	3.30	3094.79	572.09	0.21
Temescal Wash	*108733	100-Year	10,400	1207.50	1219.02	1214.24	1219.18	0.001078	3.09	3234.27	572.73	0.18
Temescal Wash	108500	100-Year	10,400	1207.00	1218.22	1213.84	1218.56	0.002195	4.16	2224.74	1063.94	0.25
Temescal Wash	*108111	100-Year	10,400	1204.00	1215.91	1212.69	1216.78	0.006245	7.29	1391.36	613.74	0.42
Temescal Wash	107700	100-Year	10,400	1201.11	1213.96	1213.01	1214.59	0.004949	6.29	1627.59	1222.02	0.31

Note: Elevations on this table have been converted from NGVD 29 to NAVD 88 for the Existing Condition HEC-RAS Model

***Denotes cross section created by ACI as an added section not originally in the HEC-2 Model**

Table 2: 100-Year Hydraulics for the Temescal Canyon Road Bridge (Proposed Condition)

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Temescal Wash	112034	100-Year	8,300	1220.21	1230.92	0.00	1232.31	0.003690	9.44	879.08	94.11	0.54
Temescal Wash	111034	100-Year	8,300	1218.21	1227.92	1225.52	1228.75	0.002938	8.13	1376.67	766.94	0.49
Temescal Wash	110484	100-Year	10,400	1217.21	1225.25	1223.80	1226.72	0.005079	9.98	1088.61	799.38	0.64
Temescal Wash	110414	100-Year	10,400	1214.61	1224.82	1222.89	1226.35	0.005190	9.94	1046.62	477.09	0.65
Temescal Wash	110413	100-Year	10,400	1214.61	1224.81	1222.89	1226.35	0.001300	9.94	1046.05	476.79	0.65
Temescal Wash	110393	Lake Street Bridge										
Temescal Wash	110373	100-Year	10,400	1214.61	1223.63	1222.89	1225.81	0.002251	11.84	878.02	384.70	0.84
Temescal Wash	110372	100-Year	10,400	1214.61	1223.76	1223.14	1225.67	0.017672	11.19	943.96	394.85	0.78
Temescal Wash	110322	100-Year	10,400	1216.75	1223.18	1222.21	1224.86	0.012035	9.25	1027.61	780.52	0.65
Temescal Wash	109572	100-Year	10,400	1210.61	1219.26	0.00	1219.41	0.001162	2.88	3425.70	609.43	0.20
Temescal Wash	109492	100-Year	10,400	1210.01	1219.23	0.00	1219.34	0.000552	2.34	3882.67	672.16	0.15
Temescal Wash	109491	100-Year	10,400	1210.01	1219.17	1215.98	1219.34	0.000983	4.58	3584.24	671.63	0.28
Temescal Wash	109478.5	Existing Temescal Canyon Road Bridge										
Temescal Wash	109466	100-Year	10,400	1210.01	1219.09	0.00	1219.26	0.001031	4.66	3528.77	670.81	0.28
Temescal Wash	109465	100-Year	10,400	1210.01	1219.12	0.00	1219.23	0.001137	2.85	3808.39	671.05	0.18
Temescal Wash	109400	100-Year	10,400	1210.00	1218.88	1215.98	1219.11	0.002420	3.88	2690.46	561.98	0.25
Temescal Wash	108773	100-Year	10,400	1207.50	1217.60	1214.24	1217.85	0.002180	3.94	2594.17	539.67	0.24
Temescal Wash	108500	100-Year	10,400	1202.10	1216.30	1210.58	1216.86	0.002754	6.08	1730.61	304.51	0.30
Temescal Wash	108462	100-Year	10,400	1202.00	1216.31	1209.08	1216.59	0.001122	3.92	2434.09	226.43	0.19
Temescal Wash	108324	Proposed Temescal Canyon Road Bridge										
Temescal Wash	108186	100-Year	10,400	1201.76	1215.78	0.00	1216.06	0.001077	3.83	2460.70	227.26	0.19
Temescal Wash	108111	100-Year	10,400	1201.57	1215.23	1209.12	1215.78	0.002179	5.39	1742.76	399.23	0.27
Temescal Wash	107700	100-Year	10,400	1201.11	1213.96	1213.01	1214.59	0.004949	6.29	1627.59	1222.02	0.31

Table 3: 100-Year Hydraulic Data for the Temescal Canyon Road Bridge (Existing Versus Proposed Conditions)

Reach	Existing River Sta	Proposed River Sta	Profile	Q Total	Existing Min Ch El	Proposed Min Ch El	DELTA	Existing W.S. Elev	Proposed W.S. Elev	DELTA	Existing Vel Chnl	Proposed Vel Chnl	DELTA
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft/s)	(ft/s)	(ft/s)
Temescal Wash	112034	112034	100-Year	8,300	1220.21	1220.21	0.00	1230.88	1230.92	0.04	9.49	9.44	0.05
Temescal Wash	111034	111034	100-Year	8,300	1218.21	1218.21	0.00	1228.08	1227.92	-0.16	7.75	8.13	0.38
Temescal Wash	110484	110484	100-Year	10,400	1217.21	1217.21	0.00	1225.26	1225.25	-0.01	9.97	9.98	0.01
Temescal Wash	110414	110414	100-Year	10,400	1214.61	1214.61	0.00	1224.82	1224.82	0.00	9.93	9.94	0.01
Temescal Wash	110413	110413	100-Year	10,400	1214.61	1214.61	0.00	1224.82	1224.81	-0.01	9.93	9.94	0.01
Temescal Wash	110393	110393	Lake Street Bridge										
Temescal Wash	110373	110373	100-Year	10,400	1214.61	1214.61	0.00	1223.73	1223.63	-0.10	11.66	11.84	0.18
Temescal Wash	110372	110372	100-Year	10,400	1214.61	1214.61	0.00	1223.86	1223.76	-0.10	11.00	11.19	0.19
Temescal Wash	110322	110322	100-Year	10,400	1216.75	1216.75	0.00	1223.34	1223.18	-0.16	8.96	9.25	0.29
Temescal Wash	109572	109572	100-Year	10,400	1210.61	1210.61	0.00	1219.93	1219.26	-0.67	2.55	2.88	0.33
Temescal Wash	109492	109492	100-Year	10,400	1210.01	1210.01	0.00	1219.91	1219.23	-0.68	2.05	2.34	0.29
Temescal Wash	109491	109491	100-Year	10,400	1210.01	1210.01	0.00	1219.87	1219.17	-0.70	4.00	4.58	0.58
Temescal Wash	109478.5	109478.5	Existing Temescal Canyon Road Bridge										
Temescal Wash	109466	109466	100-Year	10,400	1210.01	1210.01	0.00	1219.82	1219.09	-0.73	4.04	4.66	0.62
Temescal Wash	109465	109465	100-Year	10,400	1210.01	1210.01	0.00	1219.84	1219.12	-0.72	2.49	2.85	0.36
Temescal Wash	109400	109400	100-Year	10,400	1210.00	1210.00	0.00	1219.67	1218.88	-0.79	3.30	3.88	0.58
Temescal Wash	108773	108773	100-Year	10,400	1207.50	1207.50	0.00	1219.02	1217.60	-1.42	3.09	3.94	0.85
Temescal Wash	108500	108500	100-Year	10,400	1207.00	1202.10	-4.90	1218.22	1216.30	-1.92	4.16	6.08	1.92
Temescal Wash	N/A	108462	100-year	10,400	N/A	1202.00	N/A	N/A	1216.31	N/A	N/A	3.92	N/A
Temescal Wash	N/A	108324	Proposed Temescal Canyon Road Bridge										
Temescal Wash	N/A	108186	100-year	10,400	N/A	1201.76	N/A	N/A	1215.78	N/A	N/A	3.83	N/A
Temescal Wash	108111	108111	100-year	10,400	1204.00	1201.57	-2.43	1215.91	1215.23	-0.68	7.29	5.39	-1.90
Temescal Wash	107700	107700	100-year	10,400	1201.11	1201.11	0.00	1213.96	1213.96	0.00	6.29	6.29	0.00

APPENDICIES

**APPENDIX A: HEC-RAS SUMMARY OUTPUT FILES FOR
THE EXISTING CONDITION FOR THE
100-YEAR FLOOD EVENT**

HEC-RAS Plan: dup eff nad88 River: Temescal Reach: Wash Profile: 100-Year

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Wash	112034	100-Year	8300.00	1220.21	1230.88		1232.28	0.003740	9.49	875.05	94.01	0.55
Wash	111034	100-Year	8300.00	1218.21	1228.08	1225.48	1228.82	0.002616	7.75	1447.81	772.39	0.46
Wash	110484	100-Year	10400.00	1217.21	1225.26	1223.80	1226.72	0.005067	9.97	1089.43	799.66	0.64
Wash	110414	100-Year	10400.00	1214.61	1224.82	1222.89	1226.35	0.005175	9.93	1047.60	477.62	0.65
Wash	110413	100-Year	10400.00	1214.61	1224.82	1222.89	1226.35	0.001296	9.93	1047.04	477.32	0.65
Wash	110393		Bridge									
Wash	110373	100-Year	10400.00	1214.61	1223.73	1222.89	1225.84	0.002141	11.66	892.16	392.54	0.82
Wash	110372	100-Year	10400.00	1214.61	1223.86	1223.15	1225.70	0.016791	11.00	959.94	402.14	0.76
Wash	110322	100-Year	10400.00	1216.75	1223.34	1222.20	1224.93	0.010937	8.96	1056.77	785.62	0.62
Wash	109572	100-Year	10400.00	1210.61	1219.93		1220.05	0.000802	2.55	3833.91	617.75	0.17
Wash	109492	100-Year	10400.00	1210.01	1219.91		1220.00	0.000382	2.05	4342.25	678.96	0.12
Wash	109491	100-Year	10400.00	1210.01	1219.87	1216.00	1220.00	0.000674	4.00	4055.39	678.61	0.23
Wash	109478.5		Bridge									
Wash	109466	100-Year	10400.00	1210.01	1219.82		1219.95	0.000692	4.04	4020.28	678.09	0.24
Wash	109465	100-Year	10400.00	1210.01	1219.84		1219.93	0.000775	2.49	4294.87	678.26	0.15
Wash	109400	100-Year	10400.00	1210.00	1219.67	1215.98	1219.84	0.001522	3.30	3094.79	572.09	0.21
Wash	108773	100-Year	10400.00	1207.50	1219.02	1214.24	1219.18	0.001078	3.09	3234.27	572.73	0.18
Wash	108500	100-Year	10400.00	1207.00	1218.22	1213.84	1218.56	0.002195	4.16	2224.74	1063.94	0.25
Wash	108111	100-Year	10400.00	1204.00	1215.91	1212.69	1216.78	0.006245	7.29	1391.36	613.74	0.42
Wash	107700	100-Year	10400.00	1201.11	1213.96	1213.01	1214.59	0.004949	6.29	1627.59	1222.02	0.31

**APPENDIX B: HEC-RAS SUMMARY OUTPUT FILES FOR
THE PROPOSED CONDITION FOR THE
100-YEAR FLOOD EVENT**

HEC-RAS Plan: nadFix_CA_031516 River: RIVER-1 Reach: Reach-1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach-1	112034	100-YR	8300.00	1220.21	1230.92		1232.31	0.003690	9.44	879.08	94.11	0.54
Reach-1	112034	1.2X100-YR	9960.00	1220.21	1231.50		1233.27	0.004446	10.67	933.64	95.40	0.60
Reach-1	112034	1.5X100-YR	12450.00	1220.21	1233.75		1235.56	0.003730	10.79	1154.25	100.47	0.56
Reach-1	112034	200-YR	15189.00	1220.21	1234.83		1237.07	0.004203	12.01	1272.75	123.43	0.60
Reach-1	112034	1.35X100-YR	11205.00	1220.21	1233.27		1234.87	0.003418	10.13	1106.37	99.39	0.53
Reach-1	111034	100-YR	8300.00	1218.21	1227.92	1225.52	1228.75	0.002938	8.13	1376.67	766.94	0.49
Reach-1	111034	1.2X100-YR	9960.00	1218.21	1228.84	1227.78	1229.48	0.002219	7.47	1790.21	798.61	0.43
Reach-1	111034	1.5X100-YR	12450.00	1218.21	1232.66	1228.27	1232.86	0.000460	4.25	3561.52	1056.25	0.21
Reach-1	111034	200-YR	15189.00	1218.21	1233.78	1228.72	1234.00	0.000442	4.40	4093.48	1148.02	0.20
Reach-1	111034	1.35X100-YR	11205.00	1218.21	1232.21	1228.03	1232.40	0.000451	4.11	3348.82	1019.56	0.20
Reach-1	110484	100-YR	10400.00	1217.21	1225.25	1223.80	1226.72	0.005079	9.98	1088.61	799.38	0.64
Reach-1	110484	1.2X100-YR	12480.00	1217.21	1226.27	1224.47	1227.83	0.004642	10.28	1259.57	856.85	0.62
Reach-1	110484	1.5X100-YR	15600.00	1217.21	1231.70	1225.37	1232.47	0.001226	7.06	2221.23	1299.20	0.34
Reach-1	110484	200-YR	19032.00	1217.21	1232.59	1226.29	1233.59	0.001448	8.01	2380.59	1338.56	0.38
Reach-1	110484	1.35X100-YR	14040.00	1217.21	1231.38	1224.94	1232.03	0.001085	6.53	2162.90	1283.44	0.32
Reach-1	110414	100-YR	10400.00	1214.61	1224.82	1222.89	1226.35	0.005190	9.94	1046.62	477.09	0.65
Reach-1	110414	1.2X100-YR	12480.00	1214.61	1225.73	1223.63	1227.47	0.005144	10.58	1180.00	548.60	0.66
Reach-1	110414	1.5X100-YR	15600.00	1214.61	1231.46	1224.71	1232.37	0.001372	7.63	2045.25	1249.80	0.37
Reach-1	110414	200-YR	19032.00	1214.61	1232.26	1225.76	1233.46	0.001686	8.79	2166.06	1334.64	0.41
Reach-1	110414	1.35X100-YR	14040.00	1214.61	1231.18	1224.19	1231.94	0.001193	7.01	2002.19	1219.55	0.34
Reach-1	110413	100-YR	10400.00	1214.61	1224.81	1222.89	1226.35	0.001300	9.94	1046.05	476.79	0.65
Reach-1	110413	1.2X100-YR	12480.00	1214.61	1225.73	1223.63	1227.47	0.001288	10.58	1179.42	548.29	0.66
Reach-1	110413	1.5X100-YR	15600.00	1214.61	1231.46	1224.71	1232.37	0.000343	7.63	2045.08	1249.68	0.37
Reach-1	110413	200-YR	19032.00	1214.61	1232.26	1225.76	1233.46	0.000422	8.79	2165.86	1334.50	0.41
Reach-1	110413	1.35X100-YR	14040.00	1214.61	1231.18	1224.19	1231.94	0.000298	7.01	2002.06	1219.46	0.34
Reach-1	110393		Bridge									
Reach-1	110373	100-YR	10400.00	1214.61	1223.63	1222.89	1225.81	0.002251	11.84	878.02	384.70	0.84
Reach-1	110373	1.2X100-YR	12480.00	1214.61	1224.18	1223.63	1226.83	0.002490	13.07	954.92	427.13	0.89
Reach-1	110373	1.5X100-YR	15600.00	1214.61	1224.90	1224.71	1228.27	0.002812	14.73	1059.31	483.95	0.96
Reach-1	110373	200-YR	19032.00	1214.61	1225.76	1225.76	1229.77	0.002955	16.07	1184.50	550.99	1.00
Reach-1	110373	1.35X100-YR	14040.00	1214.61	1224.55	1224.19	1227.56	0.002656	13.92	1008.44	456.37	0.92
Reach-1	110372	100-YR	10400.00	1214.61	1223.76	1223.14	1225.67	0.017672	11.19	943.96	394.85	0.78
Reach-1	110372	1.2X100-YR	12480.00	1214.61	1224.40	1223.82	1226.59	0.018147	11.98	1053.82	444.70	0.80

HEC-RAS Plan: nadFix_CA_031516 River: RIVER-1 Reach: Reach-1 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach-1	110372	1.5X100-YR	15600.00	1214.61	1225.28	1224.71	1227.88	0.018543	12.97	1207.60	513.56	0.83
Reach-1	110372	200-YR	19032.00	1214.61	1226.18	1225.58	1229.20	0.018711	13.86	1366.42	583.60	0.84
Reach-1	110372	1.35X100-YR	14040.00	1214.61	1224.85	1224.28	1227.25	0.018382	12.50	1132.10	479.88	0.82
Reach-1	110322	100-YR	10400.00	1216.75	1223.18	1222.21	1224.86	0.012035	9.25	1027.61	780.52	0.65
Reach-1	110322	1.2X100-YR	12480.00	1216.75	1223.77	1222.82	1225.78	0.012227	9.89	1138.00	799.83	0.66
Reach-1	110322	1.5X100-YR	15600.00	1216.75	1224.59	1223.69	1227.06	0.012456	10.76	1289.69	832.47	0.68
Reach-1	110322	200-YR	19032.00	1216.75	1225.43	1224.57	1228.40	0.012583	11.57	1444.70	920.33	0.70
Reach-1	110322	1.35X100-YR	14040.00	1216.75	1224.19	1223.27	1226.43	0.012354	10.34	1215.51	813.39	0.67
Reach-1	109572	100-YR	10400.00	1210.61	1219.26		1219.41	0.001162	2.88	3425.70	609.43	0.20
Reach-1	109572	1.2X100-YR	12480.00	1210.61	1220.02		1220.19	0.001102	3.01	3888.71	618.85	0.20
Reach-1	109572	1.5X100-YR	15600.00	1210.61	1221.10		1221.29	0.001018	3.17	4565.02	632.37	0.20
Reach-1	109572	200-YR	19032.00	1210.61	1222.24		1222.46	0.000934	3.30	5294.61	646.63	0.19
Reach-1	109572	1.35X100-YR	14040.00	1210.61	1220.57		1220.75	0.001059	3.10	4228.93	625.69	0.20
Reach-1	109492	100-YR	10400.00	1210.01	1219.23		1219.34	0.000552	2.34	3882.67	672.16	0.15
Reach-1	109492	1.2X100-YR	12480.00	1210.01	1219.99		1220.12	0.000528	2.43	4396.48	679.76	0.14
Reach-1	109492	1.5X100-YR	15600.00	1210.01	1221.08		1221.23	0.000493	2.54	5142.75	690.65	0.14
Reach-1	109492	200-YR	19032.00	1210.01	1222.22		1222.39	0.000457	2.63	5942.34	702.13	0.14
Reach-1	109492	1.35X100-YR	14040.00	1210.01	1220.54		1220.68	0.000510	2.49	4772.48	685.27	0.14
Reach-1	109491	100-YR	10400.00	1210.01	1219.17	1215.98	1219.34	0.000983	4.58	3584.24	671.63	0.28
Reach-1	109491	1.2X100-YR	12480.00	1210.01	1219.94	1216.40	1220.11	0.000939	4.74	4100.06	679.27	0.27
Reach-1	109491	1.5X100-YR	15600.00	1210.01	1221.03	1216.69	1221.22	0.000874	4.93	4849.08	690.21	0.27
Reach-1	109491	200-YR	19032.00	1210.01	1222.18	1217.10	1222.39	0.000809	5.09	5651.42	701.74	0.26
Reach-1	109491	1.35X100-YR	14040.00	1210.01	1220.49	1216.52	1220.67	0.000906	4.84	4477.46	684.80	0.27
Reach-1	109478.5		Bridge									
Reach-1	109466	100-YR	10400.00	1210.01	1219.09		1219.26	0.001031	4.66	3528.77	670.81	0.28
Reach-1	109466	1.2X100-YR	12480.00	1210.01	1219.86		1220.04	0.000976	4.81	4048.43	678.51	0.28
Reach-1	109466	1.5X100-YR	15600.00	1210.01	1220.97		1221.16	0.000899	4.98	4804.45	689.56	0.27
Reach-1	109466	200-YR	19032.00	1210.01	1222.13		1222.34	0.000827	5.13	5612.55	701.18	0.27
Reach-1	109466	1.35X100-YR	14040.00	1210.01	1220.42		1220.61	0.000936	4.90	4429.59	684.10	0.28
Reach-1	109465	100-YR	10400.00	1210.01	1219.12		1219.23	0.001137	2.85	3808.39	671.05	0.18
Reach-1	109465	1.2X100-YR	12480.00	1210.01	1219.89		1220.01	0.001089	2.97	4327.75	678.75	0.18
Reach-1	109465	1.5X100-YR	15600.00	1210.01	1220.99		1221.14	0.001017	3.10	5083.26	689.79	0.17
Reach-1	109465	200-YR	19032.00	1210.01	1222.15		1222.31	0.000944	3.22	5890.77	701.40	0.17

HEC-RAS Plan: nadFix_CA_031516 River: RIVER-1 Reach: Reach-1 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach-1	109465	1.35X100-YR	14040.00	1210.01	1220.44		1220.58	0.001052	3.04	4708.62	684.33	0.18
Reach-1	109400	100-YR	10400.00	1210.00	1218.88	1215.98	1219.11	0.002420	3.88	2690.46	561.98	0.25
Reach-1	109400	1.2X100-YR	12480.00	1210.00	1219.66	1216.33	1219.90	0.002182	3.95	3129.07	571.98	0.25
Reach-1	109400	1.5X100-YR	15600.00	1210.00	1220.77	1216.80	1221.03	0.001902	4.02	3768.41	585.54	0.23
Reach-1	109400	200-YR	19032.00	1210.00	1221.93	1217.24	1222.22	0.001673	4.09	4442.94	596.76	0.22
Reach-1	109400	1.35X100-YR	14040.00	1210.00	1220.22	1216.57	1220.47	0.002032	3.99	3452.19	578.80	0.24
Reach-1	108773	100-YR	10400.00	1207.50	1217.60	1214.24	1217.85	0.002180	3.94	2594.17	539.67	0.24
Reach-1	108773	1.2X100-YR	12480.00	1207.50	1218.49	1214.63	1218.76	0.001988	4.03	2994.43	564.27	0.24
Reach-1	108773	1.5X100-YR	15600.00	1207.50	1219.72	1215.14	1220.02	0.001793	4.17	3551.16	586.58	0.23
Reach-1	108773	200-YR	19032.00	1207.50	1220.97	1215.63	1221.31	0.001646	4.32	4119.16	607.22	0.22
Reach-1	108773	1.35X100-YR	14040.00	1207.50	1219.12	1214.86	1219.40	0.001880	4.10	3278.69	574.67	0.23
Reach-1	108500	100-YR	10400.00	1202.10	1216.30	1210.58	1216.86	0.002754	6.08	1730.61	304.51	0.30
Reach-1	108500	1.2X100-YR	12480.00	1202.10	1217.06	1211.33	1217.76	0.003125	6.73	1872.03	315.18	0.32
Reach-1	108500	1.5X100-YR	15600.00	1202.10	1218.13	1212.82	1219.01	0.003595	7.59	2067.99	320.82	0.35
Reach-1	108500	200-YR	19032.00	1202.10	1219.21	1213.81	1220.30	0.004021	8.41	2267.11	325.54	0.37
Reach-1	108500	1.35X100-YR	14040.00	1202.10	1217.61	1211.88	1218.40	0.003371	7.18	1972.27	318.10	0.33
Reach-1	108462	100-YR	10400.00	1202.00	1216.31	1209.08	1216.59	0.001122	3.92	2434.09	226.43	0.19
Reach-1	108462	1.2X100-YR	12480.00	1202.00	1217.09	1209.65	1217.44	0.001293	4.37	2611.46	228.93	0.21
Reach-1	108462	1.5X100-YR	15600.00	1202.00	1218.17	1210.41	1218.64	0.001504	4.96	2866.86	235.00	0.23
Reach-1	108462	200-YR	19032.00	1202.00	1219.29	1211.25	1219.87	0.001694	5.52	3128.17	235.00	0.24
Reach-1	108462	1.35X100-YR	14040.00	1202.00	1217.64	1210.05	1218.05	0.001403	4.68	2741.82	235.00	0.22
Reach-1	108324	Bridge										
Reach-1	108186	100-YR	10400.00	1201.76	1215.78		1216.06	0.001077	3.83	2460.70	227.26	0.19
Reach-1	108186	1.2X100-YR	12480.00	1201.76	1216.46		1216.81	0.001277	4.32	2616.37	235.00	0.21
Reach-1	108186	1.5X100-YR	15600.00	1201.76	1217.41		1217.88	0.001539	4.95	2840.12	235.00	0.23
Reach-1	108186	200-YR	19032.00	1201.76	1218.39		1218.99	0.001786	5.57	3070.67	235.00	0.25
Reach-1	108186	1.35X100-YR	14040.00	1201.76	1216.94		1217.36	0.001413	4.64	2730.37	235.00	0.22
Reach-1	108111	100-YR	10400.00	1201.57	1215.23	1209.12	1215.78	0.002179	5.39	1742.76	399.23	0.27
Reach-1	108111	1.2X100-YR	12480.00	1201.57	1215.73	1209.90	1216.47	0.002708	6.17	1823.47	399.58	0.30
Reach-1	108111	1.5X100-YR	15600.00	1201.57	1216.41	1210.86	1217.43	0.003516	7.26	1930.26	400.03	0.34
Reach-1	108111	200-YR	19032.00	1201.57	1217.04	1211.80	1218.42	0.004429	8.40	2031.68	400.46	0.39
Reach-1	108111	1.35X100-YR	14040.00	1201.57	1216.08	1210.39	1216.96	0.003109	6.73	1878.91	399.81	0.32

HEC-RAS Plan: nadFix_CA_031516 River: RIVER-1 Reach: Reach-1 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach-1	107700	100-YR	10400.00	1201.11	1213.96	1213.01	1214.59	0.004949	6.29	1627.59	1222.02	0.31
Reach-1	107700	1.2X100-YR	12480.00	1201.11	1214.38	1213.30	1215.11	0.004907	6.41	1827.17	1270.28	0.31
Reach-1	107700	1.5X100-YR	15600.00	1201.11	1214.85	1213.75	1215.75	0.005257	6.79	2053.59	1295.38	0.33
Reach-1	107700	200-YR	19032.00	1201.11	1215.37	1214.21	1216.44	0.005365	7.04	2307.96	1310.92	0.33
Reach-1	107700	1.35X100-YR	14040.00	1201.11	1214.62	1213.54	1215.43	0.005097	6.61	1942.38	1288.50	0.32

**APPENDIX C: SCOUR CALCULATIONS FOR TEMESCAL
WASH IN THE VICINITY OF TEMESCAL
CANYON ROAD BRIDGE**

APPENDIX C.1

LOCAL SCOUR ANALYSIS FOR SIMPLE PIER

USING 200-YEAR FLOW AND 1-FOOT OF DEBRIS ON EACH SIDE OF THE PIER

TEMESCAL CANYON ROAD NEW BRIDGE OVER THE TEMESCAL WASH PROJECT (WITH-PROJECT CONDITION)

SIMPLE PIER SCOUR USING HEC-18 CSU EQUATION

$$Y_s = 2.0 Y_1 K_1 K_2 K_3 (Y_1/a)^{0.35} Fr^{0.43}$$

Y_s = Scour Depth (feet)

Y_1 = Flow Depth Directly Upstream of the Pier = 17.29 feet (200-year per HEC-RAS)

K_1 = Correction Factor for Pier Nose Shape (Dimensionless Unit) = 1.0 (round nose)

K_2 = Correction Factor for Angle of Attack of Flow (Dimensionless Unit) = 1.0 (0 degree angle of attack)

K_3 = Correction Factor for Bed Condition (Dimensionless Unit) = 1.1 (small dunes)

a = Pier Width = 9.0 feet (7' per CNS Bridge GP plus 1-foot of Debris on each side of the pier)

L = Length of Pier = 7.0 feet (per CNS Bridge GP)

Fr = Froude Number Directly Upstream of Pier = $V_1/(gy_1)^{0.5}$

V_1 = Maximum Mean Velocity of Flow Directly at the Pier = 5.52 FPS (200-year per HEC-RAS)

g = Acceleration of Gravity (32.2 feet/sec²)

PIER SCOUR WITH NO GENERAL SCOUR AND 1-FOOT OF DEBRIS ON EACH SIDE OF THE PIER										
FLOOD EVENT	Y_s	a	L	Y_1	K_1	K_2	K_3	Fr	V_1	g
200-YEAR EVENT (1-FOOT DEBRIS ON EACH SIDE OF PIER)	13.3	9.00	7.0	17.29	1.0	1.0	1.1	0.234	5.52	32.2

APPENDIX C.2

CONTRACTION SCOUR ANALYSIS USING 200-YEAR FLOW DATA

TEMESCAL CANYON ROAD NEW BRIDGE OVER THE TEMESCAL WASH PROJECT (WITH-PROJECT CONDITION)

CONTRACTION SCOUR USING LIVE BED CONTRACTION EQUATION

$$Y_2 = Y_1 (W_1/W_2)^{k_1}; \quad Y_s = Y_2 - Y_o$$

Y_s = Scour Depth (feet)

Y₂ = Average Flow Depth in the Contracted Section

Y₁ = Average Flow Depth in the Upstream Channel Section (per HEC-RAS)

W₁ = Bottom Width of the Upstream Main Channel that is Transporting Bed Material

W₂ = Bottom width of Main Channel in Contracted Section Less Pier Width

K₁ = Bed Material Transport Characteristic (mostly suspended material)

Y_o = Existing Depth in the Contracted Section Before Scour

CONTRACTION SCOUR							
LOCATION	Y _s	Y ₂	Y ₁	Y _o	W ₁	W ₂	K ₁
PIERS	1.0	18.25	17.29	17.29	185.00	171.00	0.69

APPENDIX C.3

ABUTMENT SCOUR ANALYSIS

TEMESCAL CANYON ROAD NEW BRIDGE OVER THE TEMESCAL WASH PROJECT (WITH-PROJECT CONDITION)

ABUTMENT SCOUR USING NCHRP 24-20 SCOUR APPROACH

$$Y_s = Y_{max} - Y_o; Y_{max} = \alpha_A Y_c; Y_c = Y_1 (q_{2c}/q_1)^{6/7}$$

Y_s = Scour Depth (feet)

Y_{max} = Channel Flow Depth including live-bed contraction scour (feet)

Y_c = Channel Flow Depth including live-bed contraction scour (feet)

Y₁ = Bridge Flow Depth (14.31 Ft per HEC-RAS)

Y_{ROB & LOB} = Abutment Flow Depth at Right Overbank or Abutment (14.31 feet minus 3 feet {overbank height} = 11.31 feet)

q_c = Channel Unit discharge (14.31 Ft X 3.92 FPS = 56 ft²/s)

a (ROB & LOB) = Right Abutment Area Unit discharge (11.31 Ft X 3.92 FPS = 44 ft²/s)

α_A = Taken from Figure 8.10 of the HEC-18 Manual (1.19)

Q = 100-year Flow Rate (10,400 CFS)

SBR = Setback Ratio (used to determine unit discharges q_c and q_a based on SBR less than 5)

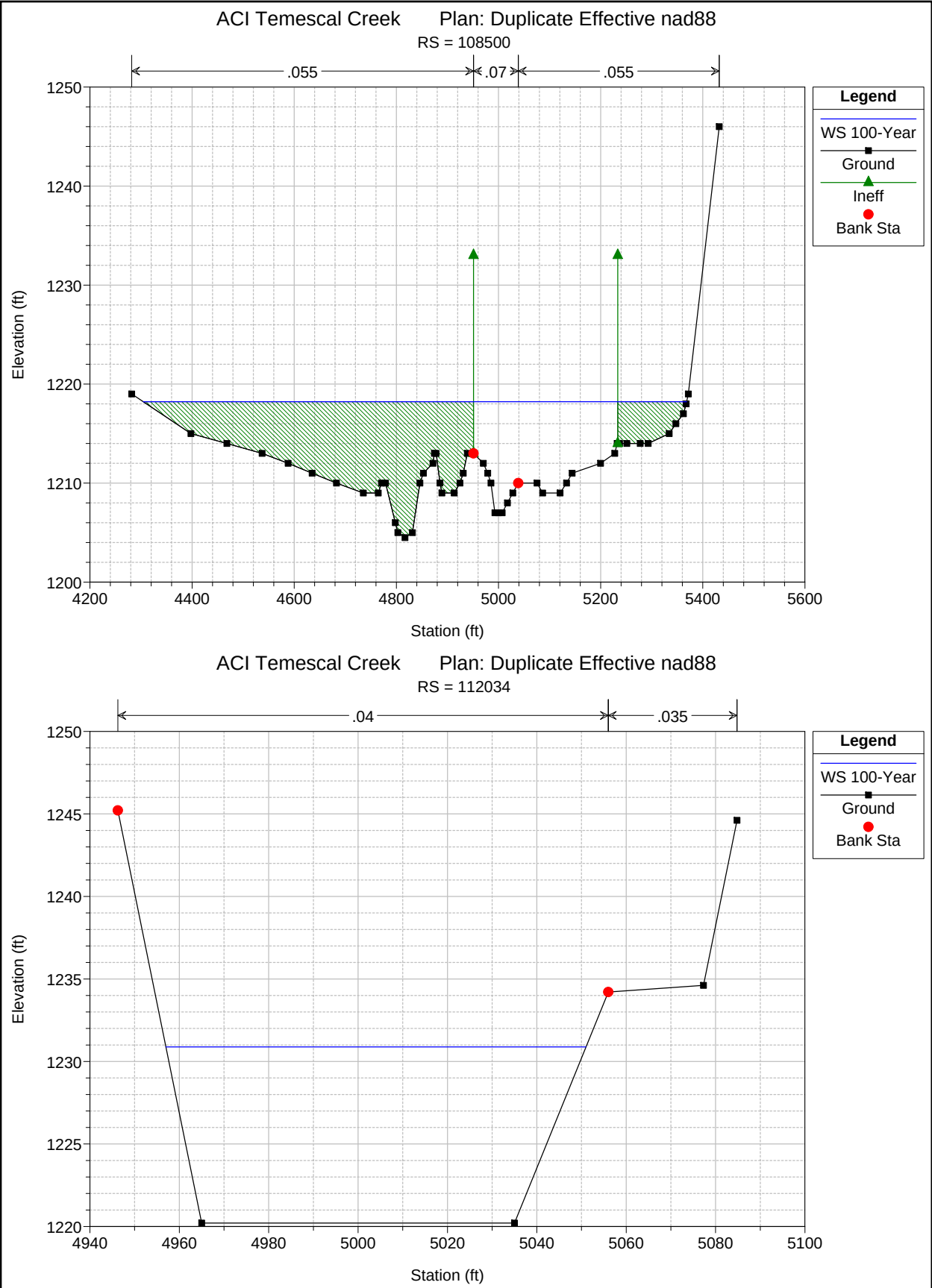
V = Flow Velocity thru Bridge (17.59 FPS per HEC-RAS)

ROB = Right Overbank

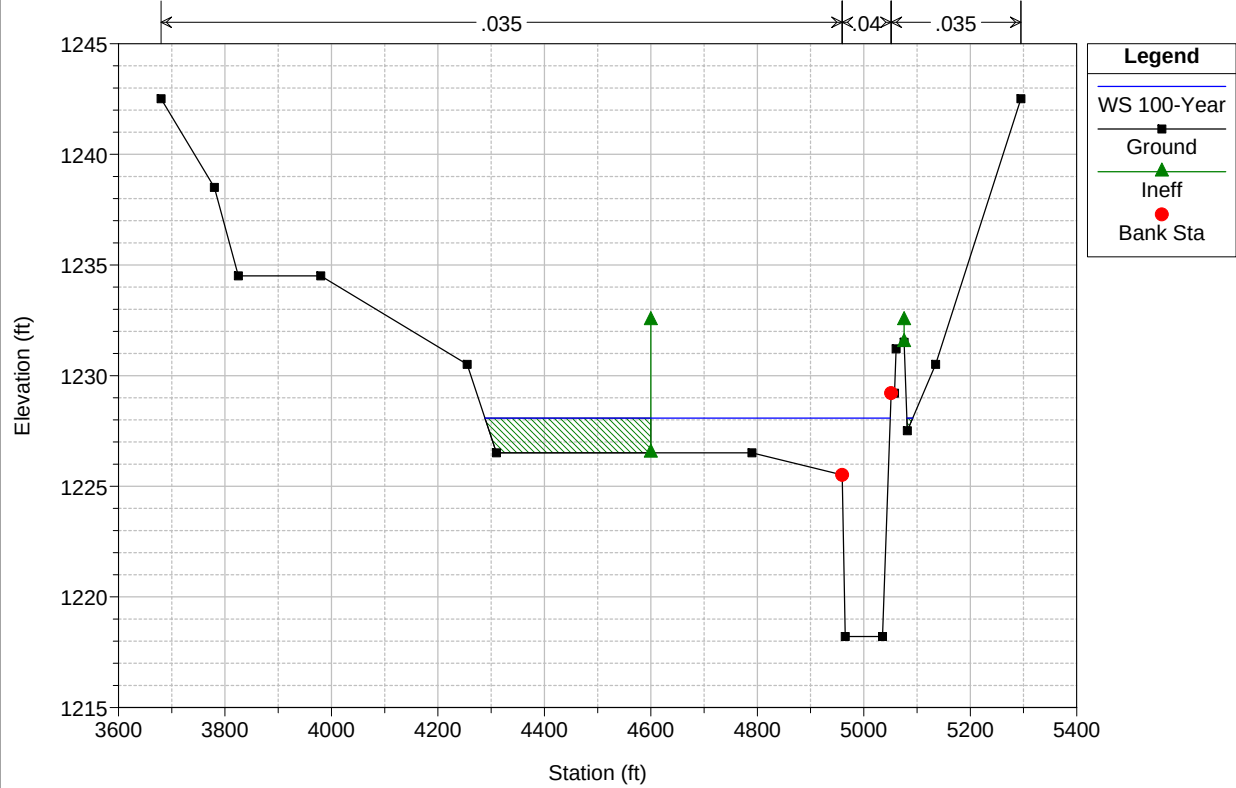
LOB = Left Overbank

ABUTMENT SCOUR											
LOCATION	Y _s	Y _{max}	Y _c	SBR	q _c	q _a	q _c /q _a	Y ₁	Y _{ROB}	V	α _A
BRIDGE ABUTMENT	6.5	20.8	17.5	3.1	56	44	1.27	14.31	11.31	3.92	1.19

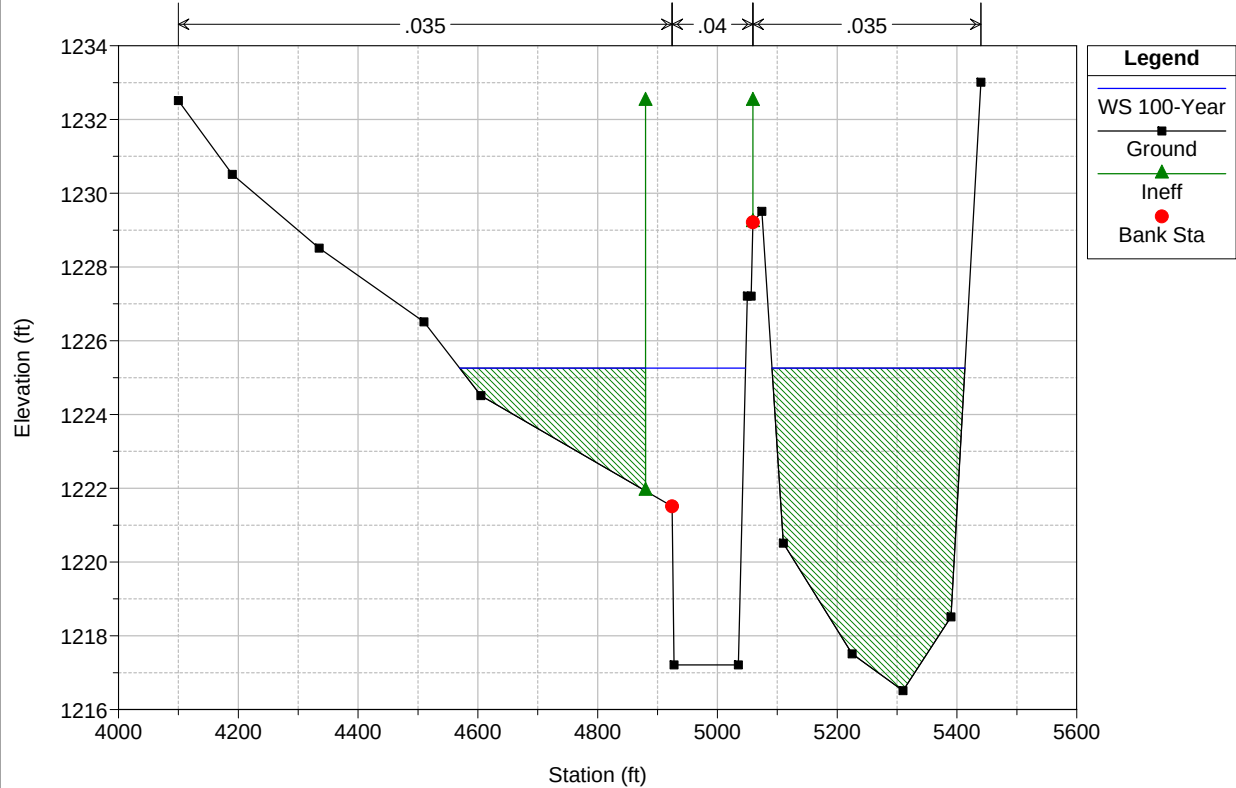
**APPENDIX D: HEC-RAS STREAM CROSS SECTIONS FOR
THE EXISTING CONDITION**

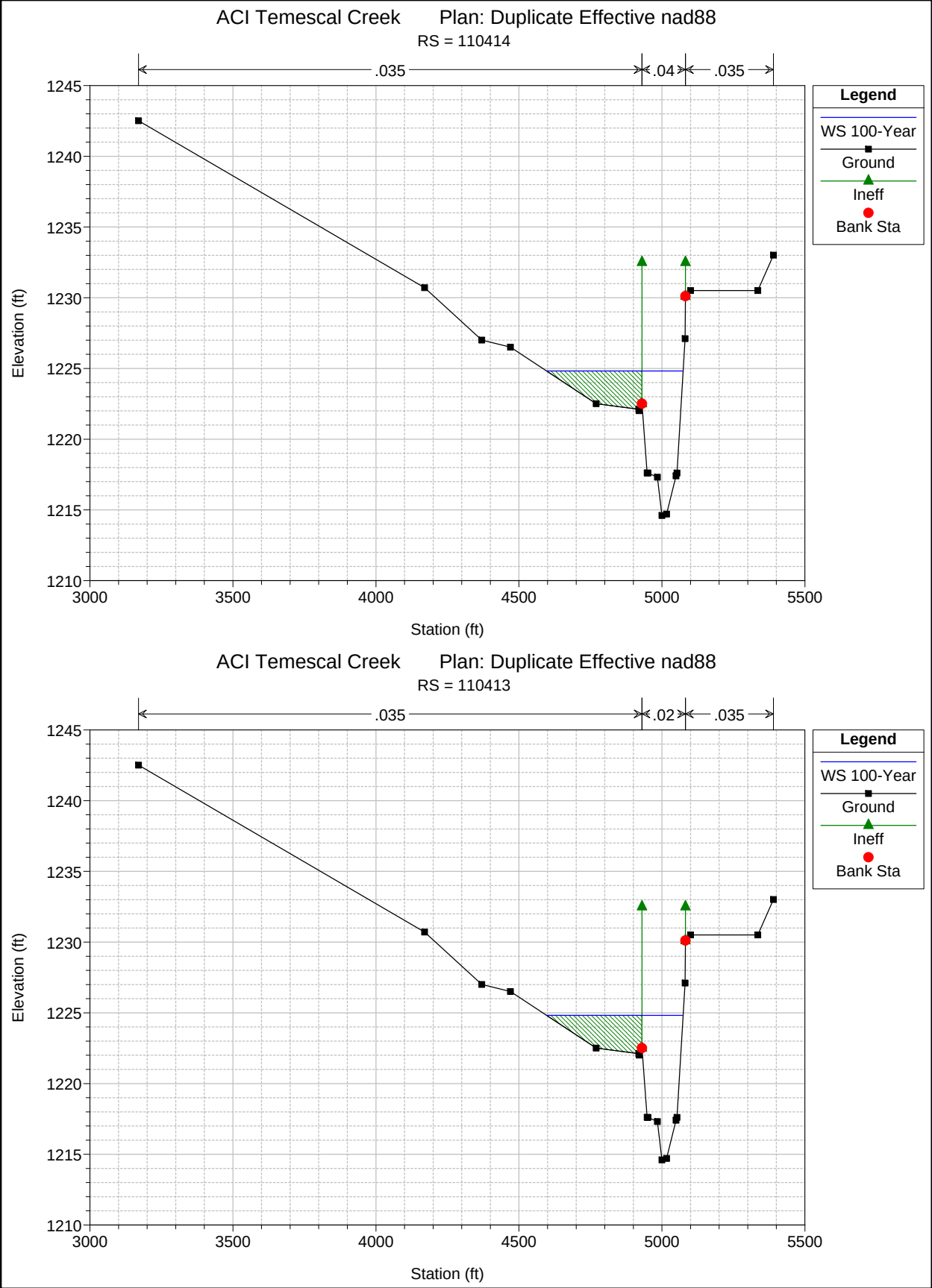


ACI Temescal Creek Plan: Duplicate Effective nad88
RS = 111034



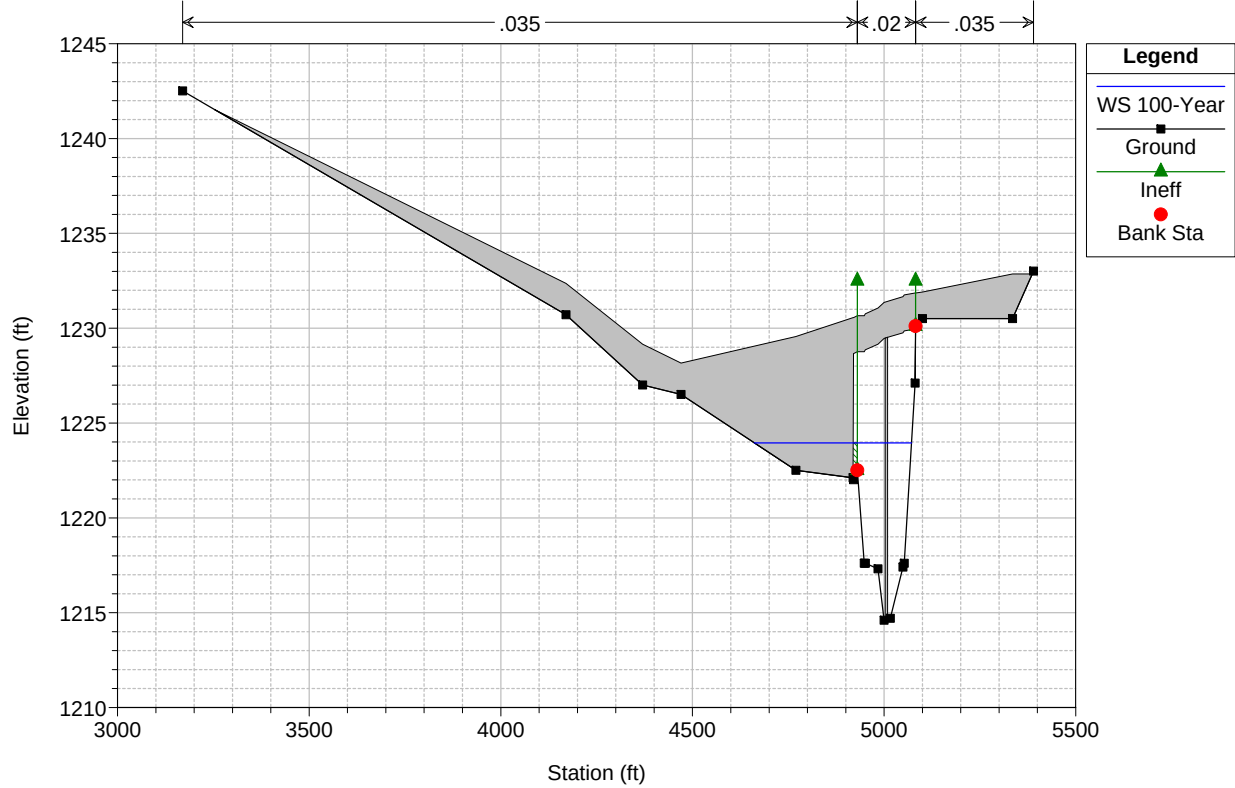
ACI Temescal Creek Plan: Duplicate Effective nad88
RS = 110484





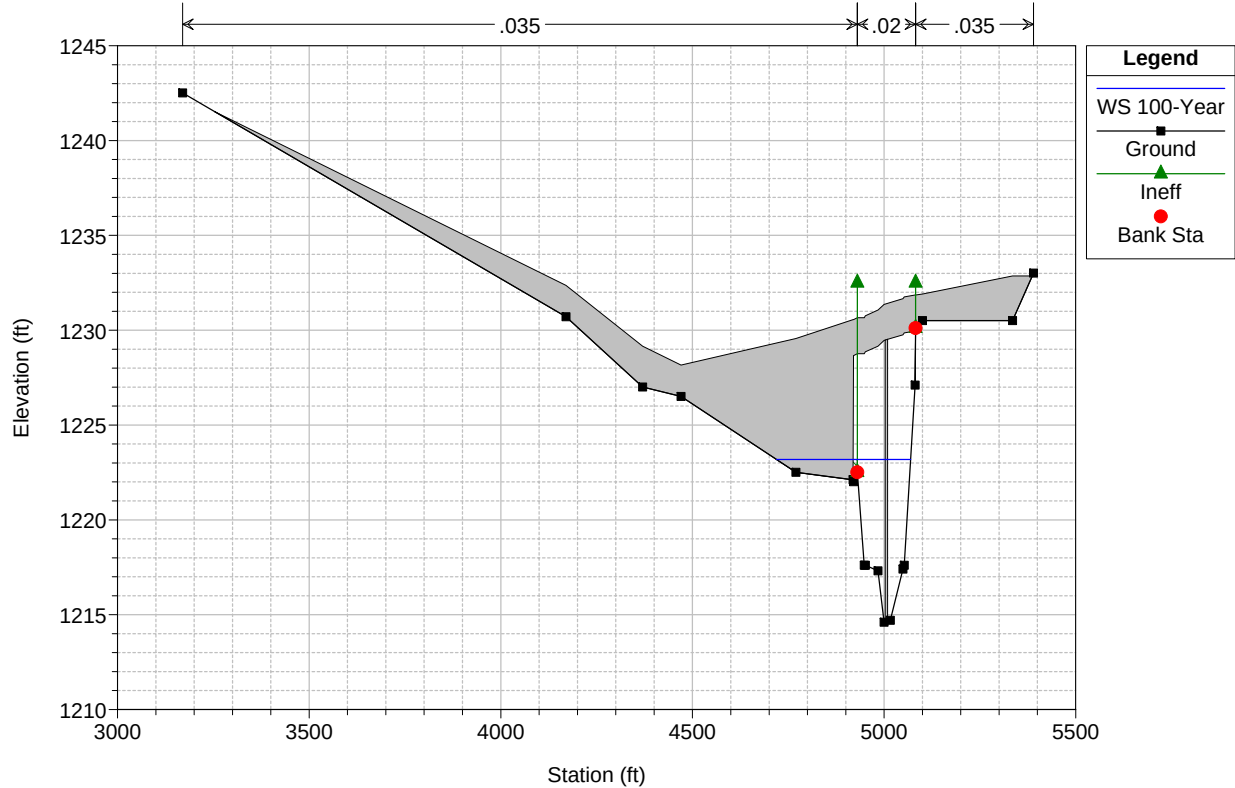
ACI Temescal Creek Plan: Duplicate Effective nad88

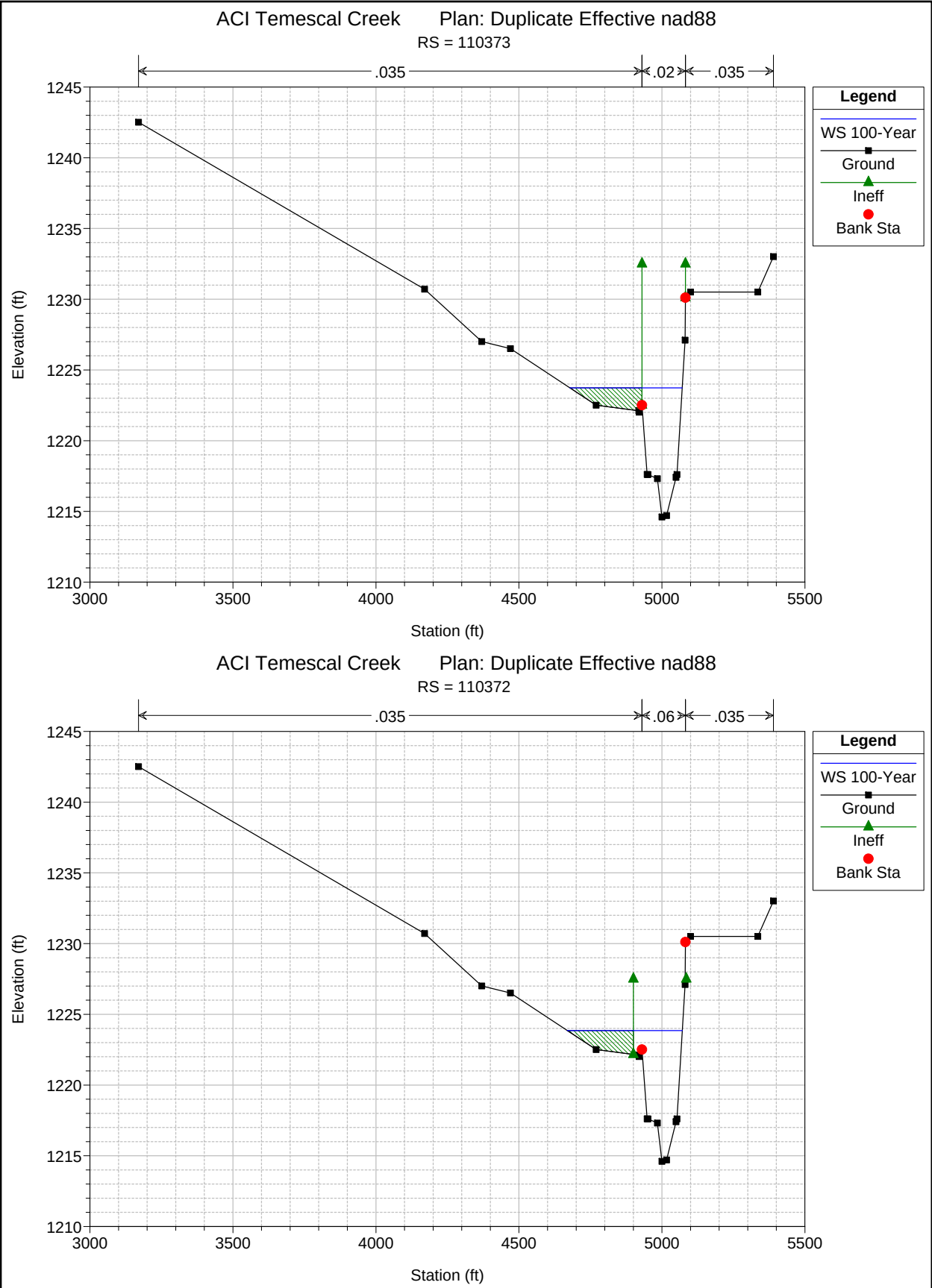
RS = 110393 BR Bridge #6

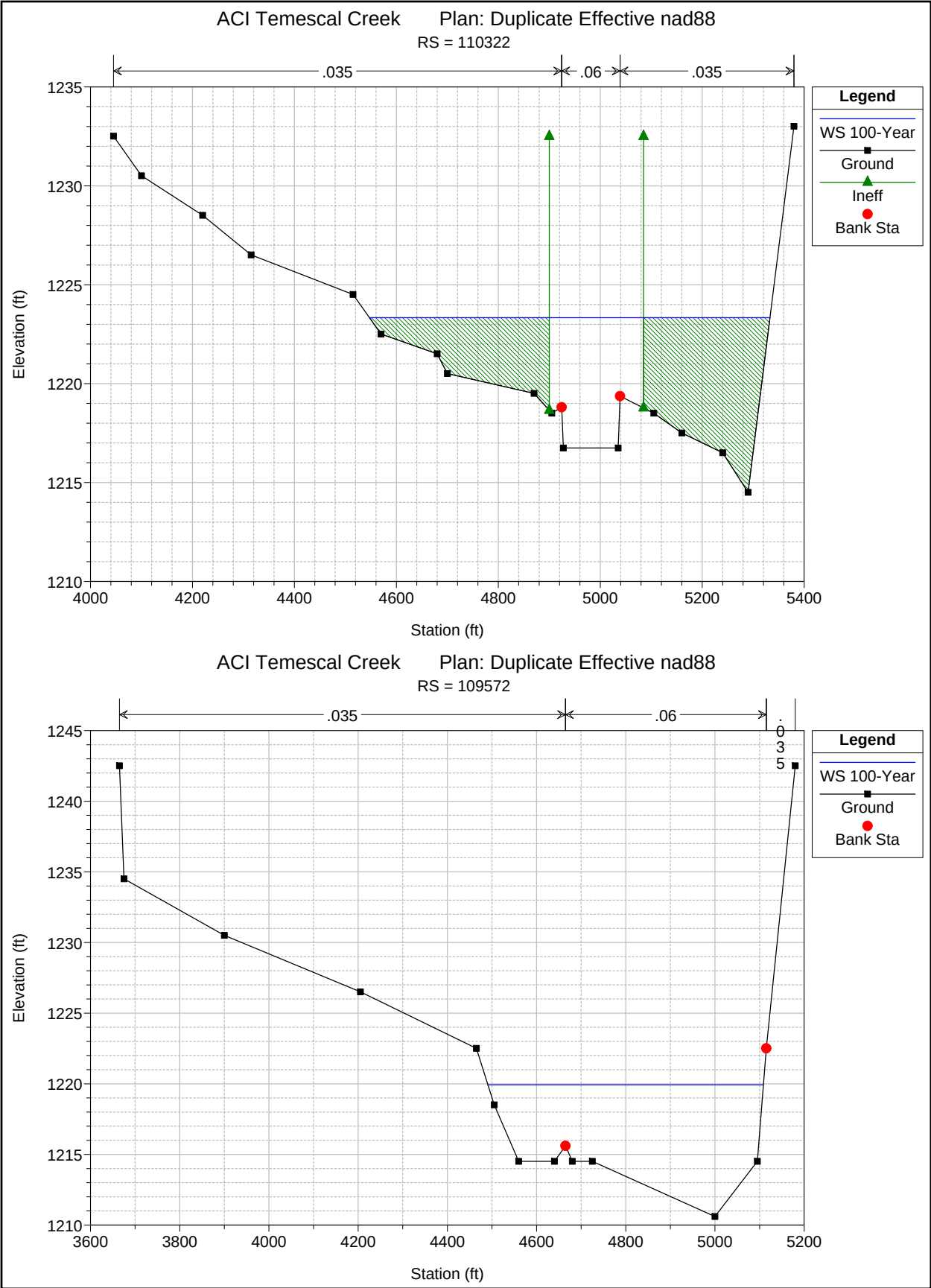


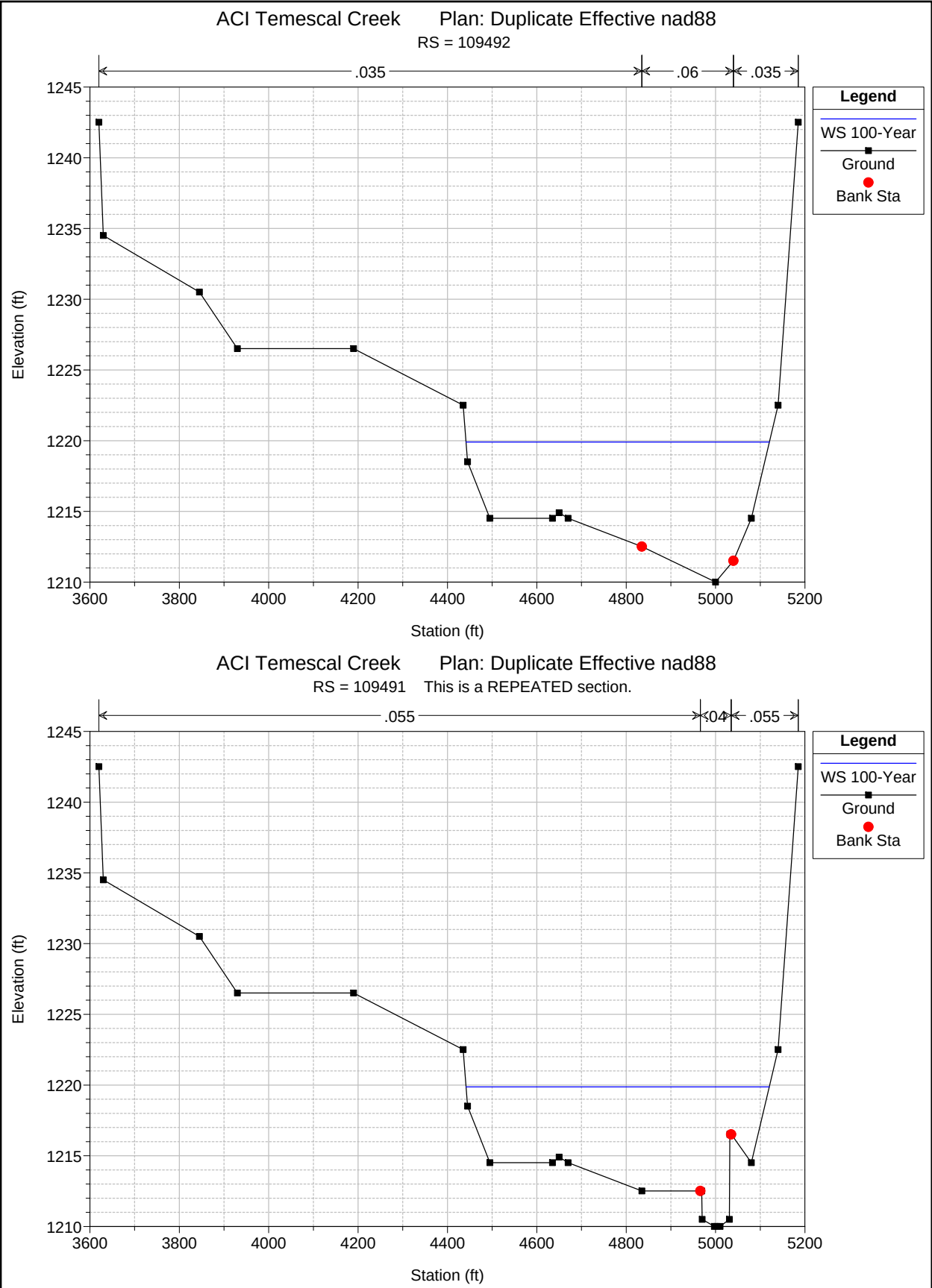
ACI Temescal Creek Plan: Duplicate Effective nad88

RS = 110393 BR Bridge #6









ACI Temescal Creek

Plan: Duplicate Effective nad88

RS = 109491 This is a REPEATED section.

Elevation (ft)

Station (ft)

Legend

WS 100-Year

Ground

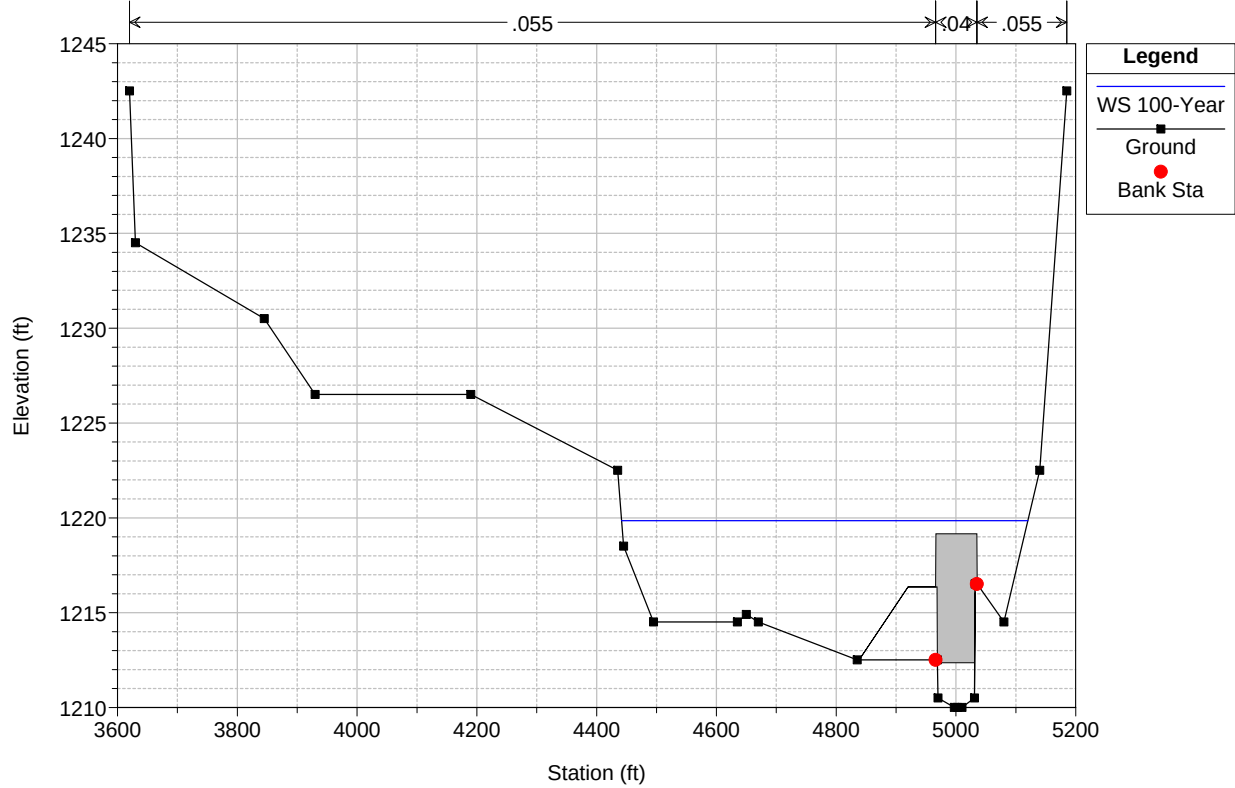
Bank Sta

.055

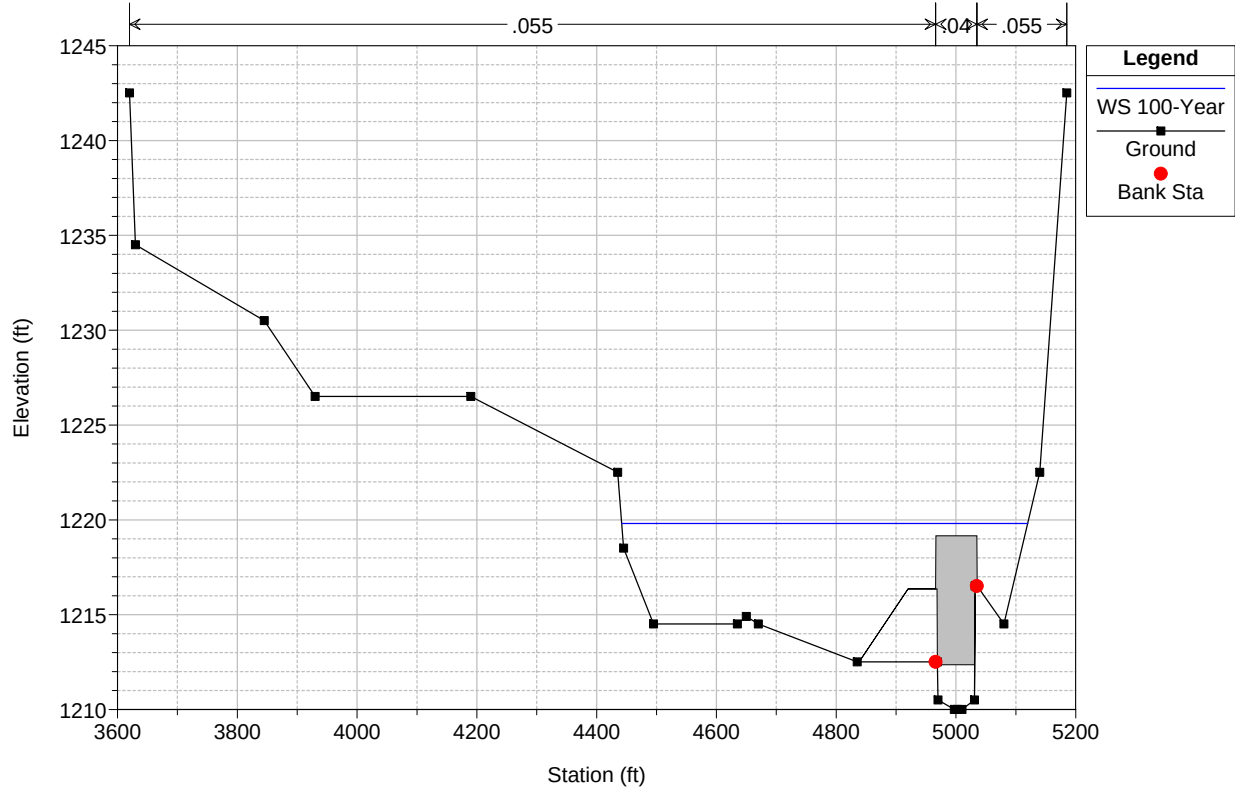
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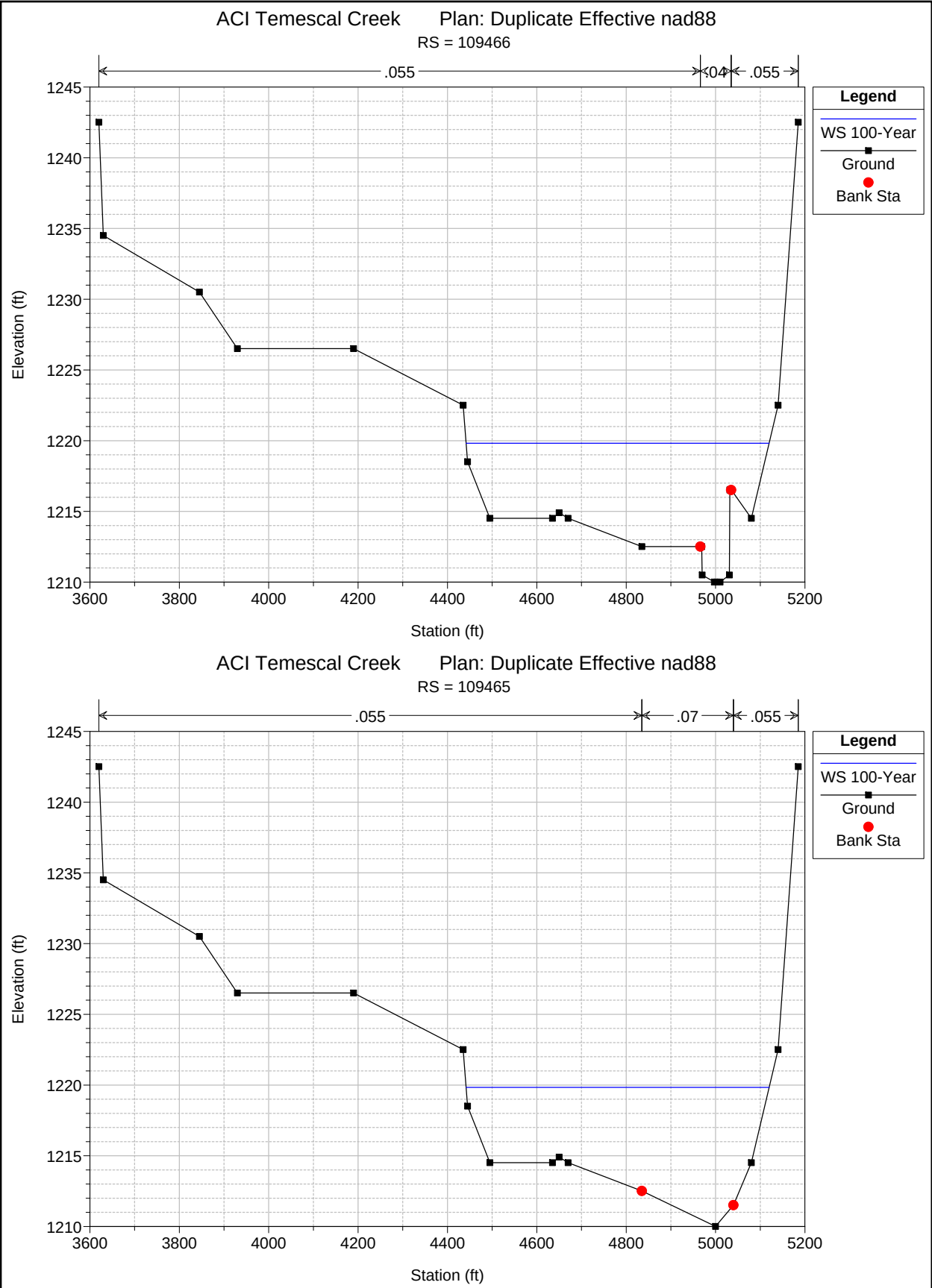
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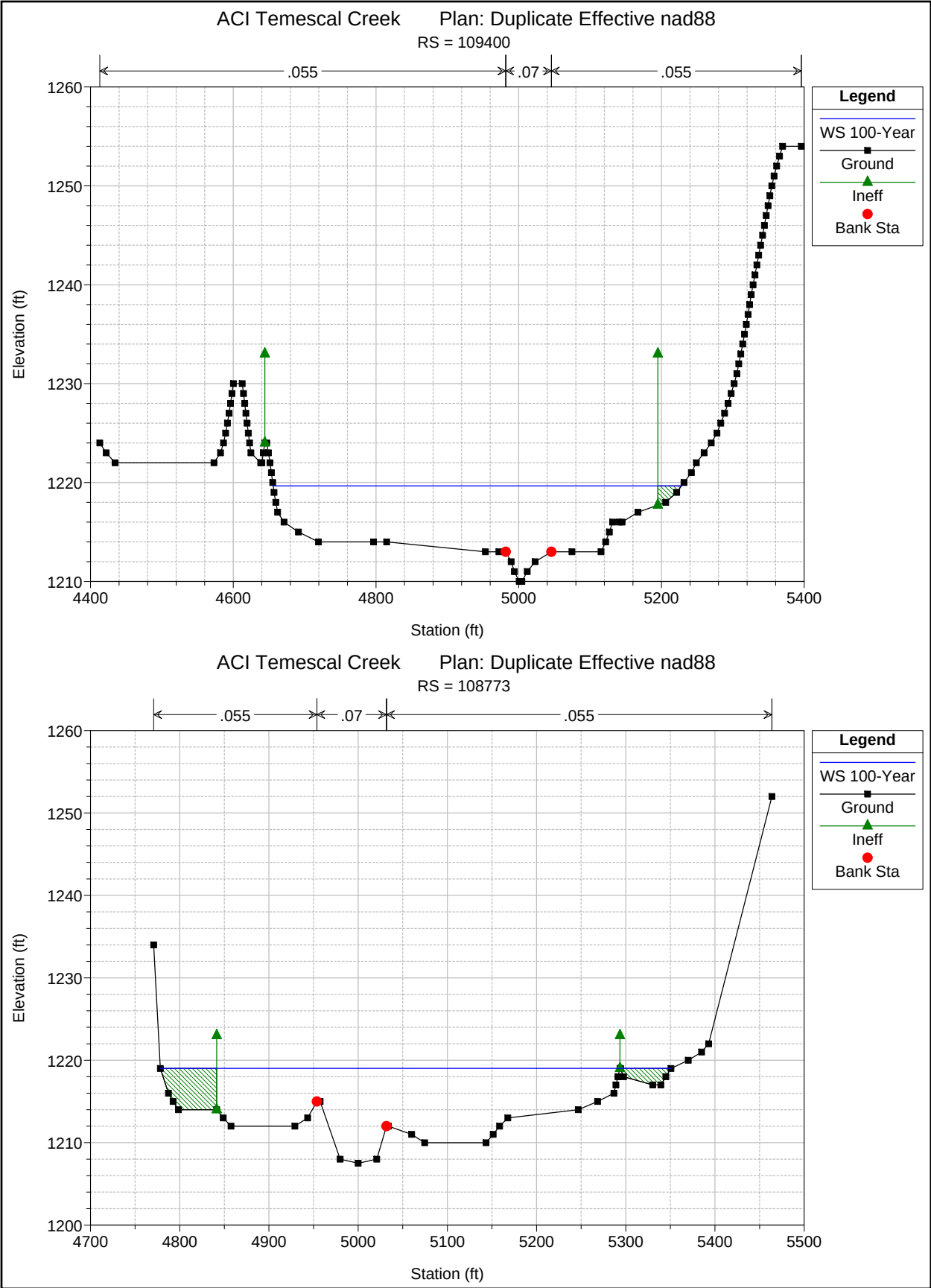
ACI Temescal Creek Plan: Duplicate Effective nad88
RS = 109478.5 BR Bridge #5

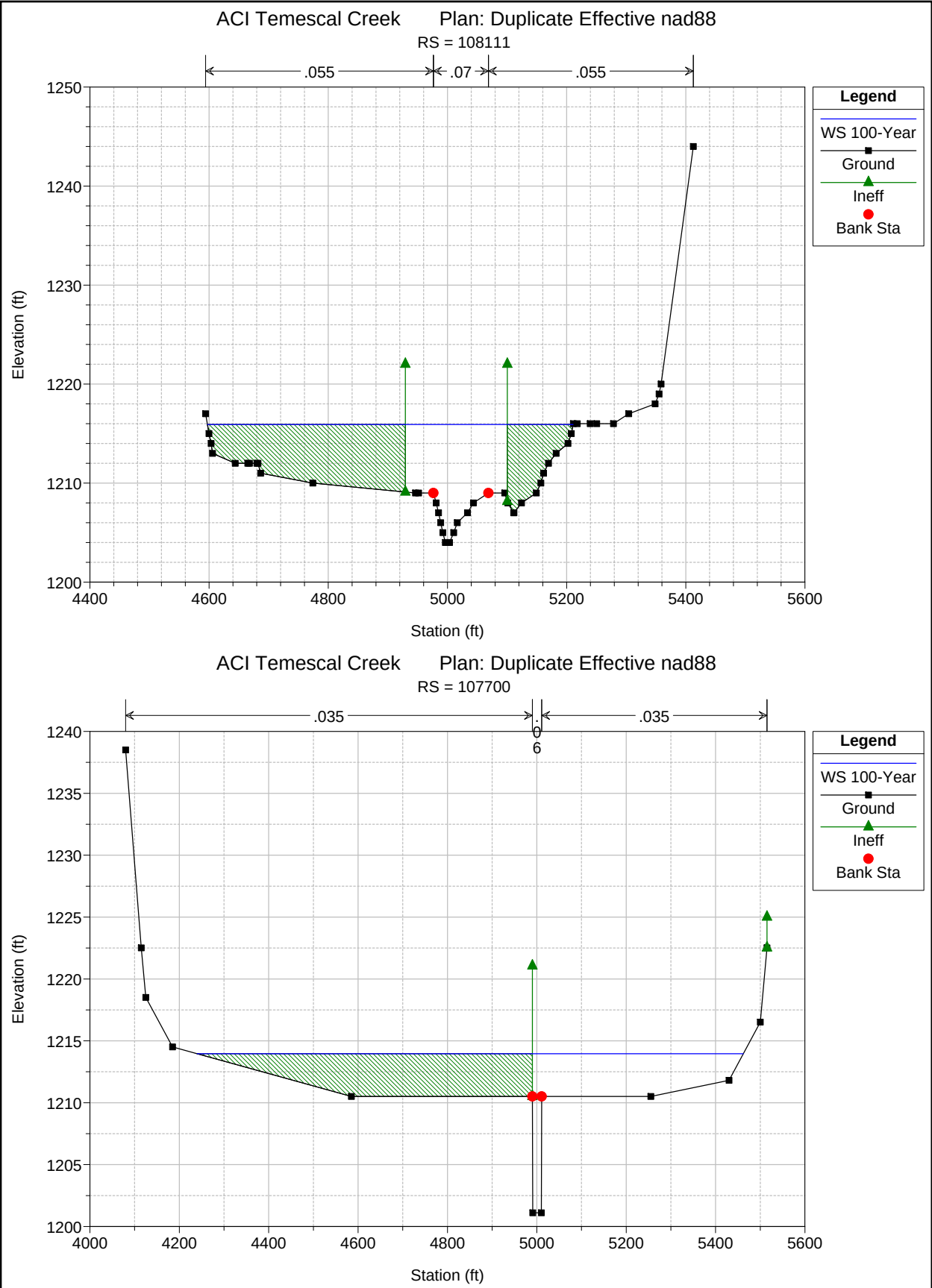


ACI Temescal Creek Plan: Duplicate Effective nad88
RS = 109478.5 BR Bridge #5

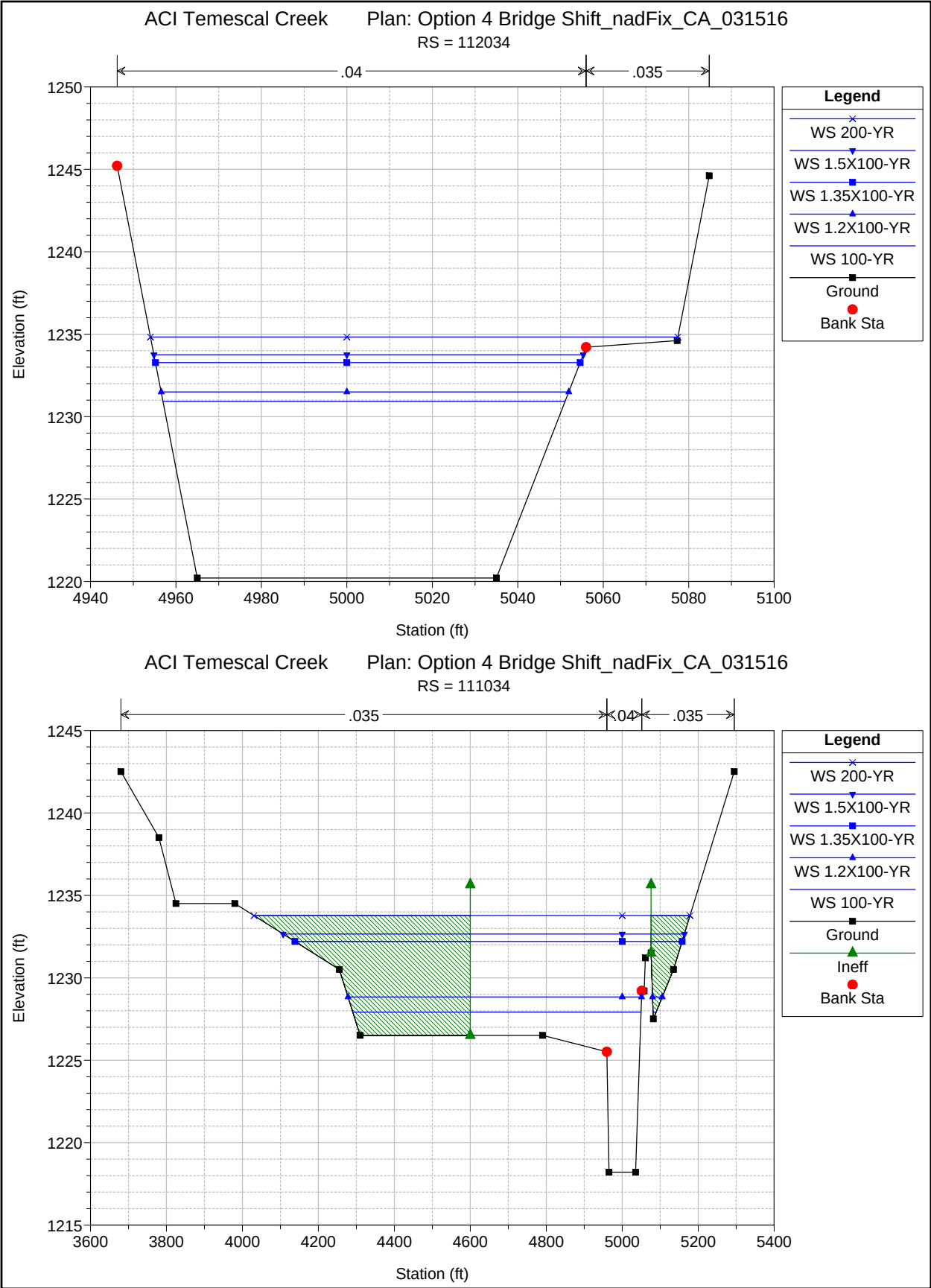


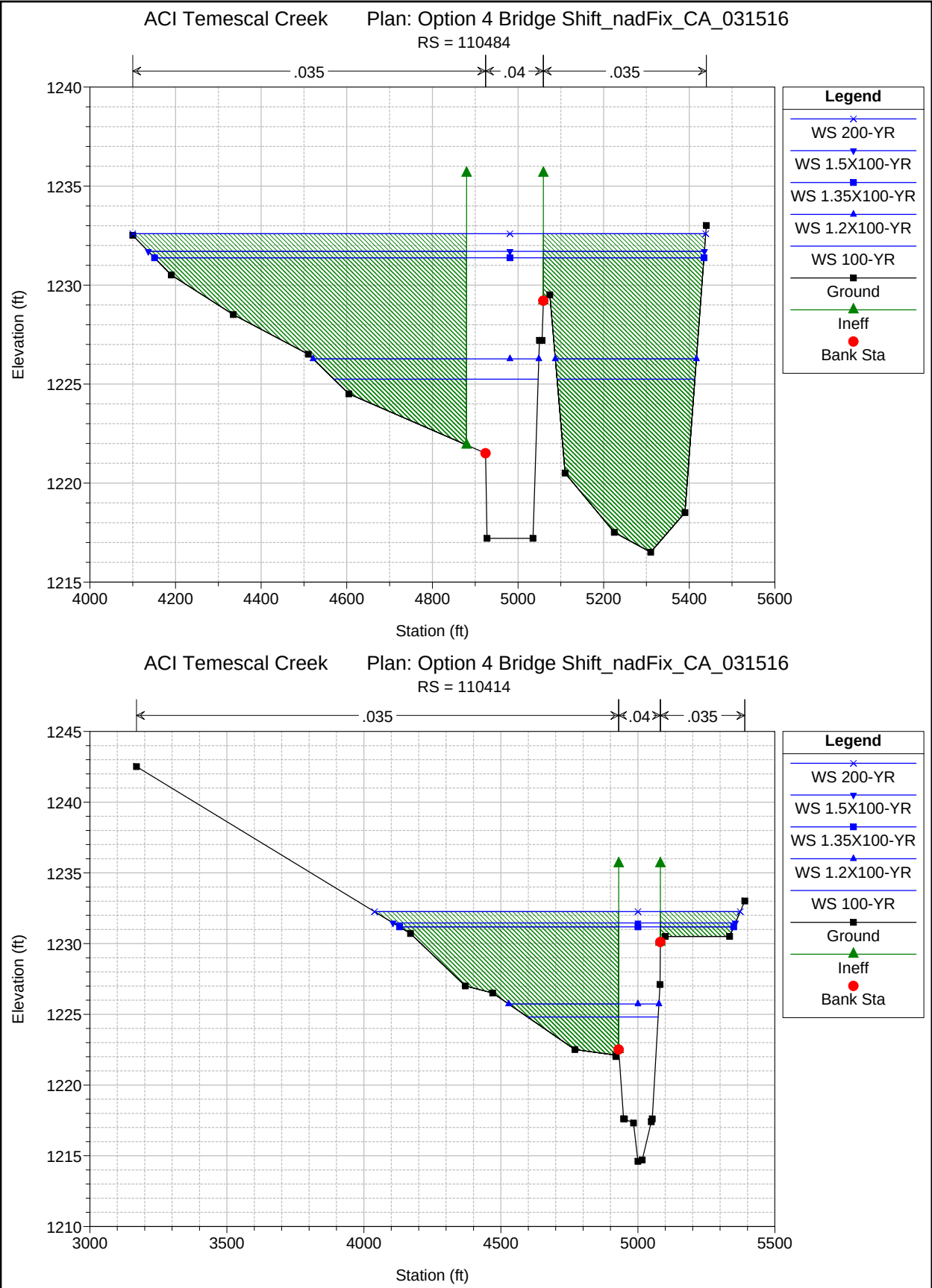






**APPENDIX E: HEC-RAS STREAM CROSS SECTIONS FOR
THE PROPOSED CONDITION**





ACI Temescal Creek

Plan: Option 4 Bridge Shift_nadFix_CA_031516

RS = 110414

Elevation (ft)

Station (ft)

Legend

WS 200-YR

WS 1.5X100-YR

WS 1.35X100-YR

WS 1.2X100-YR

WS 100-YR

Ground

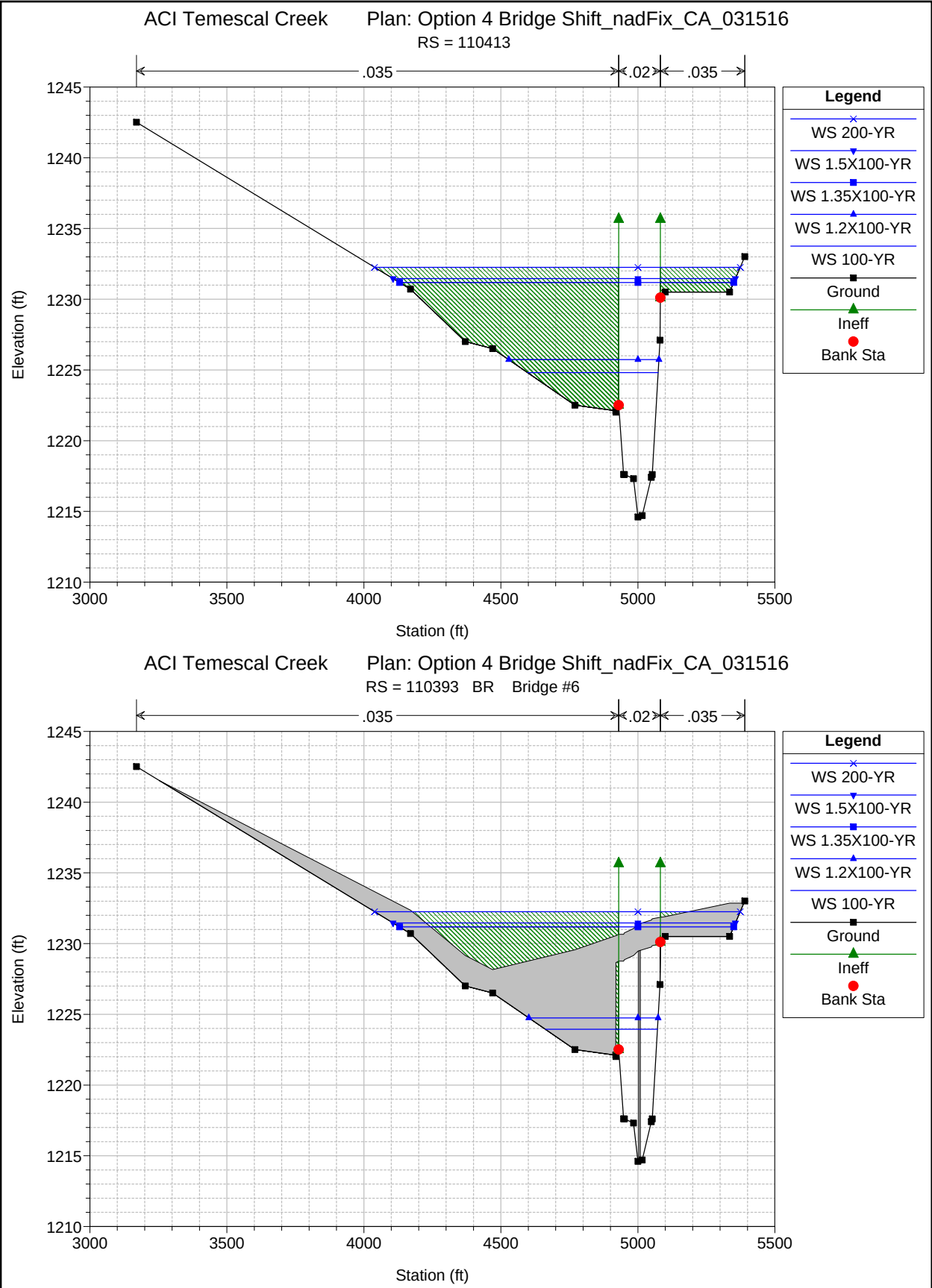
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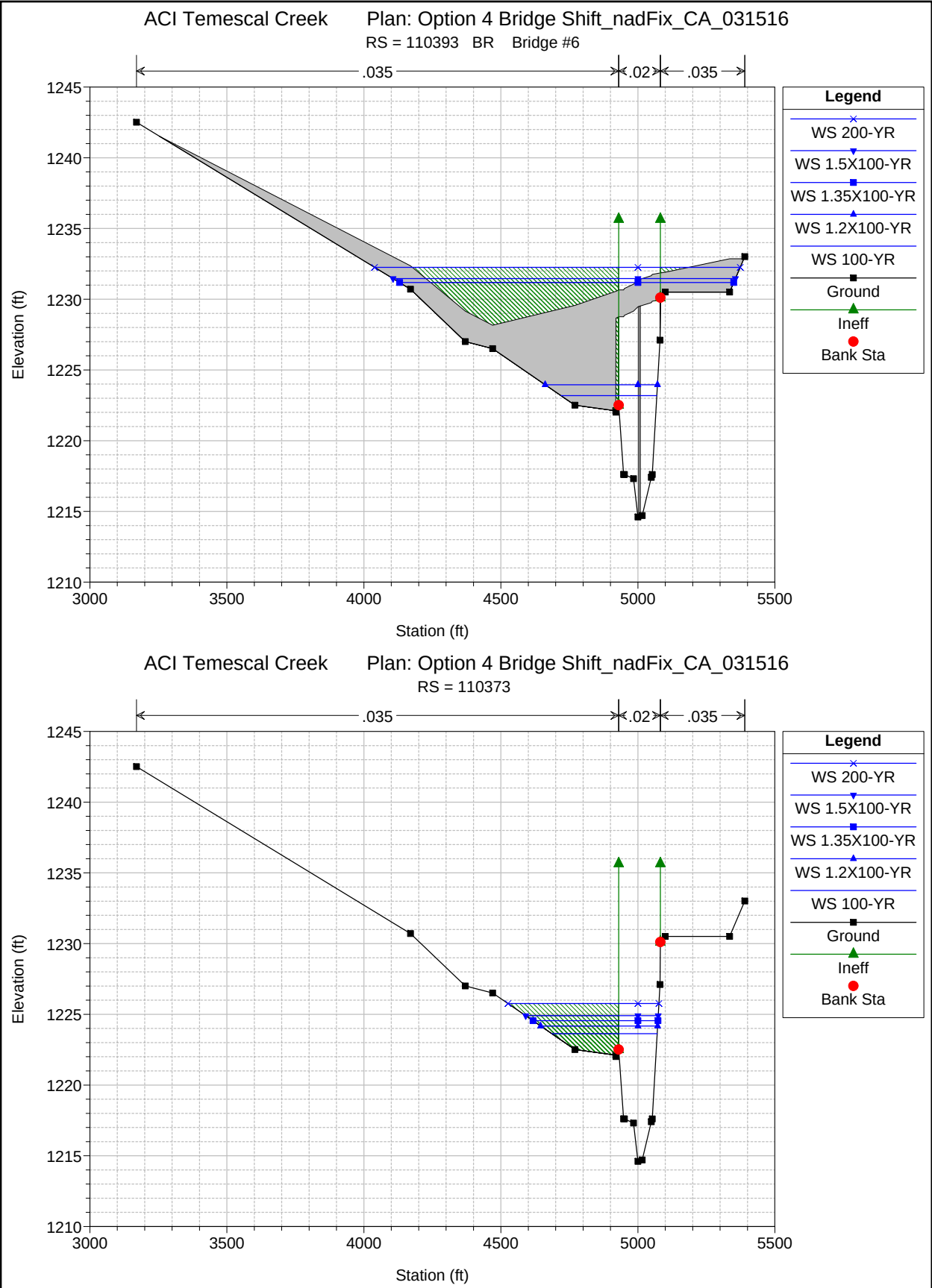
Bank Sta

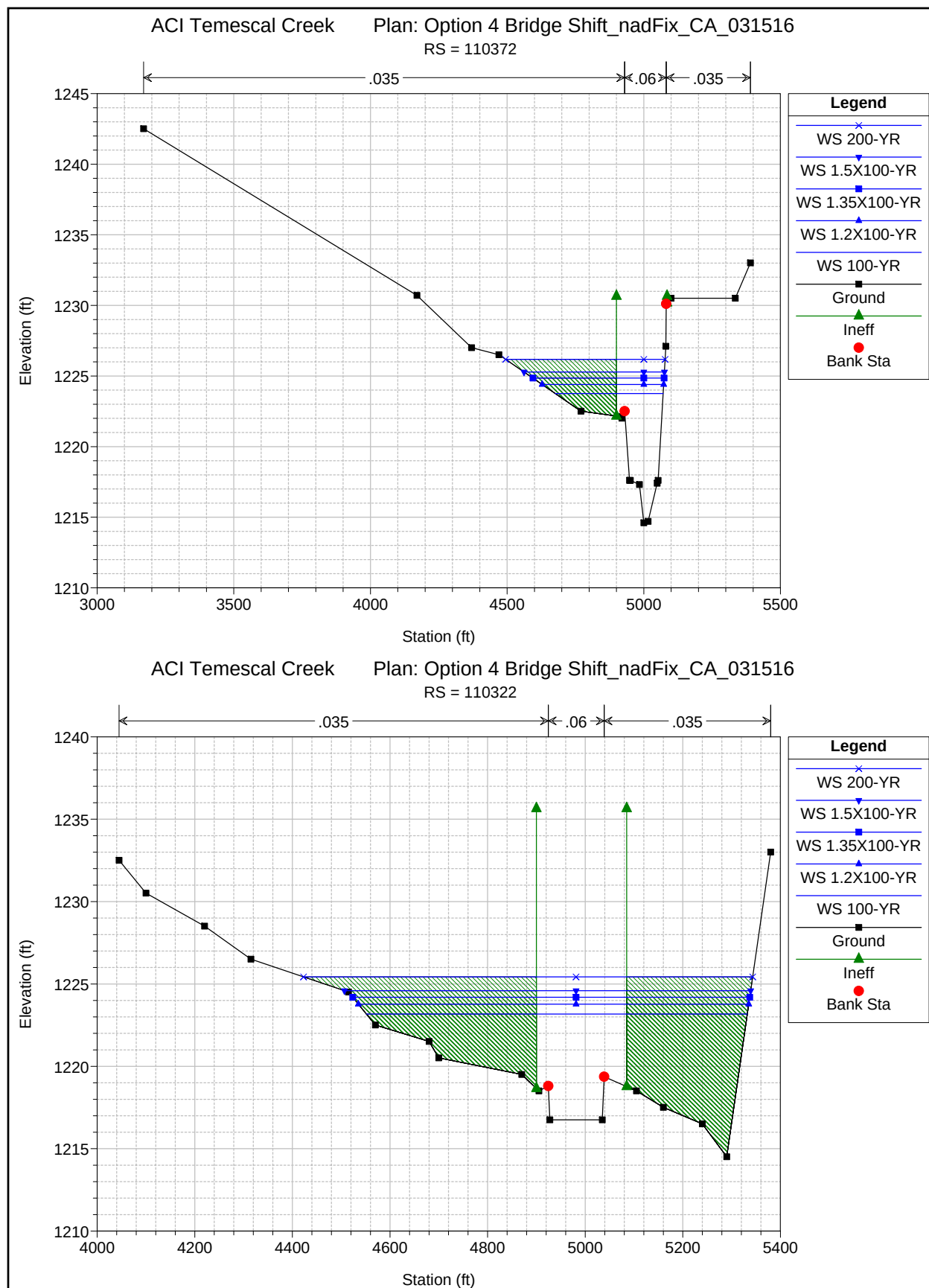
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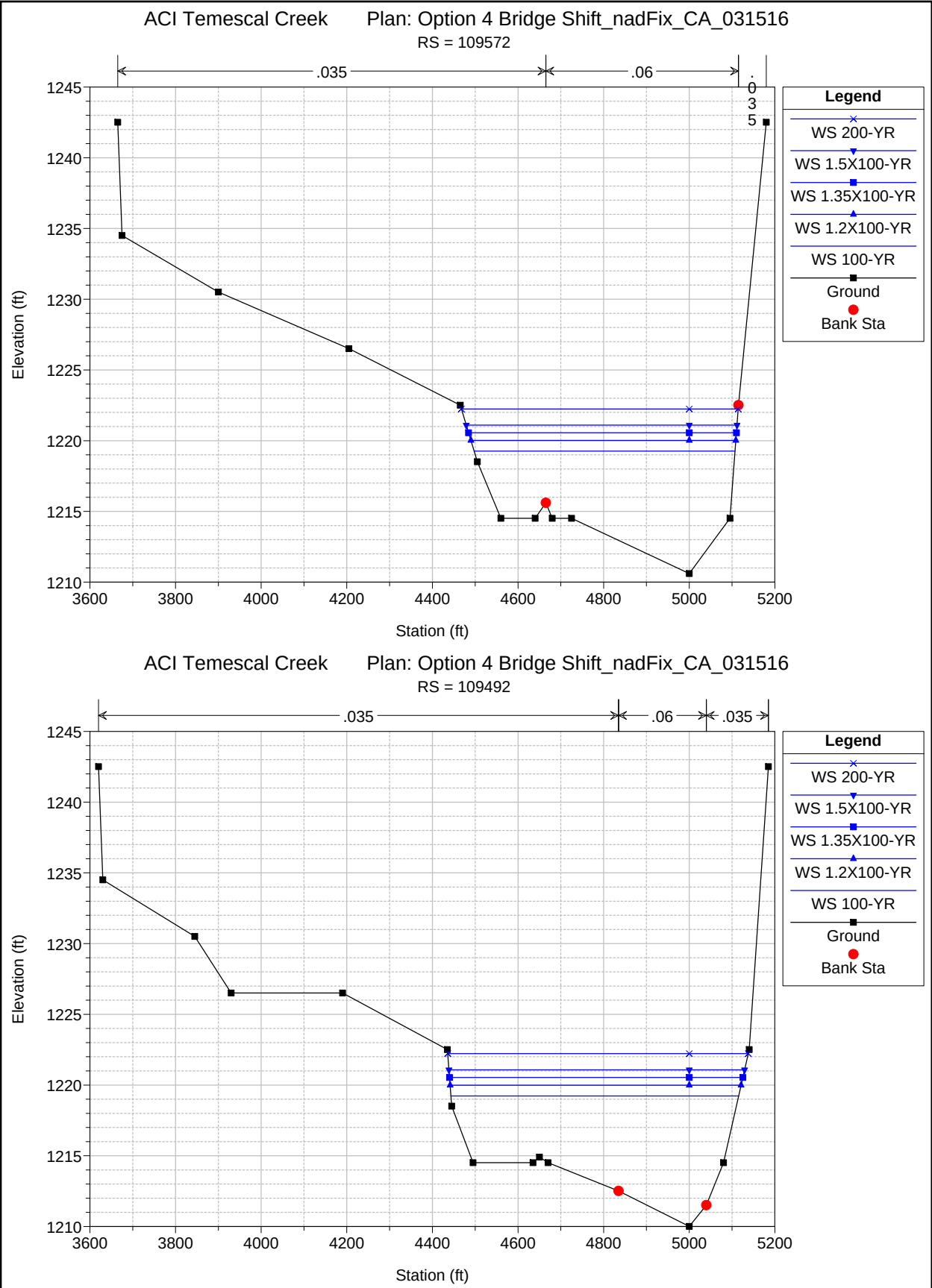
0.04

0.035

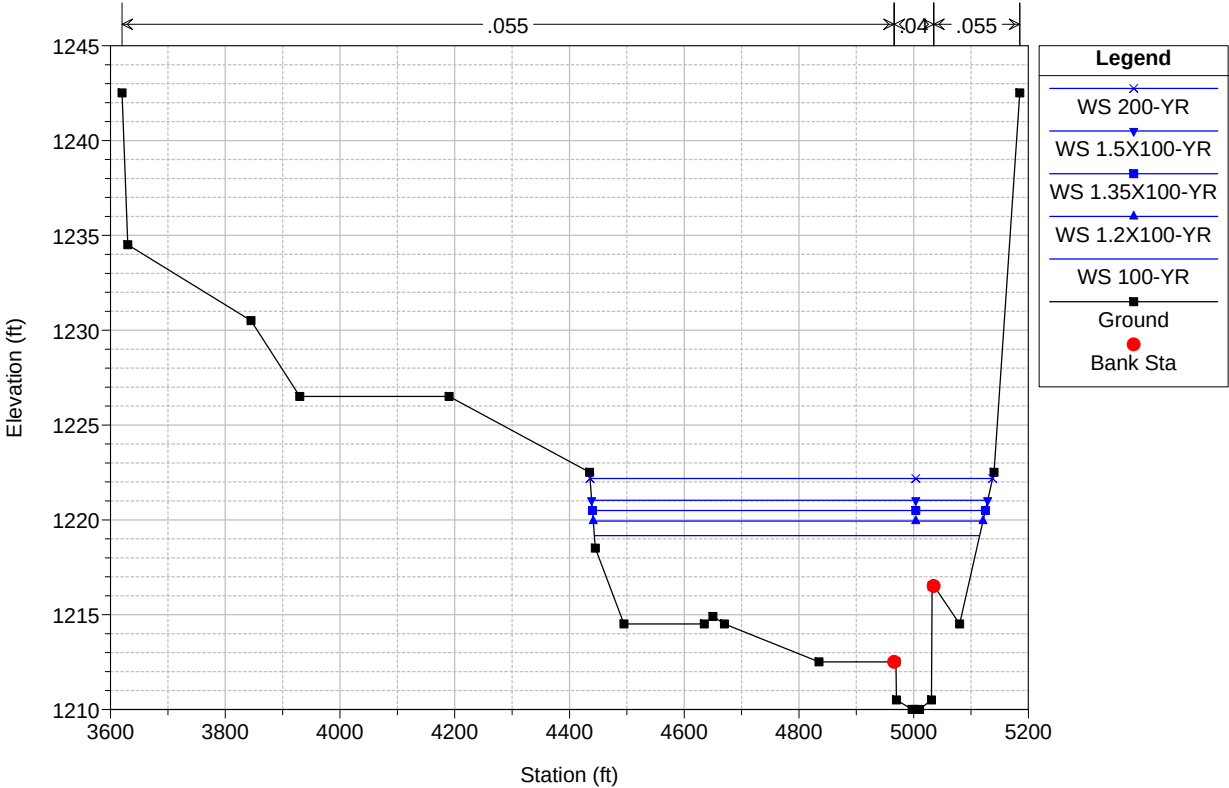




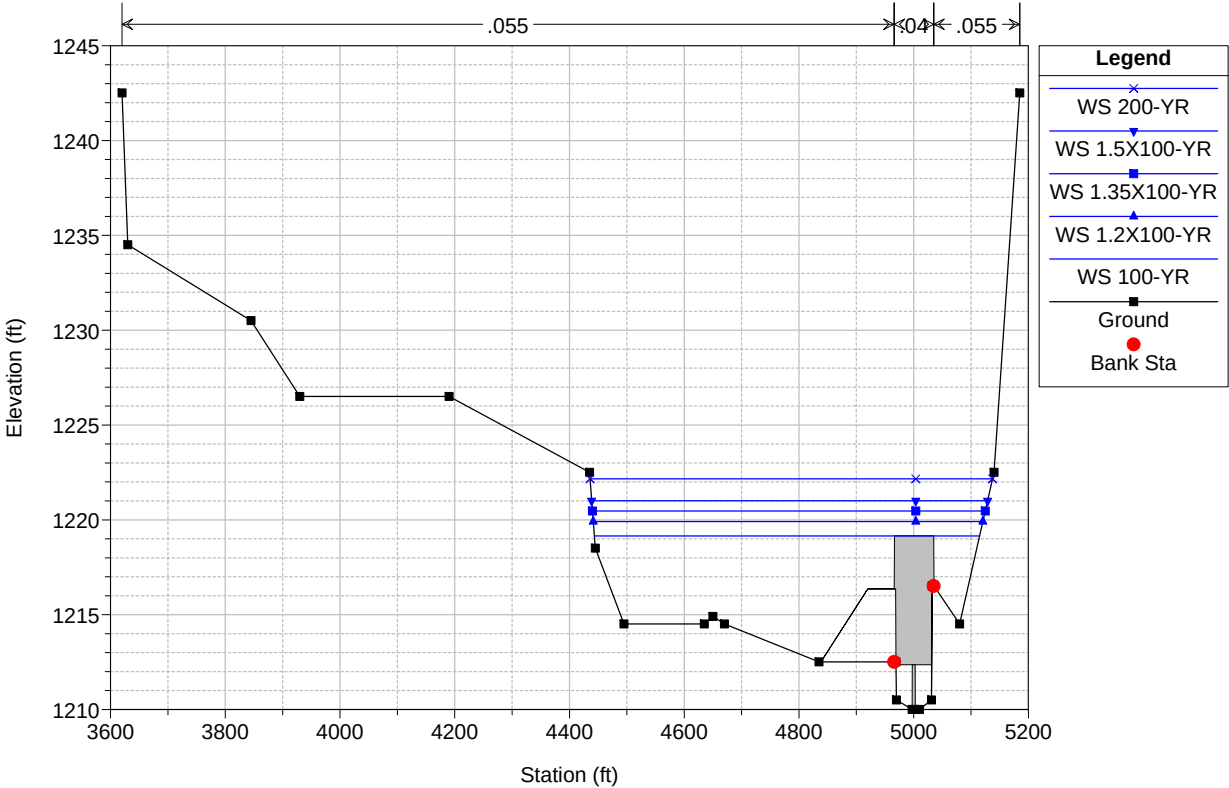




ACI Temescal Creek Plan: Option 4 Bridge Shift_nadFix_CA_031516
RS = 109491 This is a REPEATED section.



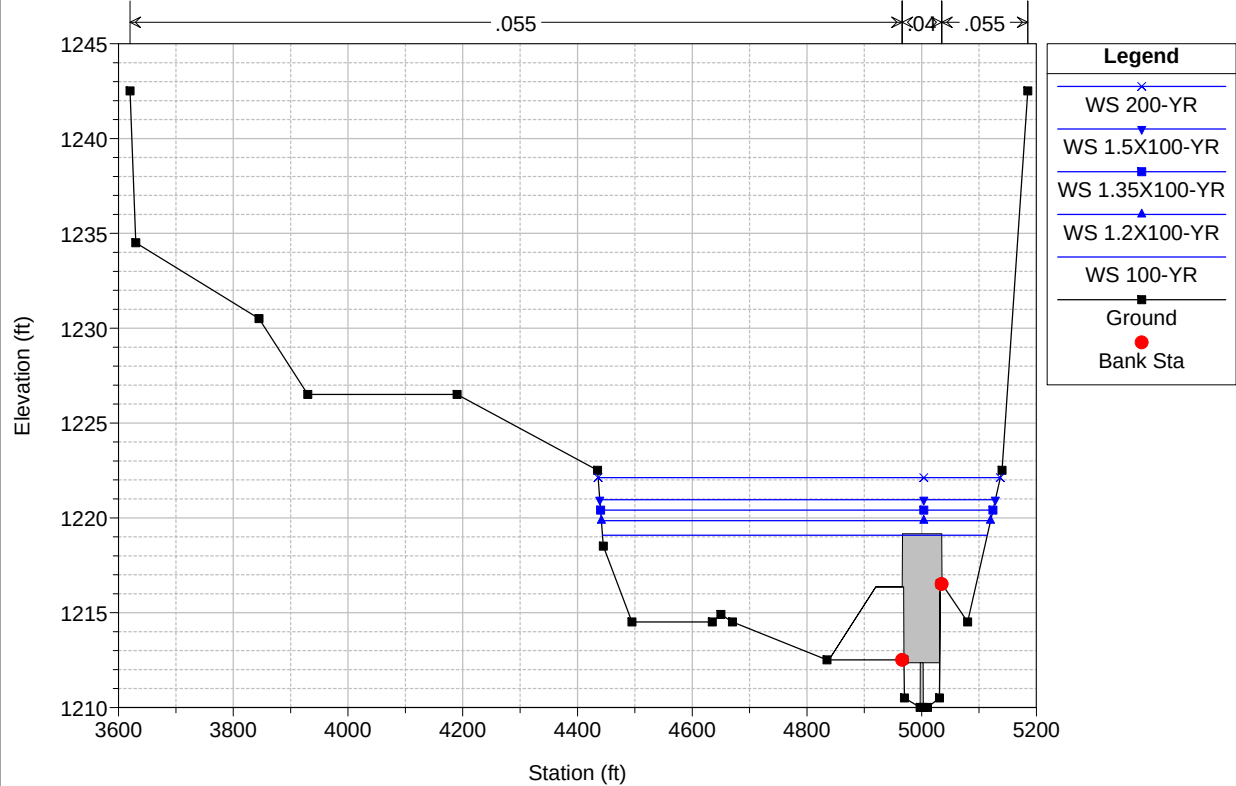
ACI Temescal Creek Plan: Option 4 Bridge Shift_nadFix_CA_031516
RS = 109478.5 BR Bridge #5



ACI Temescal Creek

Plan: Option 4 Bridge Shift_nadFix_CA_031516

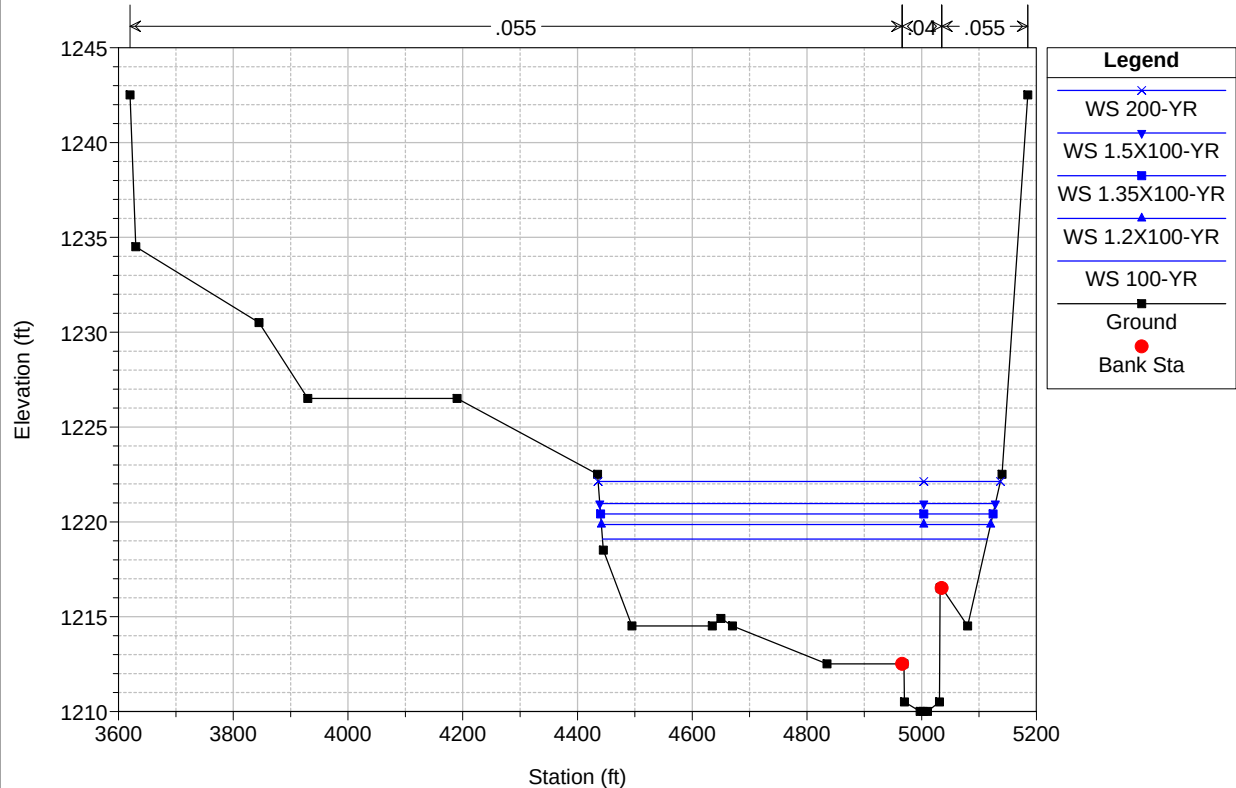
RS = 109478.5 BR Bridge #5

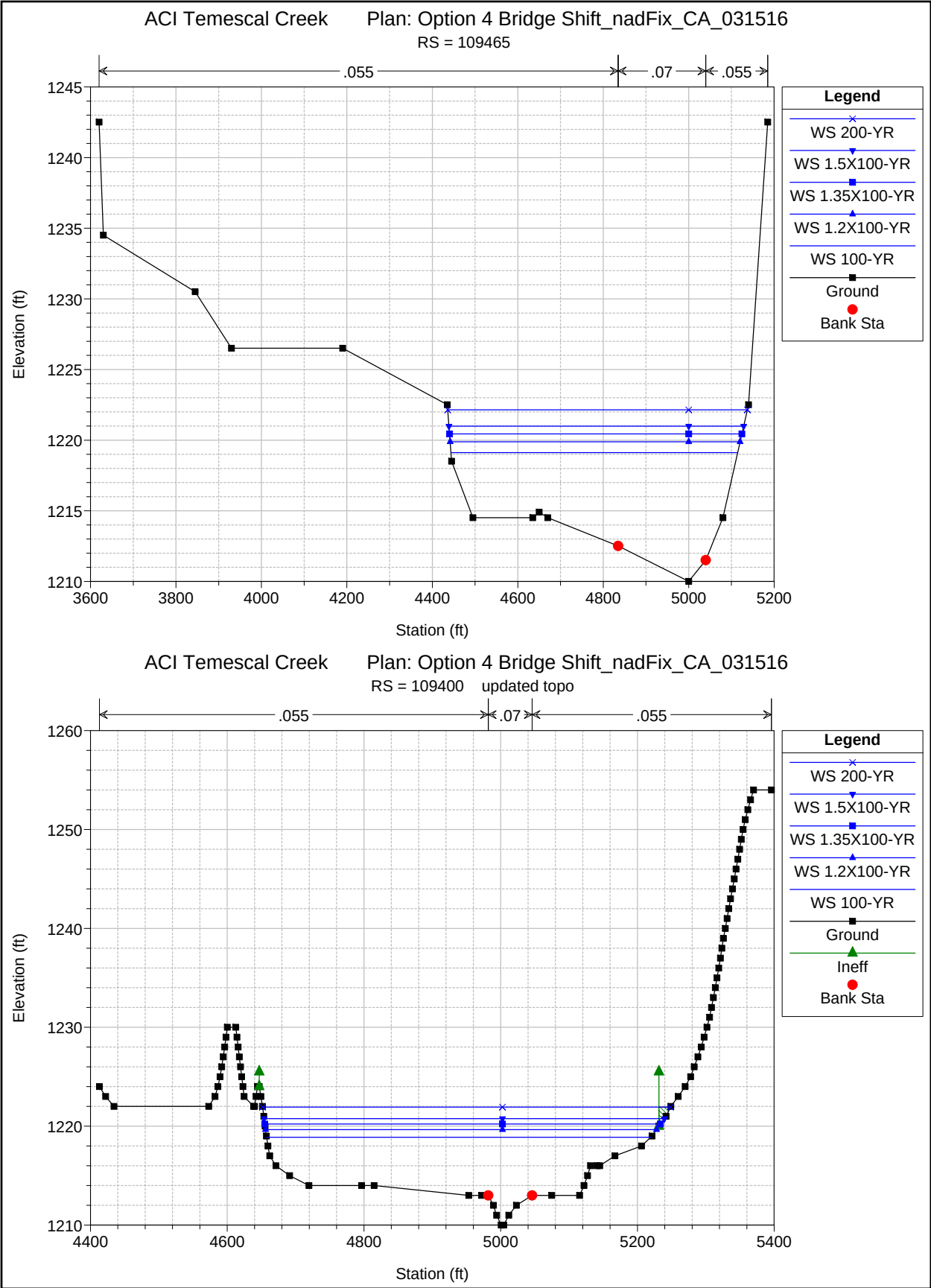


ACI Temescal Creek

Plan: Option 4 Bridge Shift_nadFix_CA_031516

RS = 109466





ACI Temescal Creek

Plan: Option 4 Bridge Shift_nadFix_CA_031516

RS = 109400 updated topo

Elevation (ft)

Station (ft)

Legend

WS 200-YR

WS 1.5X100-YR

WS 1.35X100-YR

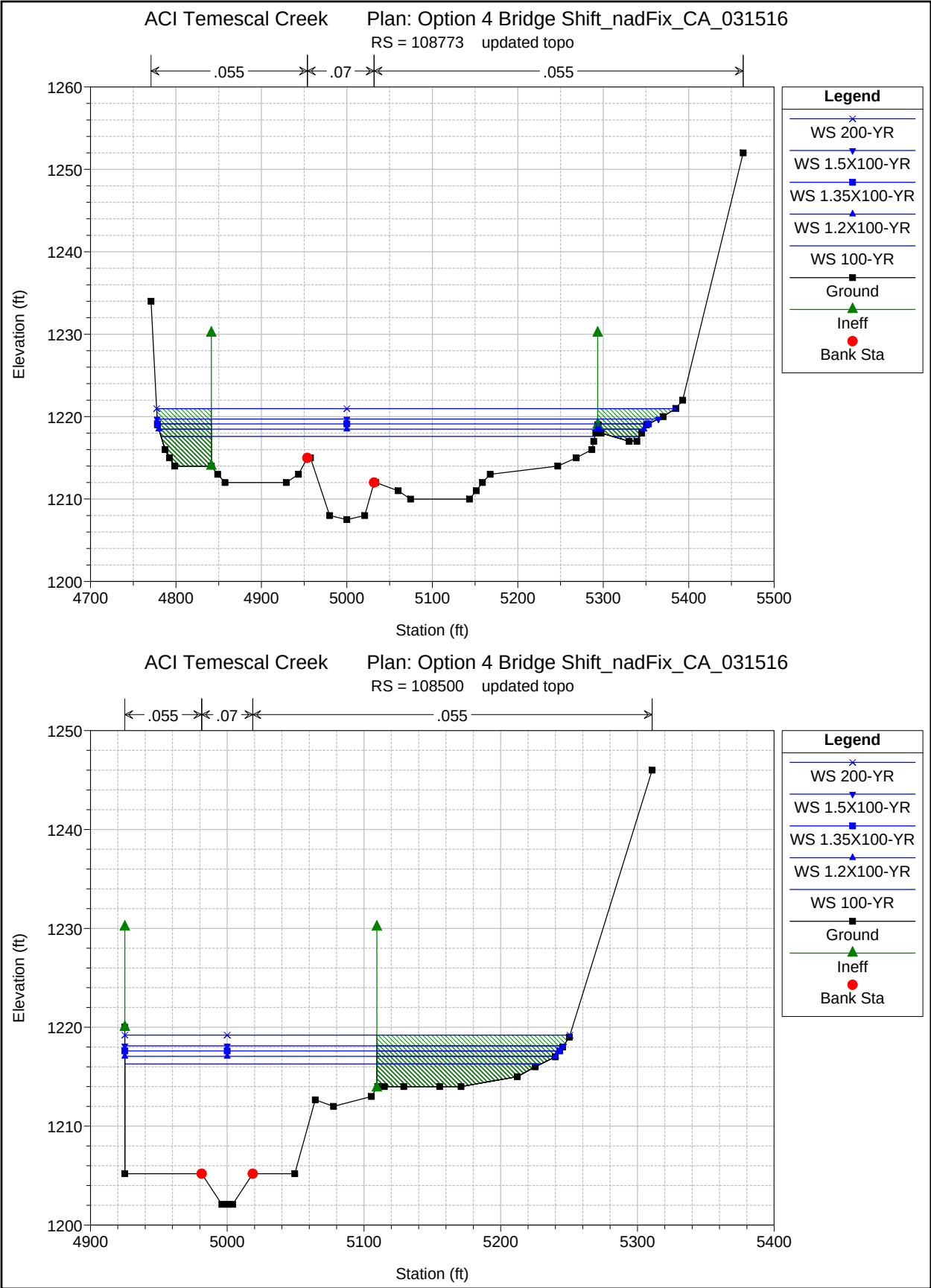
WS 1.2X100-YR

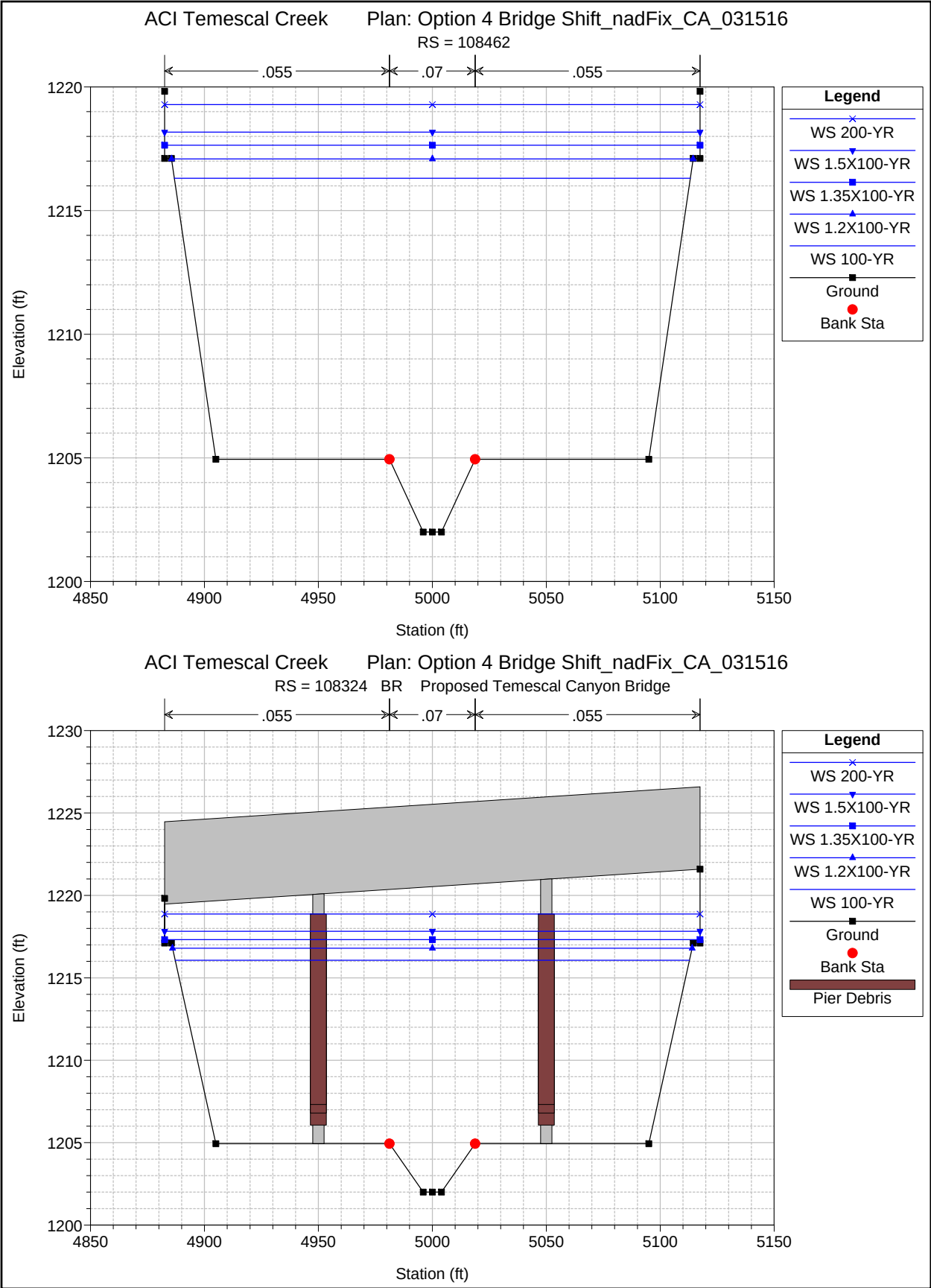
WS 100-YR

Ground

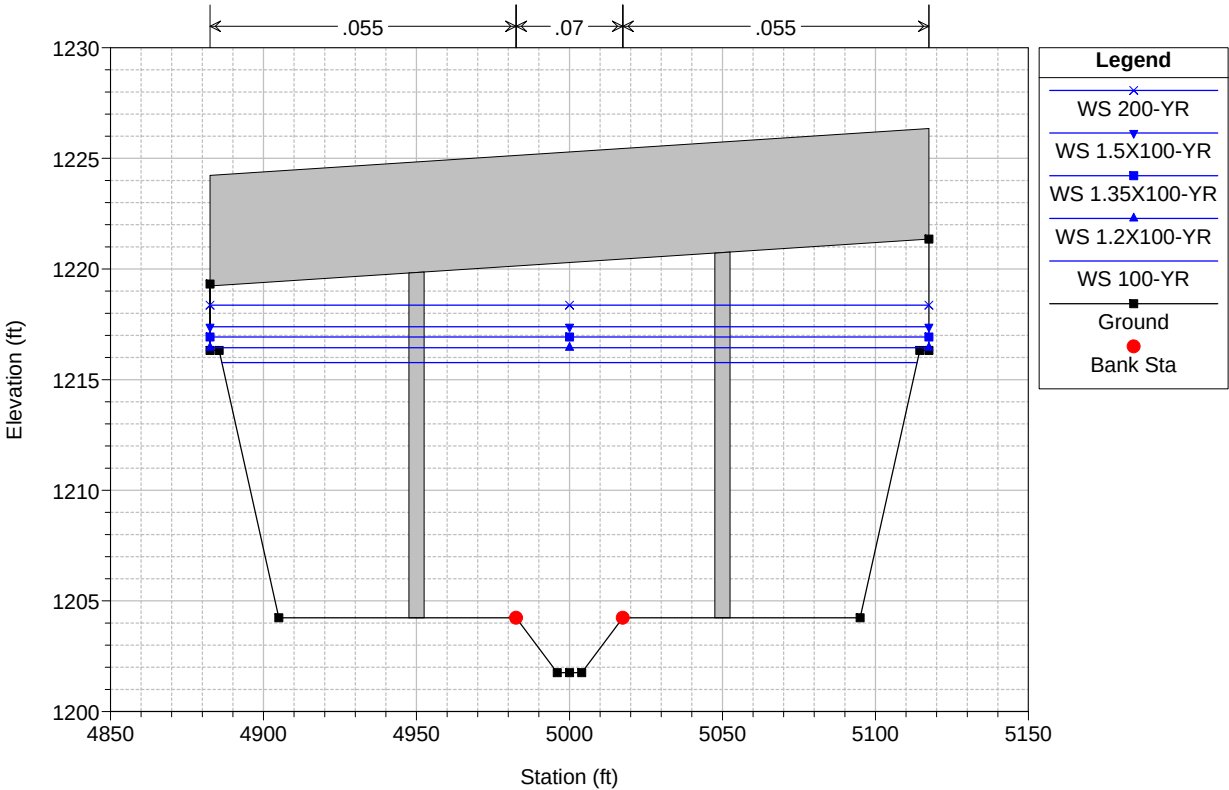
Ineff

Bank Sta

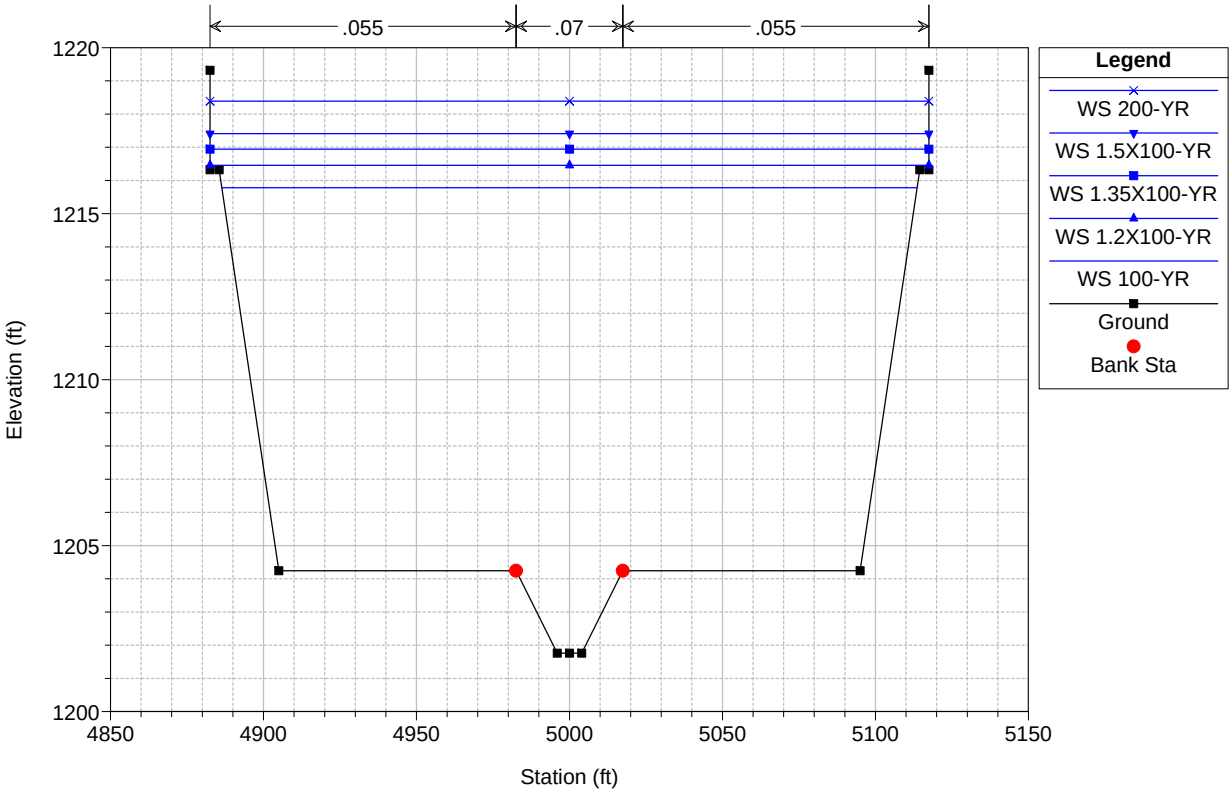


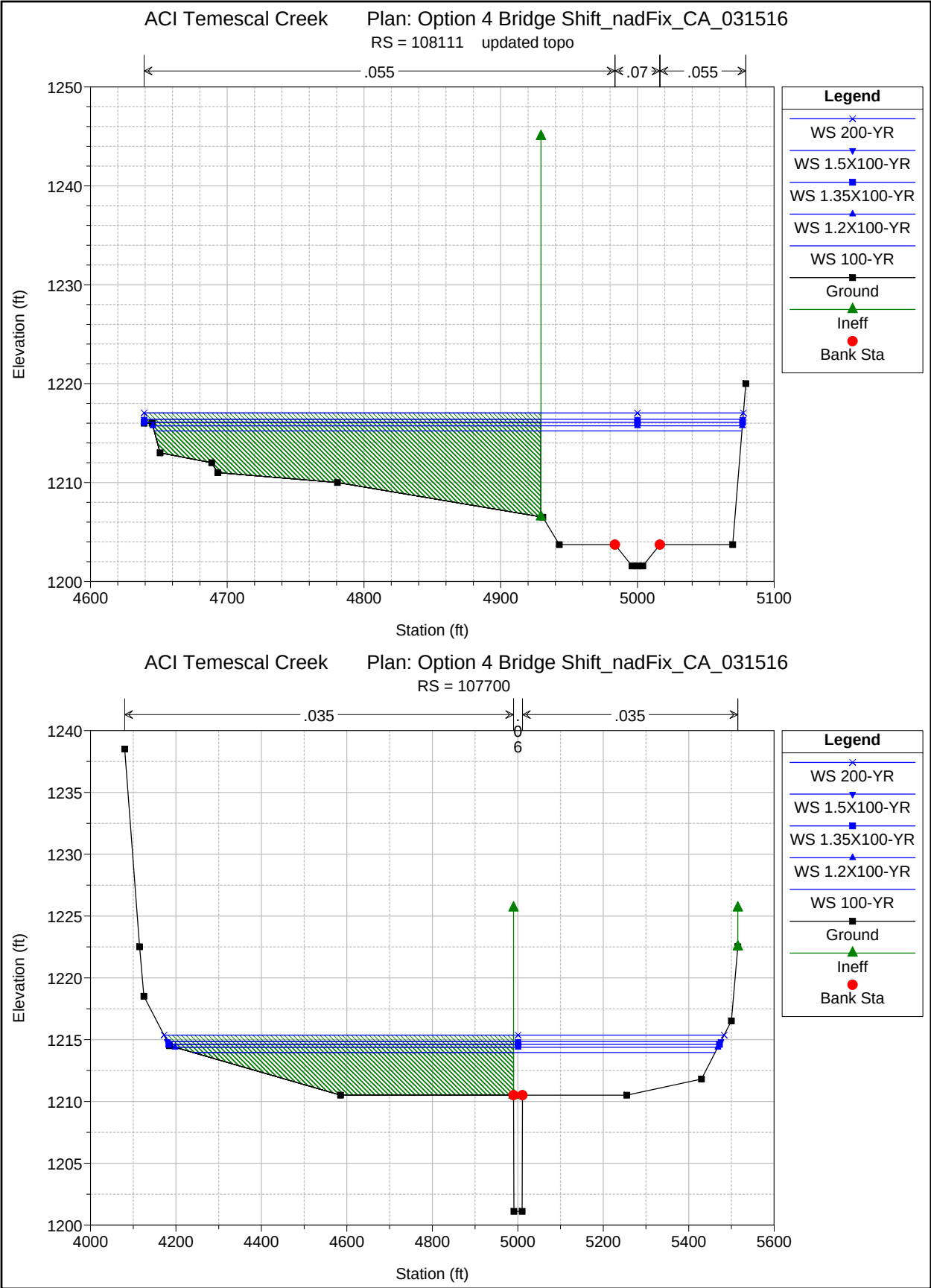


ACI Temescal Creek Plan: Option 4 Bridge Shift_nadFix_CA_031516
RS = 108324 BR Proposed Temescal Canyon Bridge



ACI Temescal Creek Plan: Option 4 Bridge Shift_nadFix_CA_031516
RS = 108186

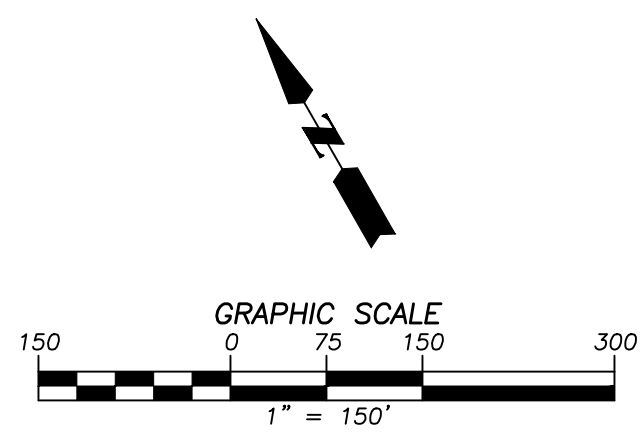
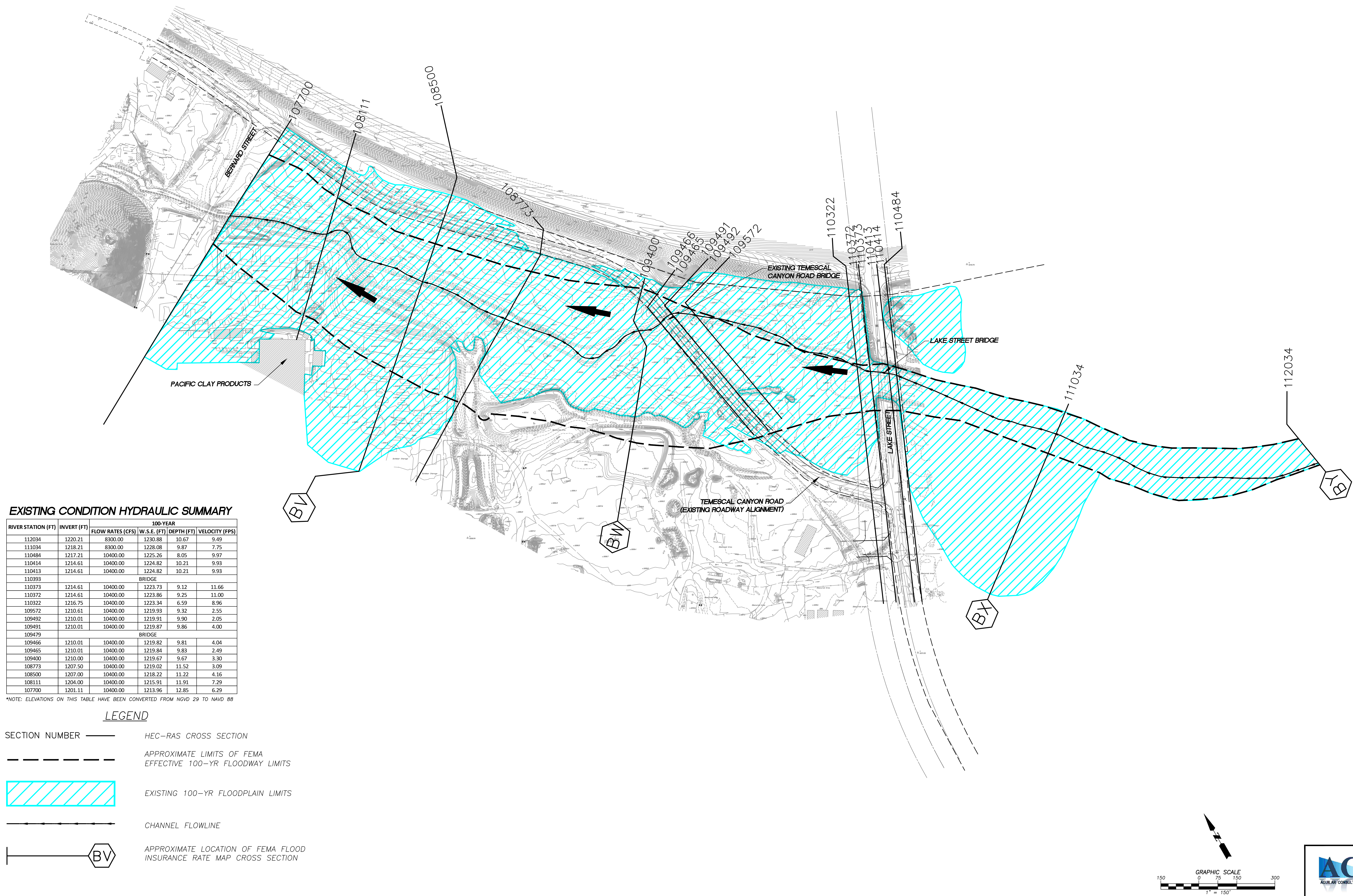




EXHIBITS

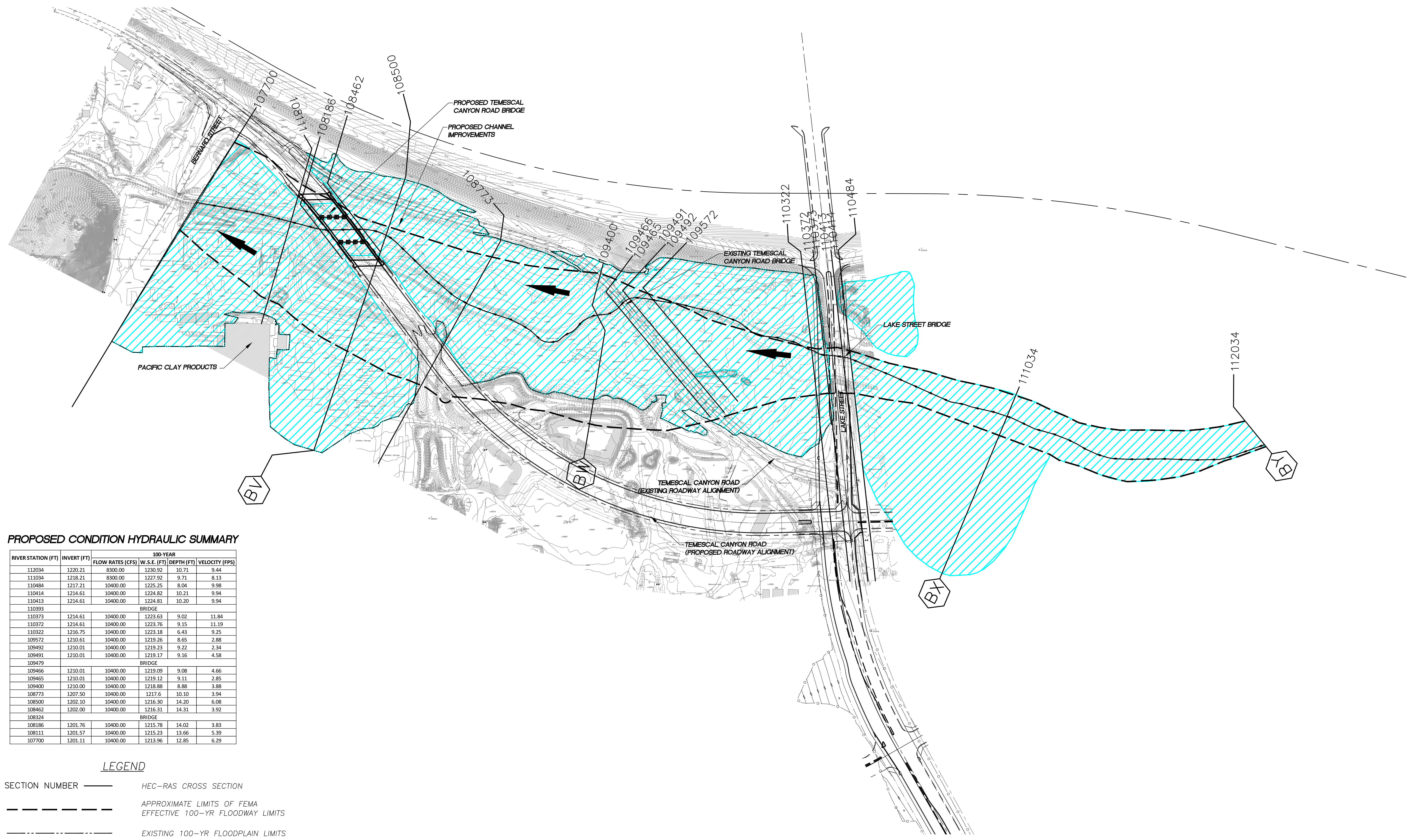
**EXHIBIT A: 100-YEAR FLOODPLAIN EXHIBIT FOR
TEMESCAL WASH BASED ON EXISTING
CONDITION IN THE VICINITY OF THE
TEMESCAL CANYON ROAD BRIDGE**

EXHIBIT A: 100-YEAR FLOODPLAIN EXHIBIT FOR TEMESCAL WASH BASED ON EXISTING CONDITION IN THE VICINITY OF THE TEMESCAL CANYON ROAD BRIDGE



**EXHIBIT B: 100-YEAR FLOODPLAIN EXHIBIT FOR
TEMESCAL WASH BASED ON PROPOSED
CONDITION IN THE VICINITY OF THE
TEMESCAL CANYON ROAD BRIDGE**

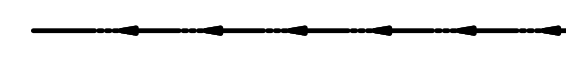
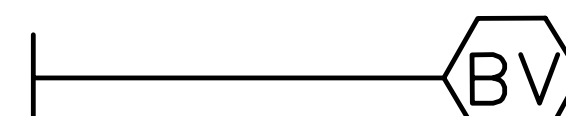
EXHIBIT B: 100-YEAR FLOODPLAIN EXHIBIT FOR TEMESCAL WASH BASED ON PROPOSED CONDITION IN THE VICINITY OF THE TEMESCAL CANYON ROAD BRIDGE

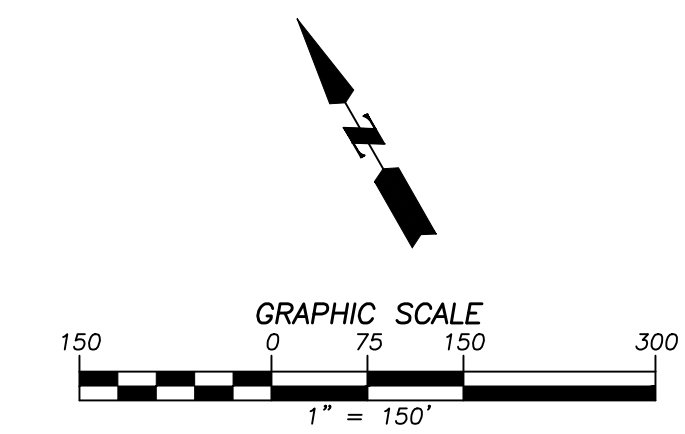


PROPOSED CONDITION HYDRAULIC SUMMARY

RIVER STATION (FT)	INVERT (FT)	100-YEAR			
		FLOW RATES (CFS)	W.S.E. (FT)	DEPTH (FT)	VELOCITY (FPS)
112034	1220.21	8300.00	1230.92	10.71	9.44
111034	1218.21	8300.00	1227.92	9.71	8.13
110484	1217.21	10400.00	1225.25	8.04	9.98
110414	1214.61	10400.00	1224.82	10.21	9.94
110413	1214.61	10400.00	1224.81	10.20	9.94
110393		BRIDGE			
110373	1214.61	10400.00	1223.63	9.02	11.84
110372	1214.61	10400.00	1223.76	9.15	11.19
110322	1216.75	10400.00	1223.18	6.43	9.25
109572	1210.61	10400.00	1219.26	8.65	2.88
109492	1210.01	10400.00	1219.23	9.22	2.34
109491	1210.01	10400.00	1219.17	9.16	4.58
109479		BRIDGE			
109466	1210.01	10400.00	1219.09	9.08	4.66
109465	1210.01	10400.00	1219.12	9.11	2.85
109400	1210.00	10400.00	1218.88	8.88	3.88
108773	1207.50	10400.00	1217.6	10.10	3.94
108500	1202.10	10400.00	1216.30	14.20	6.08
108462	1202.00	10400.00	1216.31	14.31	3.92
108334		BRIDGE			
108186	1201.76	10400.00	1215.78	14.02	3.83
108111	1201.57	10400.00	1215.23	13.66	5.39
107700	1201.11	10400.00	1213.96	12.85	6.29

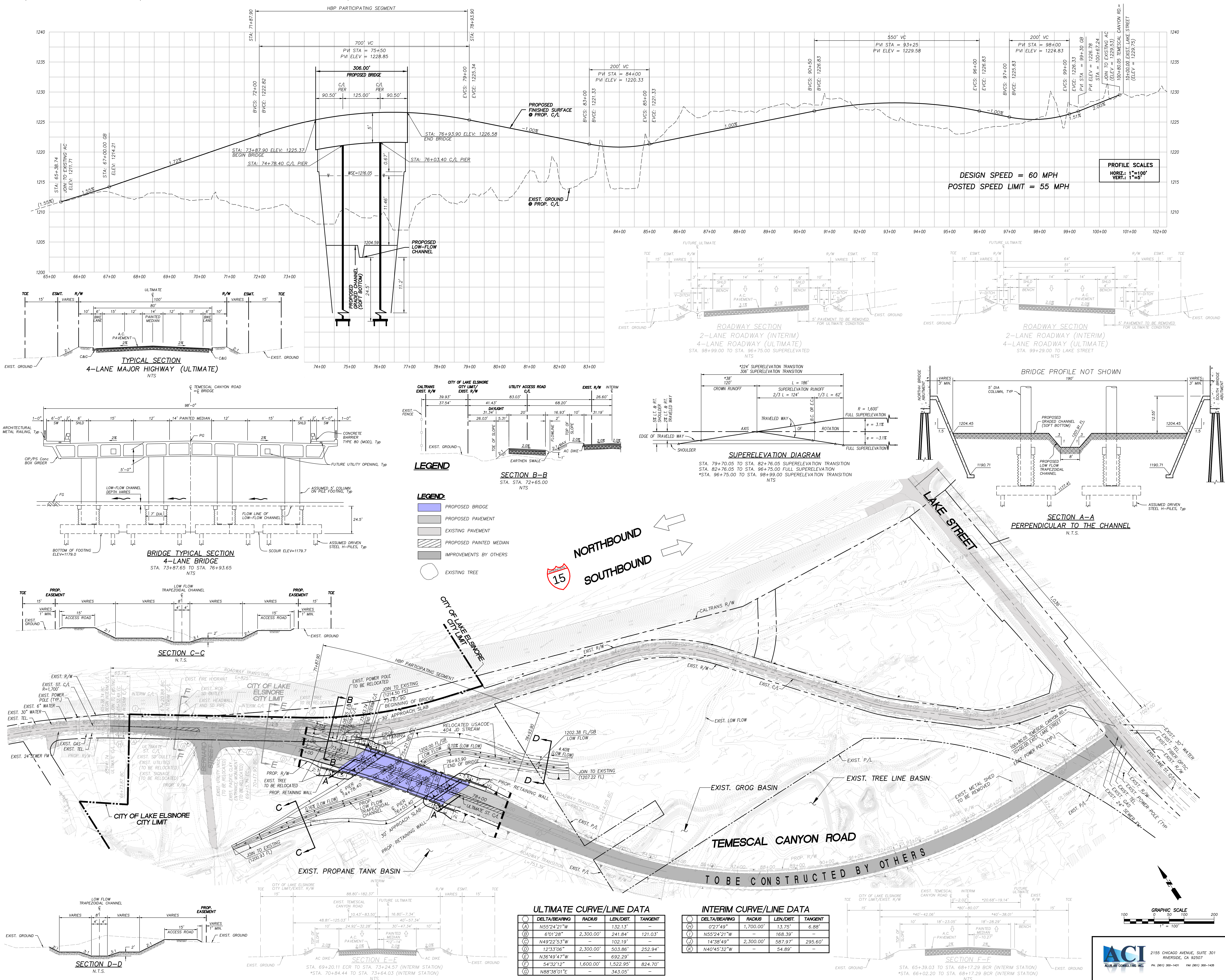
LEGEND

- SECTION NUMBER ——— HEC-RAS CROSS SECTION
- APPROXIMATE LIMITS OF FEMA EFFECTIVE 100-YR FLOODWAY LIMITS
- EXISTING 100-YR FLOODPLAIN LIMITS
-  PROPOSED 100-YR FLOODPLAIN LIMITS
-  CHANNEL FLOWLINE
-  APPROXIMATE LOCATION OF FEMA FLOOD INSURANCE RATE MAP CROSS SECTION



**EXHIBIT C: PROPOSED ROADWAY GEOMETRIC
APPROVAL DRAWING (GAD) FOR TEMESCAL
CANYON ROAD**

2,300 AND 1,600-FOOT RADIUS, 2-LANE (INTERIM), 64' R/W (INTERIM), 4-LANE (ULTIMATE), 100' R/W (ULTIMATE)



**ATTACHMENT: RIVERSIDE COUNTY FLOOD CONTROL AND
WATER CONSERVATION DISTRICT (RCFC &
WCD) APPROVAL LETTER DATED OCTOBER
31, 2016)**

JASON E. UHLEY
General Manager-Chief Engineer



1995 MARKET STREET
RIVERSIDE, CA 92501
951.955.1200
FAX 951.788.9965
www.rcflood.org

RIVERSIDE COUNTY FLOOD CONTROL AND WATER CONSERVATION DISTRICT

October 31, 2016

Mr. Jason Simpson
City of Lake Elsinore
130 South Main Street
Lake Elsinore, CA 92530

Dear Mr. Simpson:

Re: MR 295 Floodplain and Bridge Scour Study
for Temescal Wash at the New Temescal
Canyon Road Bridge and Roadway Project in
the City of Lake Elsinore, California
MS 163
Account No. 137-0-3-90181
Plan Check No. 4

The District received the following items for review from the City of Lake Elsinore on October 28, 2016 and prepared by Aguilar Consulting Inc.:

- Floodplain and bridge scour study for Temescal Wash at the new Temescal Canyon Road Bridge and Roadway Project within the city of Lake Elsinore, CA dated October 20, 2016 (submitted October 28, 2016).
- CD containing a HEC-RAS model for the existing and proposed conditions.

The District has completed Plan Check No. 4 for the subject project and offers no additional comments.

The District is aware that this floodplain and bridge scour study report was prepared in support of the Highway Bridge Program (HBP) Project Approval/Environmental Document phase (PAED phase). The District's review of the floodplain and bridge scour study report is solely a planning level review and in no way implies approval or sponsorship of the new road alignment, grading, final design and structural integrity of the new bridge. We recommend that detailed design plans consider appropriate sized channel conveyance in order to maintain adequate conveyance capacity through the skewed bridge. The report shall be updated to reflect the changes to assure that the bridge clearance, scour requirement, and overall safety are met.

The following comments from previous reviews remain as advisory and shall be considered in the final report.

1. The proposed bridge and road leading to it will be located within the effective Federal Emergency Management Agency (FEMA) floodway. The preliminary plans and model show grading and fill within the effective floodway. A hydraulic analysis to show "no rise" in the water surface elevation will need to be included with the CLOMR package.
2. FEMA requires Endangered Species Act (ESA) compliance for any grading or fill within a floodplain. Documentation will need to be included with the CLOMR package.
3. Per Pages 108 and 109 of the 2014 Flood Insurance Study (FIS), Temescal Wash debris potential is listed as high. Bridge clearance allowance or freeboard will be determined based the water surface elevation generated from the bulked flow rate (1.5xQ₁₀₀) (per Page 47 of the FIS).

October 31, 2016

-2-

Mr. Jason Simpson

Re: MR 295 Floodplain and Bridge Scour Study
for Temescal Wash at the New Temescal
Canyon Road Bridge and Roadway Project in
the City of Lake Elsinore, California
MS 163
Account No. 137-0-3-90181
Plan Check No. 4

4. Future CLOMR submittal to FEMA might require submittal of an effective model, duplicate effective model, corrective duplicate effective model, existing condition model, and proposed conditions model, no rise certificate, and a floodway analysis.

If you have any questions or concerns, you may contact Hilal Elhaddad at 951.955.8255 or me at 951.955.1265.

Very truly yours,



DEBORAH DE CHAMBEAU
Engineering Project Manager

c: Aguilar Consulting, Inc.
Attn: Ceazar V. Aguilar

HAE:mcv
P8208348