Memorandum

To: Frank Wei
Branch Chief
Bridge Design Branch 19
Office of Bridge Design South
At: Amit S. Joshi

Date: April 4, 2019

File: 12-ORA-133-PM 8.59
San Diego Creek Bridges
Br. No. 55-0290L, 55-0290F
EA 12-0N890
12 1400 0130

From: **Department of Transportation**
Engineering Service Center MS #9
Structure Hydraulics and Hydrology

Subject: Preliminary Hydraulic Evaluation

This memo is in response to your request for a preliminary hydraulic evaluation for the proposal to construct a new auxiliary lane on SB Route 133 from the SB I-5 connector (PM 8.5) to the NB I-405 connector. It is also proposed to extend the number 3 lane on SB Route 133 approximately 300 feet south of the San Diego Creek to match the existing roadway pavement. As part of the project the San Diego Creek Left Bridge (Br. No. 55-0290L) and San Diego Creek Bridge (S133-N405) Br. No. 55-0290F will be widened.

General

This location consists of three San Diego Creek Bridges, (Br. No. 50-0290R, Br. No. 50-0290L and Br. No. 0290F). The bridges are located on State Route 133 in the City of Irvine in Orange County. The right bridge was built in 1958 and widened in 1999, the left bridge was built in 1968 and widened in 1999 and the connector bridge was built in 1968. All three structures are continuous 5 span RC slab with solid RC piers and RC strutted abutments, all on driven RC piles.

According to the Caltrans Maintenance Records all three structures which share the same pier walls have a history of scour problems dating back to the mid to late 1970's. Structure Hydraulics recommends a more permanent scour countermeasure as part of the overall project.

This evaluation was based on a review of (1) General plans, profiles and As-Builts for the existing structures, (2) General plans and profiles submitted by Structure Design (3) Structure Maintenance Records for existing structures (4) DSF Office of Geotechnical Support Memo, 11/26/2015 (5) SM&I Load Rating and Analysis Branch Memo 3/3/1016.

All Elevations used in this report are based on the As-Builts, NGVD 29.

Hydrology and Hydraulics

The San Diego Creek drains a watershed of approximately 29.8 square miles at the bridge site. According to the FEMA report, dated December 3, 2009, the peak 50-year, 100- year and 200-year discharge is 9600 cfs, 12,700 cfs and 20,700 cfs respectively.

The Caltrans Hydraulic Program (BrEase) was used to perform a one-dimensional hydraulic analysis to calculate the water surface elevation (WSEL) and velocity for the existing structures. The proposed freeboard is measured from the water surface elevation to the lowest chord of the soffit of the structure approximately 182.2 feet. The parameters used to model the existing structures included the 50, 100 and 200-year flows; a manning's roughness coefficient of 0.06 and a channel slope of 0.003 ft/ft.

The results are as follows:

Discharge	WSEL	Average Velocity	Available Freeboard
50-year Design Flood 9600 cfs	170.89 ft	6.31 fps	**11.31 ft**
100-year Base Flood 12,700 cfs	172.83 ft	7.06 fps	**9.37 ft**
200-Year Flood 20,700 cfs	177.11 ft	8.59 fps	**5.09 ft**

It appears that there is adequate freeboard for both the 50, 100 and 200-year frequency events. Structure Hydraulics does not have any concerns with the proposed widening.

Scour Analysis

Scour History

All three structures have a long history of scour consisting of various levels of footing and pile exposure throughout the years. There were several attempts at

correcting the scour problem by constructing a check dam and the installation of RSP, that have all failed.

In 2000 a newer check dam was constructed and RSP was once again installed at all three bridges. In March 2001, the Bridge's scour potential was assessed in accordance with FHWA Technical Advisory T5140.23, "Evaluating Scour at Bridges" and within current Caltrans guidelines, the bridge was determined to **be not scour critical.** The item 113 code was changed to 7; countermeasures have been installed to correct a previously existing problem with scour.

The latest Caltrans Bridge Maintenance Report dated 1/29/18 indicates the rock placed in 2000 is not performing well. There has been movement of the rock and all three structures continue to experience various levels of footing & pile exposure due to scour. The recommendation was to continue to monitor the bridge in case the scour worsens.

Below are several photos of the scour at different locations:

Photo 1- Exposed footing at Pier 5

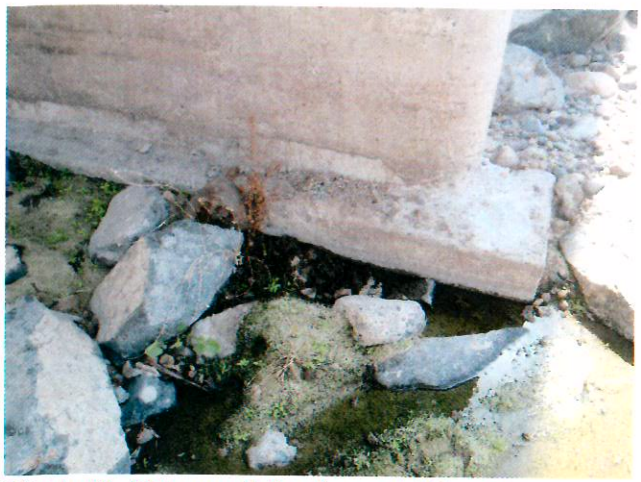


Photo 2- Exposed footing at Pier 4

Photo 3- Exposed concrete pile at Pier 3

Photo 4- Exposed footing at Pier 3

Current Scour Analysis

The FHWA Hydraulic Engineering Circular, (HEC-18), "Evaluating Scour at Bridges" was used to evaluate the potential scour for the South Fork Eel River Bridge. The scour evaluation requires an assessment of (1) Channel Bed Degradation, (2) Contraction Scour and (3) Local Pier Scour including the effects of debris and hydraulic skew.

(1) Degradation- A review of historical channel cross-sections indicates some degradation throughout the years but also shows aggradation after the check dam were installed. The old check dam appears to be failing and the new check dam was not visible during filed inspections. No degradation was considered in this report assuming the countermeasure is partially working.

(2) Contraction- There is no evidence of Contraction Scour at this site and no contraction scour was considered for this report.

(3) Local Pier Scour- There has been a long history of local pier scour. For this study the 200-year flow of 20,700 cfs was used to calculate the potential local pier scour; assuming the existing countermeasure fails. Below are the following results:

Bridge Item	Scour (ft)	Scour Elevation (ft)	Bottom of Footing Elev (ft)	Pile Tip Elev (ft)
Abutment 1	3.86	160.17	156.0	133.7
Pier 2	6.82	150.97	155.0	131.5
Pier 3	7.40	151.60	156.0	137.3
Pier 4	4.96	153.90	158.0	139.3
Pier 5	6.55	155.96	159.0	142.3
Abutment 6	3.61	162.33	159.0	142.7

Based on these results the footings at the piers would be completely undermined exposing the piles. The FHWA Hydraulic Engineering Circular, (HEC-23), "Bridge Scour and Stream Instability Countermeasures" was used to evaluate the most appropriate scour countermeasures. According to Table 2.1, "Stream Instability and Bridge Scour Countermeasure Matrix" several functional applications are recommended for local scour.

Alternative I- RSP – Rock size is designed based on velocities and requires excavation and filter fabric. The following are Structure Hydraulics recommendations for designing the RSP.

- The existing RSP should be removed to allow for excavation and may be utilized if the size is appropriate.
- ½ Ton RSP with a diameter of 24 inches should be used.
- The RSP should extend from Abutment 1 to Abutment 6 and placed in a 6.0-foot excavated trench where the top of the RSP layer is level with the top of the footings.
- The RSP should extend 10 feet upstream of the right bridge and 10 feet downstream of the connector bridge.
- The correct type of filter fabric should be installed under the RSP. The filter fabric should be extended fully beneath the RSP and extend vertically to the top of footings from all directions. The filter fabric should be terminated 2/3 of the distance from the upstream and downstream edge of the RSP, (approx. 6.7 feet).
- A 5-foot deep cut-off wall should be constructed at the upstream and downstream ends of the PGRSP, for the entire length.

Structure Hydraulics does have some concerns regarding the excavation

causing instability due to the short piles.

Alternative II-Partially Grouted Riprap-Specifically sized rock with 50% +- grouted together. Requires filter fabric and less excavation.

The following recommendations should be used for designing the PGRSP layer:

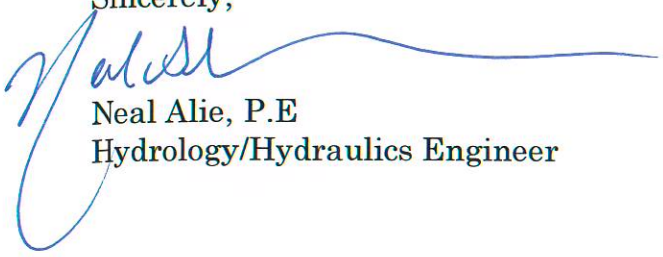
- The existing RSP should be removed and cannot be utilized for this proposed countermeasure.
- The PGRSP should extend from Abutment 1 to Abutment 6 with 9-inch diameter D50 rock used with a total PGRSP thickness layer of 18 in, but in no case greater than 2.0 feet (i.e., total footing height).
- The PGRSP should be flush with the top of the footings. Excavation should be from the top of footings down.
- The PGRSP should extend 10 feet upstream of the right bridge and 10 feet downstream of the connector bridge.
- A 5-foot deep cut-off wall should be constructed at the upstream and downstream ends of the PGRSP, for the entire length.

The Environmental permitting process can have significant effect on the planning, design and implementation of scour countermeasures. It is important to consult with the Environmental Branch early to determine if RSP or PGRSP is an acceptable countermeasure at this location.

To obtain the necessary encroachment permits from the various local and federal agencies that might be involved in this project it is necessary to obtain topographical surveys for both upstream and downstream of the existing structure. This topographical survey is needed to perform a more refined hydraulic model and scour analysis that will be implemented as part of the Final Hydraulic Report. A survey request was submitted by Structure Hydraulics on 2/28/19 to the District Survey Branch.

A more refined analysis will be conducted during the design phase of this project. If you have any questions, please call me at (916) 227-0444 or my mobile at 224-9640.

Sincerely,



Neal Alie, P.E
Hydrology/Hydraulics Engineer