

STRUCTURE HYDRAULICS & HYDROLOGY FINAL HYDRAULIC REPORT

Watson Wash Bridge (Replace)

Located approximately 2 miles west of the unincorporated community of Fenner
on State Route 40 over Watson Wash in eastern San Bernardino County

JOB:

Bridge No. 54-0805L (Existing)
Bridge No. 54-1282L (Proposed)

LOCATION:

08-SBd-040-R105.9

EA 08-0N550

Project ID 0800020102

WRITTEN BY:

Diane O'Brien

DATE:

September 5, 2014

Watson Wash (Replace)
Br. No. 54-0805L (Existing)
Br. No. 54-1282L (Proposed)
08-SBd-040-R105.9
Project ID 0800020102

Hydrology/Hydraulics Report

General

It is proposed to replace the Left Structure of the Watson Wash Bridge (Bridge No. 54-0805L) located on State Route 40 in eastern San Bernardino County. The bridge is being replaced due to extensive cracking reducing the current structural performance. The Item 113 code for scour vulnerability is 8 (Bridge foundations determined to be stable for the assessed or calculated scour condition). The Right Structure was replaced in 2004 for the same reason. The existing 18-span reinforced concrete (RC) "T" girder left structure was built in 1970. It has one-foot-wide RC pier walls and RC open end diaphragm abutments, all supported on spread footings. The existing left structure has a 38.5 degree bridge skew, -1.5% cross slope and is 741 feet long and 41 feet wide. The new proposed 17-span precast/prestressed (PC/PS) concrete slab bridge will be on the same alignment and have the same 38.5-degree bridge skew. The proposed structure has a total length of 741.5 feet, total width of 42 feet, cross slope of -2% and structure depth of 2'-2". The proposed seat abutments and four-column bents will be on spread footings. The 2.5-foot-diameter pier columns have a clear spacing of about 11.5 feet.

This report is based on the General Plan provided by Structure Design dated 08/06/14, Structure Plans dated 08/08/14 and Foundation Plans dated 08/19/14. **All elevations indicated in this report are based on Vertical Datum NGVD 1929.**

Basin

The Watson Wash watershed is located within the Mojave National Preserve in eastern San Bernardino County. Watson Wash originates in the New York Mountains and after emerging from steep canyons flows over sparsely vegetated alluvial slopes. The land is undeveloped desert. Lower portions of the alluvial slopes are vegetated with predominately creosote bush desert scrub and desert wash scrub. Scrub pine and juniper are found in the higher mountains. Most of the watershed runoff from the northerly portion of the watershed flows southerly in many separate washes which combine into one very wide sandy wash approximately 4000 feet north of the bridge. Runoff from the easterly portion of the watershed flows westerly until it is intercepted by a ditch and dike system and directed under a railroad and historic Route 66 through a series of bridges before combining with flow from the north. A dike on the east side intercepts runoff and directs it toward the bridge. A rock slope protection (RSP) armored chevron-shaped dike on the west side funnels the flow from that direction.

Watershed Modeling System (WMS) version 9.1 was used to estimate the 256 square mile drainage basin area upstream of the bridge. Elevations range from over 7,000 feet at the divide in the New York Mountains to approximately 1,980 feet in the channel at the bridge site. The Mean Annual Precipitation varies from 5 to 11 inches, with a basin weighted average of 7.5 inches.

Watson Wash (Replace)
Br. No. 54-0805L (Existing)
Br. No. 54-1282L (Proposed)
08-SBd-040-R105.9
Project ID 0800020102

Discharge

Watson Wash is an ungaged watershed. There is no information regarding the flood of record. The HEC-1 module within Watershed Modeling System (WMS) 9.1 was used to assist in the estimation of the 100-year and 50-year discharges at the bridge site. The NOAA Atlas 14 24-hour duration 100-year and 50-year precipitation depths and temporal distributions were used to develop the rainfall. The Initial Loss and Uniform Loss Rate method was used to estimate rainfall losses. Synthetic unit hydrographs were developed for each of the sub-basins using the San Bernardino County S-Graph for Desert Areas for all but one. The San Bernardino County S-Graph for Mountain Areas was used for the high altitude sub-basin in the New York Mountains. The Muskegum-Cunge channel flow routing method was applied. The estimated Q100 and Q50 discharges are 37,100 cfs and 26,600 cfs, respectively.

Water Surface Elevation

HEC-RAS 4.1.0 was used to model the Q100 and Q50 discharges in the channel and through the bridge opening. A composite Manning's roughness coefficient of 0.035 was selected to represent the braided desert wash. Due to the large bridge skew the hydraulic model was made with each piece of the bridge foundation as a separate structure to keep the channel cross sections perpendicular to the flow and better represent hydraulic conditions. The water surface elevation varies along the upstream face of the bridge. Abutment 18 is quite a bit upstream of Abutment 1. Separate model "runs" consisting of no structures, perpendicular structures and structures with adjusted skewed cross sections were needed for a complete analysis.

The minimum recommended freeboard is 2.0 feet above the Q50 water surface elevation. The overtopping flood cannot be calculated because the flow will overtop the diversion dikes upstream before reaching the bridge. The maximum water surface elevations at each structure element is shown in the following table.

Watson Wash (Replace)
 Br. No. 54-0805L (Existing)
 Br. No. 54-1282L (Proposed)
 08-SBd-040-R105.9
 Project ID 0800020102

	Q100 Water Surface Elevation (feet)	Q50 Water Surface Elevation (feet)	Low Chord Elevation (feet)	Freeboard Above Q100 (feet)	Freeboard Above Q50 (feet)
Abutment 1	1985.1	1984.0	1987.8	2.7	3.8
Pier 2	1985.3	1984.2	1988.1	2.8	3.9
Pier 3	1985.6	1984.5	1988.4	2.8	3.9
Pier 4	1985.8	1984.7	1988.7	2.9	4.0
Pier 5	1986.1	1985.0	1989.1	3.0	4.1
Pier 6	1986.3	1985.2	1989.4	3.1	4.2
Pier 7	1986.6	1985.5	1989.7	3.1	4.2
Pier 8	1986.8	1985.7	1990.0	3.2	4.3
Pier 9	1986.9	1985.9	1990.3	3.4	4.4
Pier 10	1987.5	1986.4	1990.6	3.1	4.2
Pier 11	1987.8	1986.6	1990.9	3.1	4.3
Pier 12	1988.0	1986.9	1991.3	3.3	4.4
Pier 13	1988.3	1987.2	1991.6	3.3	4.4
Pier 14	1988.5	1987.4	1991.9	3.4	4.5
Pier 15	1988.7	1987.6	1992.2	3.5	4.6
Pier 16	1988.9	1987.8	1992.5	3.6	4.7
Pier 17	1989.2	1988.1	1992.8	3.6	4.7
Abutment 18	1989.6	1988.5	1993.1	3.5	4.6

Velocity

The velocities corresponding to the Q100 discharge were computed using HEC-RAS 4.1.0. Using a “mixed” flow regime and the 100-year flood event, the average velocity approaching the proposed bridge is 12.0 fps. The peak velocity found at the thalweg is 14.1 fps.

Streambed

Watson Wash has a wide and braided channel. There are three main low flow channels within the 540-foot-wide wash. These low flow channels could move laterally, although historic cross sections show the movement is fairly localized. The current thalweg elevation of approximately 1978.0 feet is at the far west side of the channel. The elevations and locations of the other two low flow channel inverts are 1979.5 feet in the vicinity of proposed Pier 10 and 1981.0 feet near proposed Pier 14. The streambed is composed of silty fine to coarse sand and gravel with some cobbles. This material is scorable and subject to erosion.

Watson Wash (Replace)
Br. No. 54-0805L (Existing)
Br. No. 54-1282L (Proposed)
08-SBd-040-R105.9
Project ID 0800020102

Scour

The long-term degradation of the channel invert over the life of the new structure is estimated to be 3.0 feet. There is no contraction scour. Abutments 1 and 18 are outside the channel behind RSP. Following recommendations in Hydraulic Engineering Circular No. 18 for abutments with spread footings on soil, the top of the abutment spread footings should be below the elevation of the toe of the channel banks. This elevation is 1980.0 feet for Abutment 1 and 1984.0 feet for Abutment 18.

The 2.5-foot-diameter pier columns are spaced 14'-0³/₄" apart, center to center, with a clear spacing of 11.5 feet. There is no hydraulic skew during high flows. The local scour depth for Piers 2-17 is estimated to be 7.5 feet. A laterally migrating thalweg was assumed within sections of the channel that envelope where migration has occurred historically. The existing thalweg elevations used for the total scour elevation computations were Elevation 1978.0 feet for Piers 2 - 6, Elevation 1979.5 feet for Piers 7 - 12 and Elevation 1981.0 feet for Piers 13 - 17.

Debris

The watershed is sparsely vegetated and no debris accumulation was reported or observed on the existing pier walls. Debris problems are not anticipated.

Bank Protection

District should design RSP appropriate for the velocities in the channel in order to protect the abutment slopes.

Demolition

Existing Piers 2-7 and 13-18 will be completely removed. For existing Piers 8-12 the proposed removal limits are 3 feet below original ground. The top width of a scour hole in cohesionless bed material from one side of a pier can be estimated as 2.0 times the scour depth. The distance between the edge of the proposed columns and the edge of the existing pier walls barely falls within this range when measured perpendicular to the flow for Existing Pier 8 and Proposed Pier 8 and Existing Pier 12 and Proposed Pier 11. However, the scour produced from a one-foot-wide cut-off pier wall will not impact the new bridge foundations.

Watson Wash (Replace)
 Br. No. 54-0805L (Existing)
 Br. No. 54-1282L (Proposed)
 08-SBd-040-R105.9
 Project ID 0800020102

Summary Information for the Bridge Designer

Below are summaries of key design parameters based on the hydrologic and hydraulic analyses performed for the Left Bridge:

HYDROLOGIC AND HYDRAULIC SUMMARY		
Drainage Area: 256 mi ²		
Frequency	100-year	50-year
Discharge (cfs)	37,100	26,600
Water Surface Elevation (feet)	See Table on Page 4	
Average Velocity (fps)	12.0	-
Peak Velocity (fps)	14.1	-
Minimum Soffit Elevation (feet)	See Table on Page 4	
Freeboard (feet)	See Table on Page 4	
Flood plain data are based upon information available when the plans were prepared and are shown to meet federal requirements. The accuracy of said information is not warranted by the State and interested or affected parties should make their own investigation.		

Long Term Scour Depths

	Degradation (feet)	Contraction Scour Depth (feet)
Pier 2-17 (2.5-ft-dia. columns)	3.0	0

Scour Data (Elevations and Depths)

	Long Term (Degradation and Contraction) Scour Elevation (feet)	Short Term (Local) Scour Depth (feet)
Piers 2-6 (2.5-ft-dia. columns)	1975.0	7.5
Piers 7-12 (2.5-ft-dia. columns)	1976.5	7.5
Piers 13-17 (2.5-ft-dia. columns)	1978.0	7.5

Top of Spread Footings should be below these Elevations

Abutment 1	1980.0 feet
Abutment 18	1984.0 feet

ALL CALCULATED ELEVATIONS IN THIS REPORT ARE BASED ON THE VERTICAL DATUM NGVD29.

Watson Wash (Replace)
Br. No. 54-0805L (Existing)
Br. No. 54-1282L (Proposed)
08-SBd-040-R105.9
Project ID 0800020102

References

1. Watson Wash Bridge - Left (Replace) - Sheet 1 dated 08/06/14, Sheets 2, 18 dated 08/14/14, Sheets 3, 4 dated 08/08/14, Sheets 9, 11, 14 dated 08/13/14, Sheets 6, 7 dated 08/19/14, Sheets 8, 10, 13, 15, 16, 17, 19, 20, 21 dated 08/04/14 and Sheet 12 dated 08/12/14.
2. Watson Wash Bridge – As Built Plans, Date Completed 08/24/70.
3. San Bernardino County Hydrology Manual, August 1986.
4. Drainage Design Manual for Maricopa County, Arizona, 4th Edition, August 15, 2013.
5. Hydraulic Engineering Circular No. 18, Evaluating Scour at Bridges, Fifth Edition, April 2012.
6. Caltrans Bridge Maintenance Records.

Watson Wash (Replace)
Br. No. 54-0805L (Existing)
Br. No. 54-1282L (Proposed)
08-SBd-040-R105.9
Project ID 0800020102

This report has been prepared under my direction as the professional engineer in responsible charge of the work, in accordance with the provisions of the Professional Engineers Act of the State of California.



Diane K. O'Brien

REGISTERED CIVIL ENGINEER (SIGNATURE)

REGISTRATION NUMBER C 48483

DATE: June 30, 2016