Shoemaker Bridge Replacement Project

Location Hydraulic Study

07-LA-710 PM6.0/6.4
EA: 27300
SCH No. 2016041007

August 2019

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Location Hydraulic Study

Shoemaker Bridge Replacement Project

City of Long Beach, Los Angeles County, California

07-LA-710-PM 6.0/6.4

EA 27 3000

August 2019

CALIFORNIA DEPARTMENT OF TRANSPORTATION

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Shoemaker Bridge Replacement Project

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EA No. 27300

August 8, 2019

Submitted to:
California Department of Transportation, District 7

This report has been prepared by or under the supervision of the following Registered Engineer. The Registered Civil Engineer attest to the technical information contained herein and has judged the qualifications of any technical specialist providing engineering data upon which recommendations, conclusions, and decisions are based.

Prepared By: D Stefanovic Date: 8/8/2019

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HDR Engineering, Inc.

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Acronyms and Abbreviations

BMP	Best Management Practice
BSA	Biological Study Area
Caltrans	California Department of Transportation
City	City of Long Beach
CDFW	California Department of Fish and Wildlife
cfs	Cubic Foot Per Second
EAP	Early Action Project
EFH	Essential Fish Habitat
EPA	Environmental Protection Agency
ESA	Environmentally Sensitive Area
FEMA	Federal Emergency Management Agency
FTIP	Federal Transportation Improvement Program
HEC-RAS	Hydrologic Engineering Center – River Analysis System
HMMP	Habitat Mitigation and Monitoring Plan
I	Interstate
LA River	Los Angeles River
LAFCD	Los Angeles Flood Control District
LB MUST	Long Beach Municipal Urban Stormwater Treatment
Metro	Los Angeles County Metropolitan Transportation Authority
NMFS	National Marine Fisheries Service Habitat Division
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollution Discharge Elimination System
ROW	Right-of-Way
RTP	Regional Transportation Plan
RWQCB	Regional Water Quality Control Board
SCAG	Southern California Association of Governments
SR	State Route
SWPPP	Storm Water Pollution Prevention Plan
SWRCB	State Water Resources Control Board
TCE	Temporary Construction Easement
USACE	United States Army Corp of Engineers
USFWS	U.S. Fish and Wildlife Service

Executive Summary

This report presents the findings of the Location Hydraulic Study for the proposed Shoemaker Bridge Replacement Project (Project). The City of Long Beach (City), in cooperation with the California Department of Transportation (Caltrans), is proposing to replace the Shoemaker Bridge (West Shoreline Drive) (Bridge No. 53C0932; referred as Project here) located in the City of Long Beach, California. The Project involves replacing the existing Shoemaker Bridge over the Los Angeles River with a new bridge constructed just south of the existing bridge.

This report has evaluated the existing and proposed conditions for the Los Angeles River channel at the Shoemaker Bridge (West Shoreline Drive) crossing (Bridge No. 53C0932) to document any potential impacts to or encroachments upon floodplains and any mitigation that may be required. The Project is located within a 100-year floodplain. However, the hydraulic analysis (see Section 3) demonstrates that the proposed bridge replacement has sufficient horizontal and vertical clearances to not cause any significant backwater upstream of the bridge. The proposed bridge replacement will have a minimal impact on floodplains with a maximum increase in water surface elevation of 2 inches, which would not increase the floodplain extents since the existing levee walls are high enough to contain all flows within the flood control channel. No mitigation measures are required. Project design features and implementation of construction Best Management Practices would minimize any direct and indirect water quality impacts. The Project would not support probable incompatible floodplain development.

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1 Introduction

1.1 Purpose of Report

Executive Order 11988 (Floodplain Management) directs all federal agencies to refrain from conducting, supporting, or allowing actions in floodplains unless it is the only practicable alternative. Federal financial assistance and/or issuance of a federal permit(s) required for a proposed state/local project constitute federal support and/or allowing actions. The Federal Highway Administration requirements for compliance are outlined in 23 CFR 650 Subpart A. In order to comply with 23 CFR 650 Subpart A and determine if an encroachment itself is “minimal,” or “significant,” the following must be analyzed:

- The practicability of alternatives to any longitudinal encroachments
- Risks of the action (to life and property)
- Impacts on natural and beneficial floodplain values
- Support of incompatible floodplain development (inconsistencies with existing watershed and floodplain management programs)
- Measures to minimize floodplain impacts and to preserve/restore any beneficial floodplain values impacted by the project.

1.2 Project Purpose and Need

The City of Long Beach (City), in cooperation with the California Department of Transportation (Caltrans), is proposing to replace the Shoemaker Bridge (West Shoreline Drive) (Bridge No. 53C0932) in the City of Long Beach, California. A regional location map and a project location map is included in Figure and Figure 1-2, respectively. The Shoemaker Bridge Replacement Project (Project) is an Early Action Project (EAP) of the Interstate 710 (I-710) Corridor Improvement Project and is located at the southern end of State Route 710 (SR-710) in the City of Long Beach, bisected by the Los Angeles River (LA River).

1.2.1 Purpose of the Project

The purpose of the Project is to:

- Provide a structure and highway facility that meets current structural and geometric design standards
- Provide a facility that is compatible with planned freeway improvements and downtown development projects
- Improve connectivity from the downtown area to surrounding communities and adjacent recreational use areas
- Improve safety and operations for all modes of transportation

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Shoemaker Bridge Replacement Project

Figure 1-1. Regional Location

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Shoemaker Bridge Replacement Project

Figure 1-2. Project Location

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The Project limits are generally bounded by 9th and 10th Street ramp connections and West Shoreline Drive to the west, Magnolia Avenue to the east, Ocean Boulevard and West Shoreline Drive to the south, and Anaheim Street to the north. The Project limits on the east side extend beyond Magnolia Avenue along Anaheim, 6th and 7th Streets to Atlantic Boulevard. These limits provide the logical termini to facilitate the replacement of the existing bridge and accommodate planned City improvements, as well as the proposed improvements in the I-710 Corridor Project.

1.2.2 Need for the Project

The existing Shoemaker Bridge has structural deficiencies and a high accident rate due to non-standard geometric features that cannot be upgraded to current State highway standards. The Project is needed to improve safety, operations, and connectivity between downtown Long Beach and regional transportation facilities. It is also needed to accommodate planned improvements in the area, such as the City’s planned expansion of Cesar E. Chavez and Drake Parks.

If the existing Shoemaker Bridge were to continue to be used for vehicular traffic, the non-standard features would remain, and the existing bridge alignment would preclude planned improvements by other locally and regionally significant projects, specifically, the I-710 Corridor Project. Implementation of the proposed Project would provide consistency with the improvements proposed as part of the I-710 Corridor Project and the Mobility Element of the City of Long Beach General Plan (City of Long Beach 2013), in addition to meeting the needs for traffic safety and accommodating the projected increase in demand for the City's non-motorized transportation facilities.

1.3 Project Description

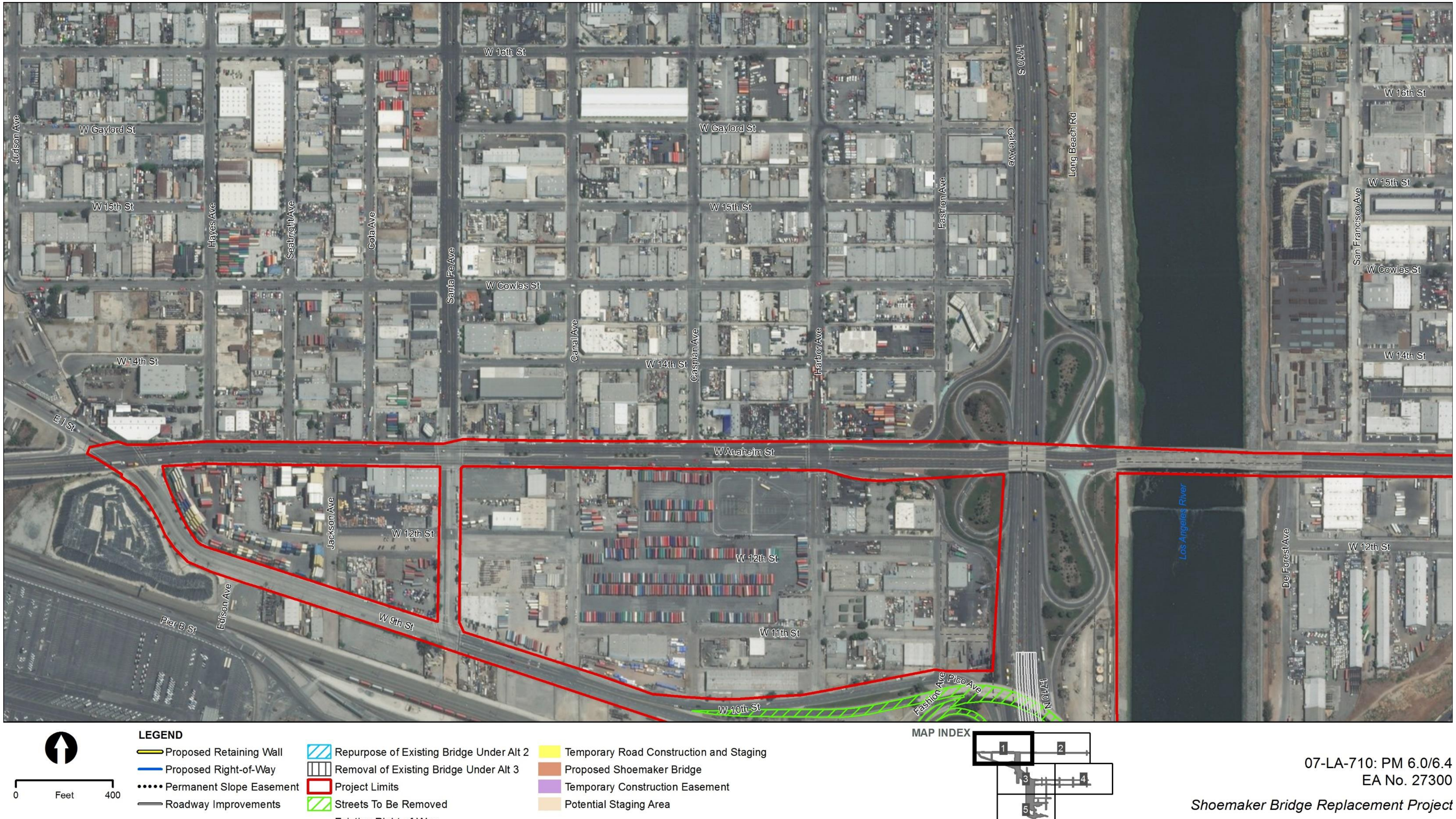
Three alternatives, a No Build Alternative (Alternative 1), and two build alternatives (Alternatives 2 and 3) are being evaluated as part of the proposed Project. Alternatives 2 and 3 would replace the existing Shoemaker Bridge over the LA River with a new bridge constructed just south of the existing bridge. In both Alternatives 2 and 3, the Shoemaker Bridge would accommodate bicycle and pedestrian use and include the evaluation of design options for a roundabout (Design Option A) or a “Y” intersection (Design Option B) at the easterly end of the new bridge. The primary difference between Alternatives 2 and 3 is Alternative 2 includes repurposing a portion of the existing Shoemaker Bridge for non-motorized transportation and recreational use, and Alternative 3 includes the removal of the existing Shoemaker Bridge in its entirety.

Alternatives 2 and 3 would also provide improvements to associated roadway connectors to downtown Long Beach and along West Shoreline Drive from SR-710, as well as improvements along portions of 3rd, 6th, and 7th Streets, and West Broadway from Cesar E. Chavez Park to Magnolia Avenue. The proposed improvements may include additional street lighting; restriping; turn lanes; and bicycle, pedestrian, and streetscape improvements. The Project also includes the removal of the Golden Shore grade separation over West Shoreline Drive and modifications along Golden Shore to create a new controlled intersection at Golden Shore and West Shoreline Drive. Additionally, the Project would evaluate street improvements on 6th and 7th Streets from Magnolia Avenue to Atlantic Avenue and on Anaheim Street between 9th and Atlantic Avenue. As an EAP of the I-710 Corridor Project, Alternatives 2 and 3 would evaluate the impacts from the closure of the 9th and 10th Street ramp connections into downtown Long Beach.

Although most of the modifications and construction would occur within the existing Caltrans or City right-of-way (ROW), a partial property acquisition, aerial easement, and temporary construction easements (TCE) from the Los Angeles Flood Control District (LACFCD) would be required as part of the proposed Project. In addition, a small partial acquisition and a TCE may be required from an existing parking lot to complete the downtown street modifications along West Broadway. To accommodate the removal of the grade separation at Golden Shore and West Shoreline Drive, TCEs may be required along the west and east side of Golden Shore north of West Shoreline Drive, and along the south side of West Shoreline Drive east of Golden Shore.

TCEs would be required along multiple portions of the LARIO Trail to accommodate for trail connections associated with the proposed Project, and along portions of 6th Street, 7th Street, Golden Avenue, and San Francisco Avenue. The TCEs required along 6th Street and 7th Street (between Golden Avenue and Daisy Avenue) would accommodate restriping, and curb and sidewalk improvements. The Project limits are shown in Figure 1-3.

The proposed Project is included in the Final 2017 Adopted Federal Transportation Improvement Program (FTIP) and the Southern California Association of Government's (SCAG) 2016 Regional Transportation Plan (RTP) for Los Angeles County as Project ID: LA0G830.



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Shoemaker Bridge Replacement Project

Figure 1-3. Project Design Features of Alternatives 2 and 3 (Sheet 1 of 5)

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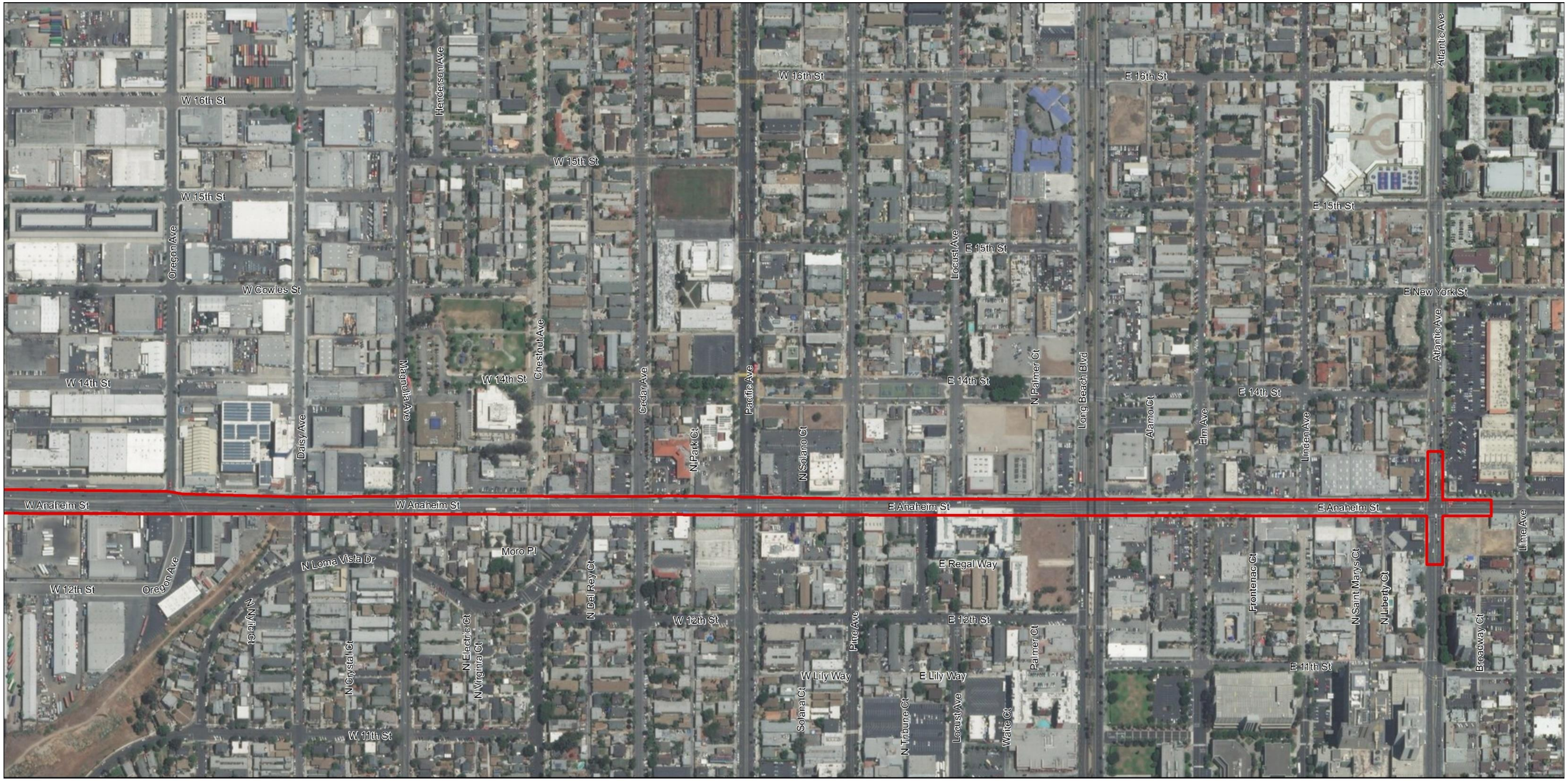

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LEGEND

- Proposed Retaining Wall
- Proposed Right-of-Way
- Permanent Slope Easement
- Roadway Improvements
- Repurpose of Existing Bridge Under Alt 2
- Removal of Existing Bridge Under Alt 3
- Project Limits
- Streets To Be Removed
- Existing Right-of-Way
- Temporary Road Construction and Staging
- Proposed Shoemaker Bridge
- Temporary Construction Easement
- Potential Staging Area

MAP INDEX

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Shoemaker Bridge Replacement Project

Figure 1-3. Project Design Features of Alternatives 2 and 3 (Sheet 2 of 5)

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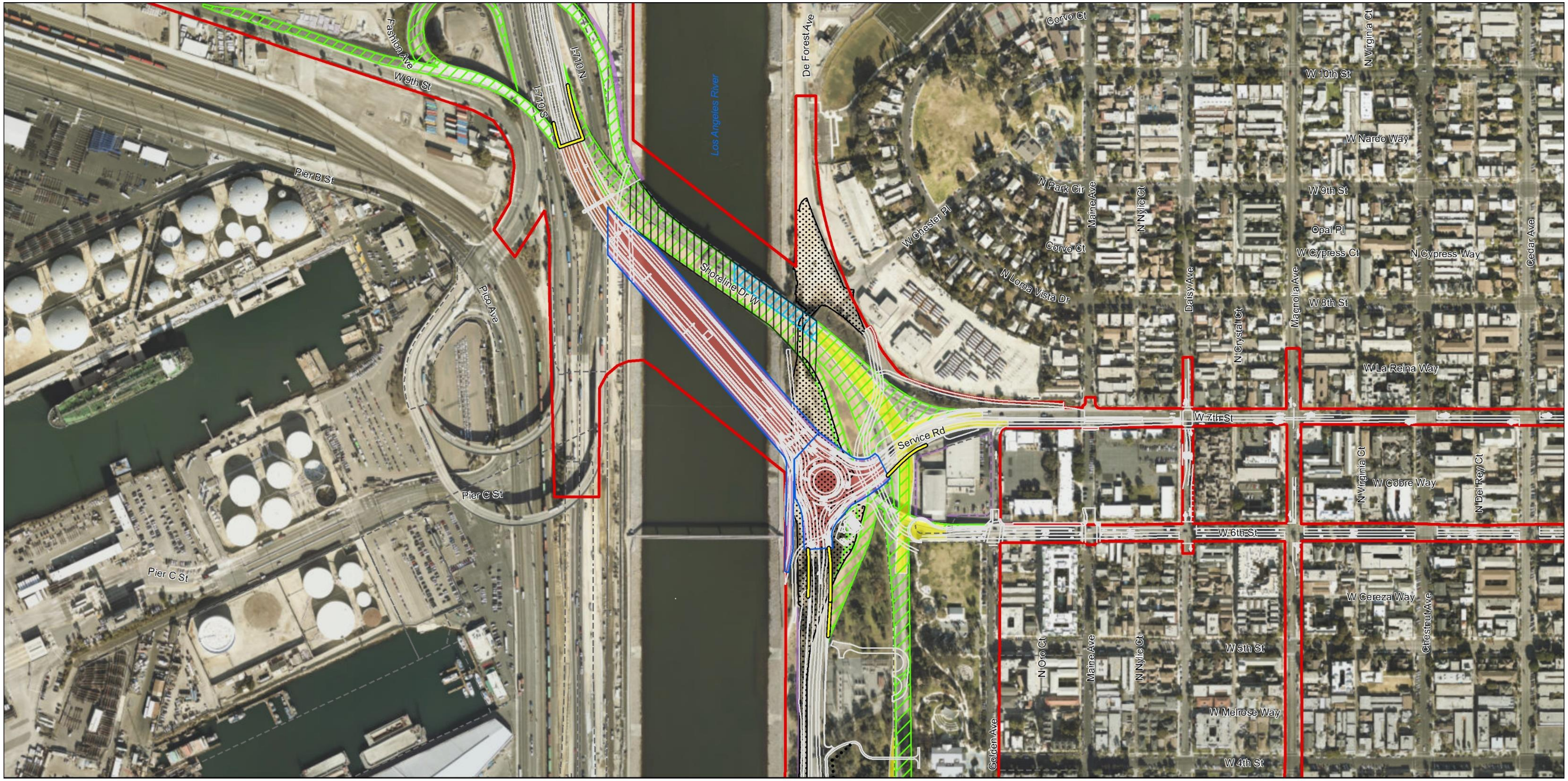

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LEGEND

- Proposed Retaining Wall
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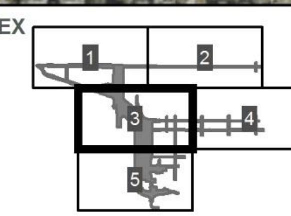
- Proposed Shoemaker Bridge
- Temporary Construction Easement
- Potential Staging Area
- Long Beach MUST Project

MAP INDEX



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Shoemaker Bridge Replacement Project

Figure 1-3. Project Design Features of Alternatives 2 and 3 (Sheet 3A of 5)

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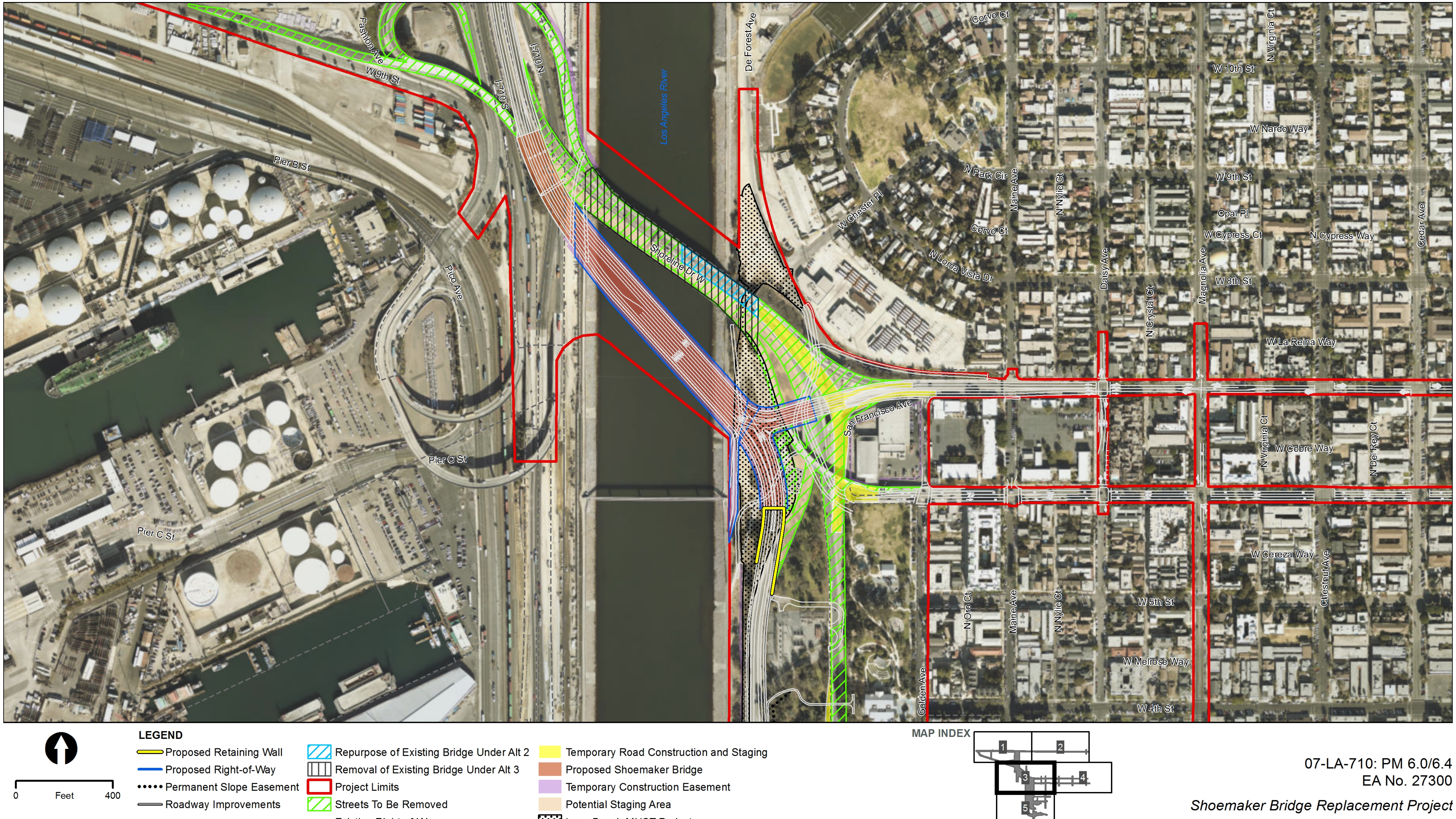

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Shoemaker Bridge Replacement Project

Figure 1-3. Project Design Features of Alternatives 2 and 3 (Sheet 3B of 5)

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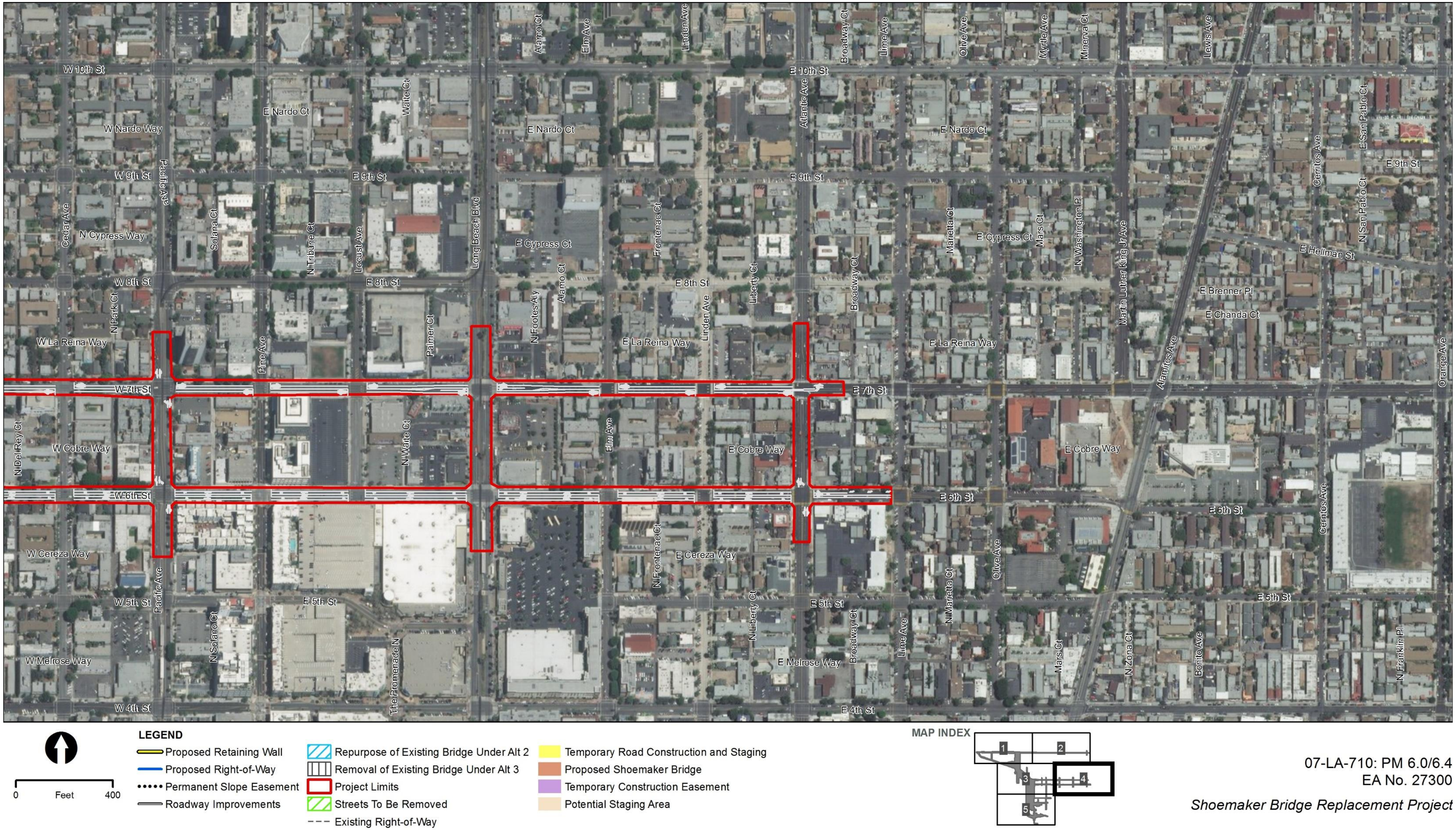

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Shoemaker Bridge Replacement Project

Figure 1-3. Project Design Features of Alternatives 2 and 3 (Sheet 4 of 5)

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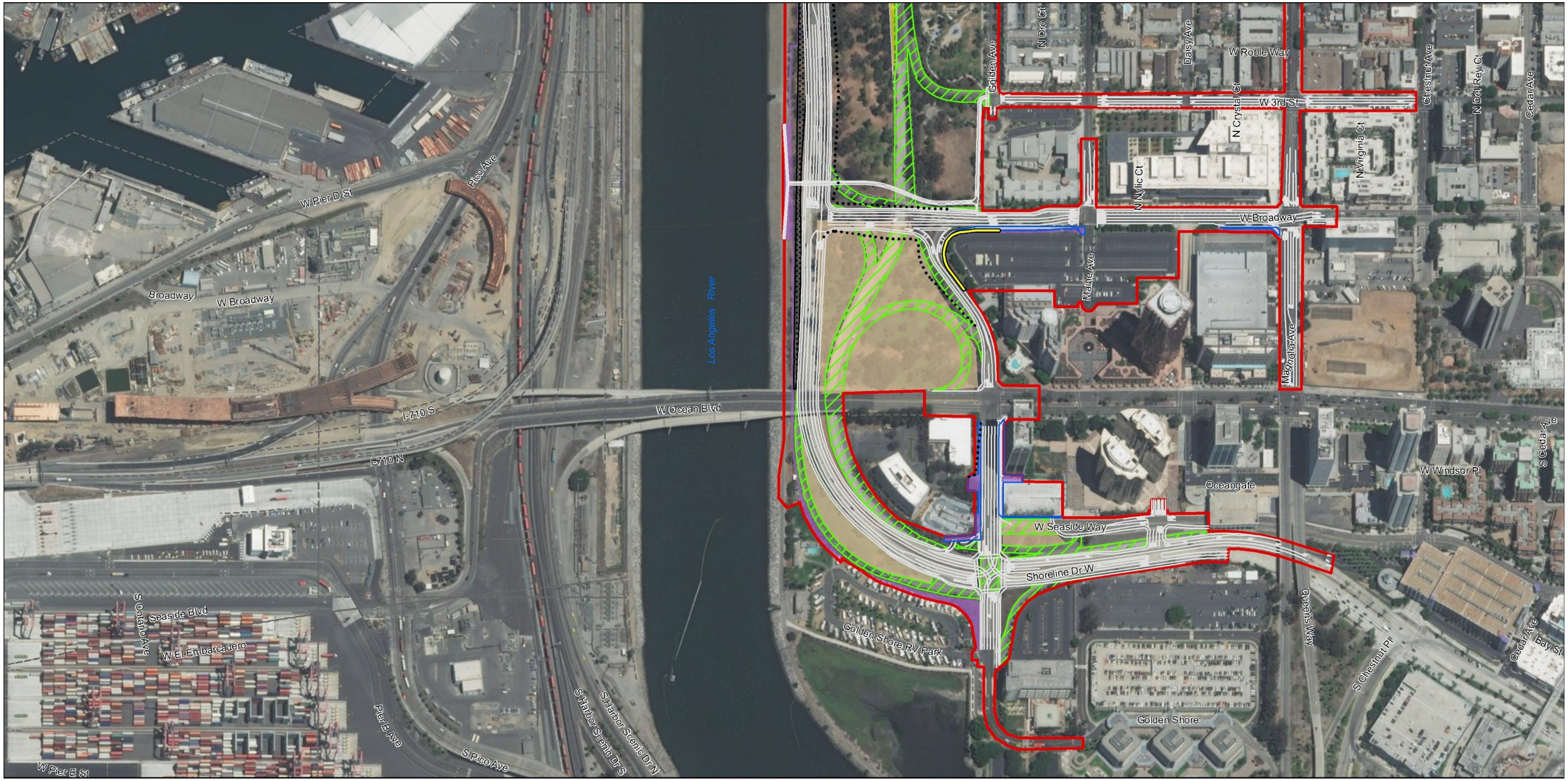

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LEGEND

- Proposed Retaining Wall
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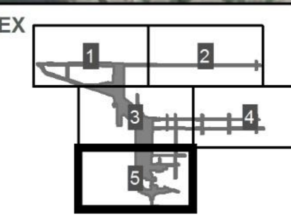
MAP INDEX



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Shoemaker Bridge Replacement Project

Figure 1-3. Project Design Features of Alternatives 2 and 3 (Sheet 5 of 5)

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1.4 Project Alternatives

This section describes the proposed design alternatives developed by a multidisciplinary team to achieve the proposed Project's purpose while avoiding or minimizing environmental impacts. The alternatives, as described in this section, consist of Alternative 1 (No Build), Alternative 2, and Alternative 3.

1.4.1.1 Alternative 1 (No Build)

Under the Alternative 1 (No Build), the proposed Project improvements would not be implemented; therefore, no construction activities would occur. The existing structure and highway facility would not meet current structural and geometric design standards and, thus, safety and connectivity would not be improved within the Project area.

1.4.1.2 Alternative 2

Build Alternative 2 includes the replacement of the ramp structures that connect to the downtown Long Beach roadway system. This alternative would evaluate the roundabout design option (Design Option A) and the “Y” interchange design option (Design Option B) at the east end of the proposed bridge. The new bridge would consist of multiple structures, with numerous spans that cross the LA River, the northbound (NB) lanes of SR-710, and the LA River and Rio Hondo (LARIO) Trail. The new ramps would be located approximately 500 feet (measured from centerline) south of the existing Shoemaker Bridge. A portion of the existing bridge would be repurposed into a non-motorized recreational public space maintained by the City. The bottom of the new river-spanning structures would exceed the existing 43 foot mean high water level (MHWL).

The deck of the new bridge would accommodate two through ramp lanes in each direction, shoulders, barriers, and a bicycle and pedestrian path on the south side of the bridge. Under Design Option B, the bridge would also include two turn lanes in the southbound (SB) direction. On the west side of the river, the ramps would connect on the left side of the freeway, at approximately the same merge and diverge existing ramp locations. On the east side of the river, a roundabout or controlled intersection would be provided at the ramp termini. The ramp termini would be located at or near the eastern abutment of the river-spanning section of the new Shoemaker Bridge.

Local Streets

As shown in Figure 1-3, the build alternatives include modifications to nine local streets, including West Shoreline Drive, Ocean Boulevard, Golden Shore/Golden Avenue, West Broadway, 3rd Street, 6th Street, 7th Street, 9th Street, 10th Street, and Anaheim Street.

West Shoreline Drive

At the eastern end of the new bridge, a new roundabout or controlled intersection would be constructed to allow West Shoreline Drive and 7th Street ingress and egress. The existing NB and SB West Shoreline Drive is currently separated by Cesar E. Chavez Park and the Southern California Edison (SCE) Seabright Substation. The NB roadbed would be removed and integrated into Cesar E. Chavez Park. The existing SB roadbed, located adjacent to the LA River, would be reconfigured and widened to allow two-way traffic and access from the newly configured West Shoreline Drive to the substation. A new controlled intersection would be introduced at West Shoreline Drive and the termini of West Broadway. The loop ramp connector between NB West Shoreline Drive and Ocean Boulevard would be removed and converted into park space. The existing Golden Shore Bridge that crosses over West Shoreline Drive would be removed, and a new controlled intersection would be created at West Shoreline Drive and Golden Shore.

3rd Street

The existing 3rd Street alignment curves to the north through Cesar E. Chavez Park and merges onto NB West Shoreline Drive. The proposed realignment of 3rd Street would be revised to end at Golden Avenue, and the 3rd Street section that curves into the park would be removed and converted into park space. The street, which currently carries one-way traffic in the westbound (WB) direction, would be reconfigured to allow for two-way traffic between Golden and Magnolia Avenues.

Ocean Boulevard

The loop ramp connecting NB West Shoreline Drive and Ocean Boulevard would be removed and converted into park space. The Ocean Boulevard and Golden Shore intersection would be modified to accommodate two-way traffic on Golden Shore between Ocean Boulevard and West Broadway.

Golden Shore/Golden Avenue

Golden Shore is currently a two-way street from Queensway Drive to Ocean Boulevard. North of Ocean Boulevard, Golden Shore becomes Golden Avenue and the roadway splits, providing connections to and from NB West Shoreline Drive and West Broadway. The proposed Project would eliminate the existing Golden Shore Bridge over West Shoreline Drive and reconstruct the street at a lower elevation to create a new controlled intersection at West Shoreline Drive. The connector ramps from SB West Shoreline Drive to Golden Shore and from NB Golden Shore to eastbound (EB) West Shoreline Drive would be removed. The intersection of Golden Shore and West Seaside Way would be eliminated. The proposed Project would also eliminate the ramp connection from NB West Shoreline Drive and realign Golden Avenue to provide connections to and from West Broadway. Access from West Broadway to Golden Avenue would be limited to right-in and right-out only.

West Seaside Way

West Seaside Way between Golden Shore and Queens Way would be reconfigured, and the controlled intersection at Golden Shore would be eliminated. The street would continue to provide access to parking structures and local office buildings. A new intersection allowing access between West Shoreline Drive and West Seaside Way would be constructed approximately 675 feet east of Golden Shore.

West Broadway

The existing terminus of West Broadway is uncontrolled and diverges from the left side of SB West Shoreline Drive. The portion of West Broadway from West Shoreline Drive to Maine Avenue, including its grade separation structure, would be removed. The connection would be replaced by a controlled intersection at West Shoreline Drive and West Broadway. West Broadway would be configured for two-way traffic from West Shoreline Drive to Magnolia Avenue. Traveling EB, a right turn pocket would be provided on West Broadway at the approach to Magnolia Avenue.

6th Street

The existing terminus of 6th Street is uncontrolled and diverges from the right side of SB West Shoreline Drive, on the Shoemaker Bridge. The existing grade separated structure would be removed. The portion of 6th Street from SB West Shoreline Drive to Golden Avenue would be reconfigured to provide access to the warehouse properties located at Topaz Court and Golden Avenue and would not provide connectivity to West Shoreline Drive. 6th Street would be converted from one-way WB to two-way traffic flow between Golden Avenue and Atlantic Avenue. Additionally, a new bicycle path would extend from the new 6th Street terminus, providing connections to the

LARIO Trail and the proposed Shoemaker Bridge. A new roadway would also extend from the existing 6th Street terminus to provide access to Drake Park.

7th Street

The existing terminus of 7th Street is uncontrolled and merges on the right side of NB West Shoreline Drive, on the Shoemaker Bridge. The portion of 7th Street from Golden Avenue to West Shoreline Drive, including its grade separation structure, would be removed and reconstructed. The connection would be replaced by a roundabout or Y intersection at West Shoreline Drive. 7th Street would be reconfigured from one-way EB to two-way traffic between West Shoreline Drive and Atlantic Avenue and would feature two lanes in each direction.

9th Street

The existing terminus of 9th Street is uncontrolled and merges on the right side of SB West Shoreline Drive, on the Shoemaker Bridge. The portion of 9th Street from Fashion Avenue to West Shoreline Drive, including its grade separation structure, would be removed. The connection would not be replaced. The Project would also evaluate traffic calming and signal improvements on 9th Street between Caspian Avenue and Anaheim Street.

10th Street

The existing terminus of 10th Street is uncontrolled and diverges from the right side of NB West Shoreline Drive, on the Shoemaker Bridge. The portion of 10th Street from West Shoreline Drive to Fashion Avenue, including its grade separation structure, would be removed. The connection would not be replaced.

Anaheim Street

The Project would evaluate traffic calming and signal improvements on Anaheim Street between West 9th Street and Atlantic Avenue.

Ramps/Connectors

The new ramps would be operated and maintained by Caltrans. The area owned and maintained by Caltrans after completion of the proposed Project would include the new Shoemaker Bridge terminus on the east of the LA River, the main span over the LA River to SR-710, the structure spanning the NB lanes of SR-710, and the roadbed connecting to SR-710.

1.4.1.3 Alternative 3

Similar to Alternative 2, Alternative 3 includes the replacement of the ramp structures that connect to the downtown Long Beach roadway system. It would also evaluate both Design Options A and B at the east end of the proposed bridge. In addition, similar to Alternative 2, the bridge under Alternative 3 with Design Option B would include two turn lanes in the SB direction. On the west side of the river, the ramps would connect on the left side of the freeway, at the same merge and diverge locations of the existing ramps. On the east side of the river, a roundabout (Design Option A) or a controlled intersection (Design Option B) would be provided at the ramp termini. The ramp termini are located at or near the eastern abutment of the river-spanning section of the new Shoemaker Bridge. Local street improvements described under Alternative 2 would also apply under Alternative 3. The difference between Alternatives 2 and 3 is the removal of the existing Shoemaker Bridge. The same ramp/connectors proposed under Alternative 2 would apply under Alternative 3.

1.5 Permits and Approvals Needed

Coordination with agencies to obtain permits and/or approvals would be required and are listed in Table 1-1.

Table 1-1. Required Permits, Reviews, and Approvals

Agency	Permit/Approval	Status
Federal Highway Administration (FHWA)	Section 6005 of Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) for satisfying Air Quality Conformity Requirements	Prior to approval of the Finding of No Significant Impact (FONSI).
United States Army Corps of Engineers (USACE)	Nationwide Permit 14 for Linear Transportation Projects	Permit will be acquired prior to construction.
United States Army Corps of Engineers (USACE)	Nationwide Permit 33 for Temporary Construction, Access, and Dewatering	Permit will be acquired prior to construction.
United States Army Corps of Engineers (USACE)	Section 404 Permit for discharge of dredged or fill material into waters of the United States	Application would be submitted after environmental document approval.
United States Army Corps of Engineers (USACE)	Section 408 Permit for modification to USACE facility (levees)	Application would be submitted after environmental document approval.
California Department of Fish and Wildlife	1602 Lake or Streambed Alteration Agreement	Permit would be obtained after certification of environmental document and prior to construction.
California Coastal Commission	Coastal Zone Management Act (CZMA) consistency determination	A CZMA consistency determination is needed 90 days prior to issuance of the FONSI.
State Water Resources Control Board	Section 402 National Pollutant Discharge Elimination System (NPDES)/ Caltrans NPDES Permit CAS000003 and CAS000002 (Construction General Permit)	The Construction General Permit has been adopted and was effective as of July 1, 2010. The Caltrans NPDES Permit was effective as of July 1, 2013.
Los Angeles Regional Water Quality Control Board (RWQCB)	NPDES Permit no. CAG994004 (Dewatering Permit)	Permit will be acquired prior to construction.
Los Angeles Regional Water Quality Control Board (RWQCB)	NPDES Permit no. CAG914001 (Dewatering Permit for Contaminated Sites)	Permit will be acquired prior to construction.
Affected Utilities	Approvals to relocate, protect in place, or remove utility facilities	Prior to any construction that would affect utility facilities.

Table 1-1. Required Permits, Reviews, and Approvals

Agency	Permit/Approval	Status
Los Angeles County Regional Water Quality Control Board	Section 401 Water Quality Certification Section 402 NPDES (Construction Activity)	Section 401 Water Quality Certification would be obtained after certification of environmental document and prior to construction. Section 402 NPDES (Construction Activity) Application would be submitted after environmental document approval.
Los Angeles County Flood Control District	Encroachment Permit	Letter or permit would be obtained prior to construction.
City of Long Beach	Approval of encroachment permits and street construction permits, street closures and rerouting, and associated improvements in the public ROW Section 4(f) consultation for Cesar E. Chavez Park Water Quality Management Plan	Actions/permits would be obtained prior to the start of construction. Section 4(f) consultation would be completed prior to completion of the environmental document. Prior to start of construction.
City of Long Beach Local Coastal Program/California Coastal Commission	Coastal Development Permit application for consistency determination	An application would be submitted for a consistency determination after certification but prior to approval of the environmental document.
Sanitation District of Los Angeles	Construction Work Discharge Permit	Required for discharge of construction water into local sewer system. To be applied for prior to construction.

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2 Affected Environment

2.1 Introduction

The Los Angeles River Watershed is one of the largest in the region at 834 square miles. The Los Angeles River is 51 miles long, of which 21.7 miles of the Los Angeles River is a flooding source to six cities (Compton, Cudahly, Long Beach, Los Angeles, Paramount, and South Gate) and Los Angeles County Unincorporated Areas (FEMA, 2016). Other flooding sources to the City of Long Beach include creeks and channels, such as the Back Channel, Compton Creek, and Los Cerritos Channel (FEMA, 2016). The Los Angeles River Waterhsed is also one of the most diverse in terms of land use patterns. Approximately 324 square miles of the watershed are covered by forest or open space land including the area near the headwaters which originate in the Santa Monica, Santa Susana, and San Gabriel Mountains. The rest of the watershed is highly developed. South of the Glendale Narrows, the river is contained in a concrete-lined channel down to Willow Street in Long Beach. The main tributaries to the river in this stretch are the Arroyo Seco (which drains areas of Pasadena and portions of the Angeles National Forest in the San Gabriel Mountains), the Rio Hondo, and Compton Creek.

The Project area is within the Los Angeles River tidal prism/estuary. The estuary begins in Long Beach at Willow Street and runs approximately three miles before joining with Queensway Bay located between the Port of Long Beach and the city of Long Beach. The Project area is located within a 100-year floodplain, occupying a well-defined channel with a natural, soft bottom in this reach with concrete-lined or rock riprap sides. The channel is managed by the USACE. Queensway Bay is heavily water recreation-oriented; however, major pollutant inputs are likely more related to flows from the LA River which carries the largest storm flow of any river in southern California (CSWRCB, 2018).

2.1.1 Land Use

The LA River flows through the San Fernando Valley past heavily developed residential and commercial areas. From the Arroyo Seco, north of downtown Los Angeles, to the confluence with the Rio Hondo, the LA River flows through industrial and commercial areas and is bordered by rail yards, freeways, and major commercial and government buildings. From the Rio Hondo to the Pacific Ocean, the LA River flows through industrial, residential, and commercial areas, including major refineries and petroleum products storage facilities, major freeways, rail lines, and rail yards serving the Ports of Los Angeles and Long Beach. The Los Angeles River Watershed land use map is shown in Figure 2-1 from CSWRCB (2018).

According to the City’s General Plan Land Use Map, land use designations within the Project area are primarily Commercial, Parks and Recreation, Transportation and Utilities, and Residential (City of Long Beach, 2012). Other designated land uses in the Project area include Public Facilities, Mixed Urban, Industrial, Water, and Vacant.

2.1.2 Topography

As shown in Figure 2-2, the topography of the Los Angeles River Watershed is dramatic, dropping from 7,103 feet in the northwestern San Gabriel Mountains to sea level (0 feet) over 51 miles (CWH, 2012). The deeply incised, mountain slopes are as steep as 65-70% and are some of the steepest in the world. The Verdugo Mountains and the San Rafael Hills lie between the eastern edge of the San Fernando Valley and the San Gabriel Mountains. Verdugo Peak, at 3,126 feet, is the highest point in these small ranges and lies entirely within the watershed. To the southeast lies the San Gabriel

Valley, the western portion of which is within the Los Angeles River Watershed. Elevations in the mountain-rimmed San Fernando Valley range from 3,747 feet in the north against the Santa Susana Mountains to 1,965 feet in the Santa Monica Mountains. South of the Elysian Hills the coastal plain slopes gently southward with elevations dropping from about 300 feet to sea level over a distance of 20 miles.

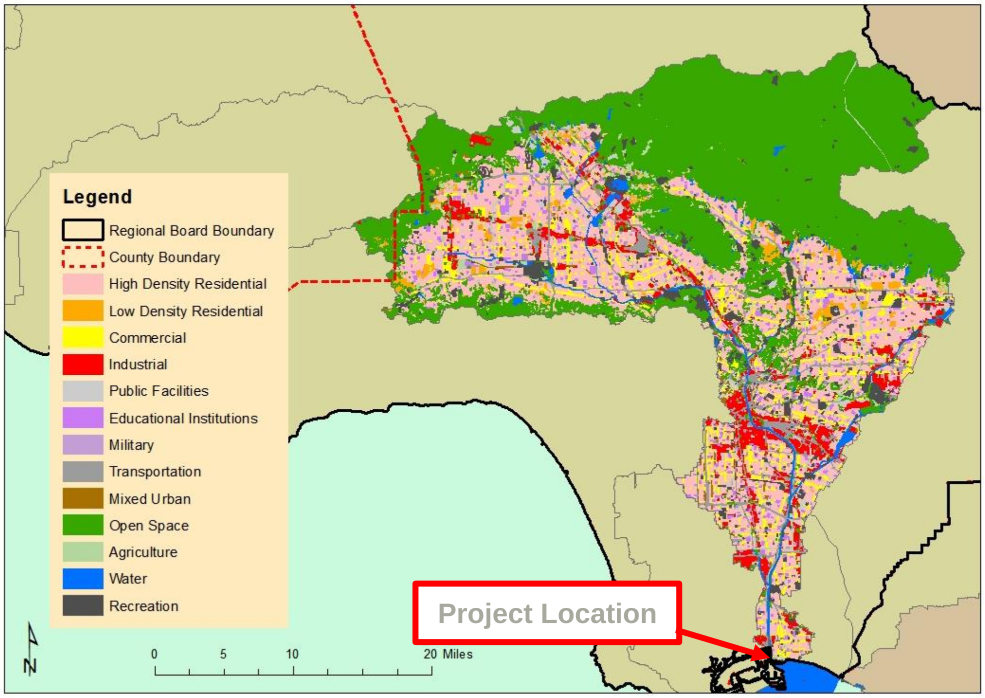

Figure 2-1. Los Angeles River Watershed Land Use (CSWRCB, 2018)

Figure 2-2. Topography of Los Angeles River Watershed (CWH, 2012)

The Project area is located in the Los Angeles Basin, which is characterized as an alluviated lowland (i.e., a flat landform that is less than 200 meters below sea level and was created from the deposition of sediment from rivers over a long period of time) (USGS, 1965). The Los Angeles Basin is largely flat and gently slopes toward the Pacific Ocean to the south. Long Beach is slightly elevated due to plate movement (i.e., uplift and local folding and faulting) in the region; however the majority of the city has an elevation of less than 60 feet (City of Long Beach, 1998).

The Project area is relatively flat and slopes gently to the south toward the Pacific Ocean. The Project area includes slopes and embankments adjacent to existing roadways, but none that are unusually steep.

2.1.3 Regional Hydrology

The Project area is in the Los Angeles Region, which is under the jurisdiction of the Los Angeles RWQCB – Region 4 (Los Angeles Regional Water Quality Control Board, 2014). The Los Angeles Region includes the coastal watersheds and drainages that flow into the Pacific Ocean from Ventura and Los Angeles Counties, and portions of Santa Barbara and Kern Counties. Specifically, the Los Angeles Region includes the drainages between Rincon Point (on the coast of western Ventura County) and the eastern Los Angeles County line. The Los Angeles Region also contains the drainage flows of the five coastal islands of Anacapa, San Nicolas, Santa Barbara, Santa Catalina, and San Clemente, as well as coastal waters within three miles of the continental and island coastlines (Los Angeles RWQCB, 2014).

The classification system for surface waters employed by the Los Angeles RWQCB was developed by the United States Geological Survey (USGS) (Los Angeles RWQCB, 2014). The classification system, known as the Watershed Boundary Dataset (WBD), divides surface waters into hydrologic units, which are classified into regions, sub-regions, accounting units, and cataloging units (USGS, 2017). The Project area is located in Region 18 (California Region), Subregion 1807 (Southern California Coastal), Accounting Unit 180701 (Ventura-San Gabriel Coastal), and Cataloging Unit 18070105 (Los Angeles). The Los Angeles Cataloging Unit covers an area of 819 square miles.

The classification system for ground water was developed by the California Department of Water Resources (CDWR), and divides groundwaters into hydrologic regions, basins, and subbasins (CDWR, 2003). The Project is located in the South Coast Hydrologic Region (HR), the Coastal Plain of Los Angeles Basin, and West Coast Subbasin.

The Los Angeles RWQCB also defines Watersheds and Watershed Management Areas for planning purposes (Los Angeles RWQCB, 2014). The Watershed Management Area in the Project area is the LA River Watershed (SWRCB, n.d.) (depicted as Lower Los Angeles River subwatershed in Figure **2-3**.

Four hydrologically distinct sub-regions are identified within the Los Angeles River Watershed: (1) upper watershed streams dominated by natural flows; (2) Los Angeles River mainstem (including the Burbank Western Channel) dominated by treatment plant effluent flows; (3) tributaries in the middle and lower watershed dominated by urban runoff; and (4) intertidal Los Angeles River estuary.

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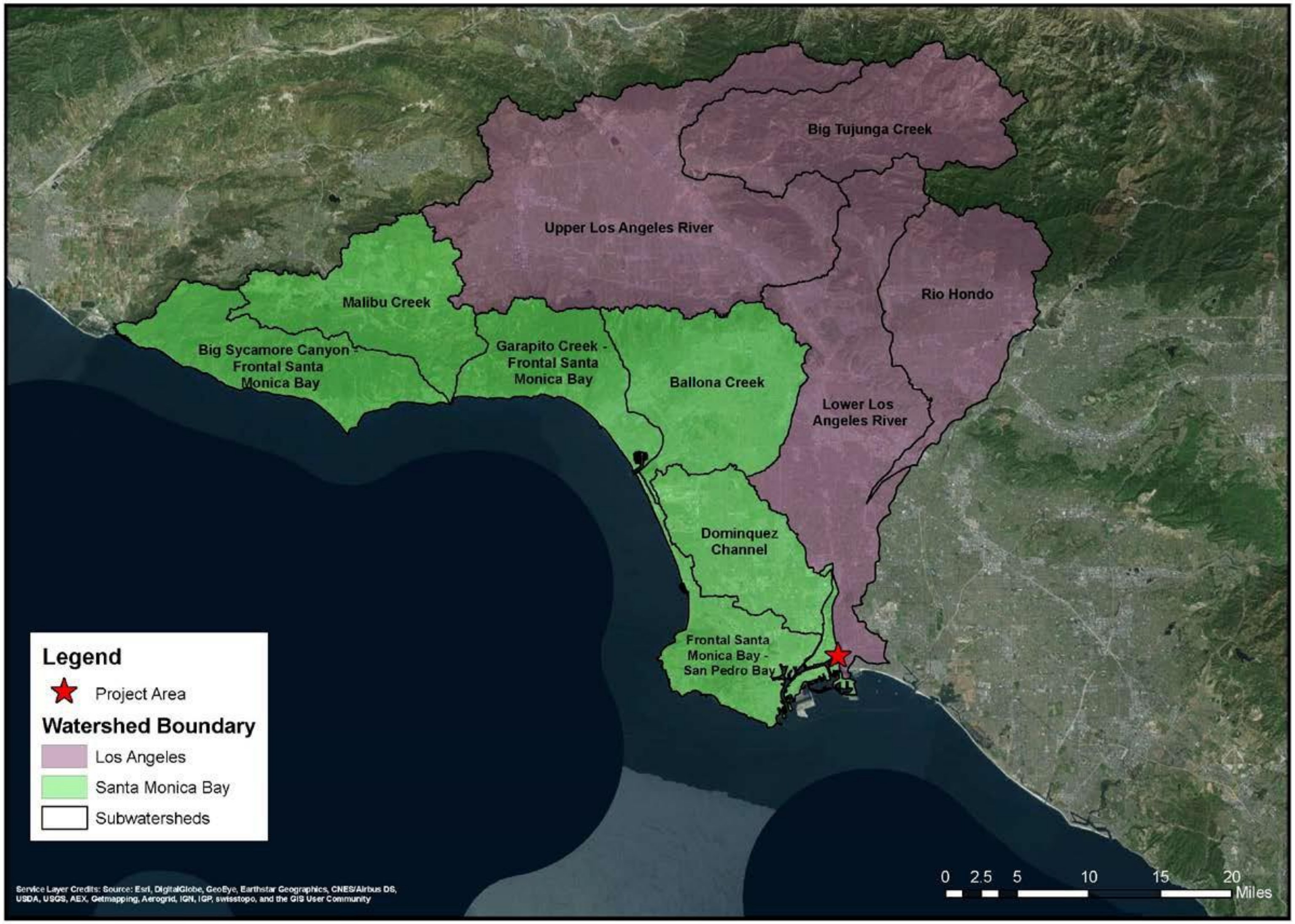

Figure 2-3**. Watersheds in Los Angeles County**

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2.1.4 Local Hydrology

2.1.4.1 Precipitation and Climate

The climate of the Los Angeles River watershed varies considerably with elevation and distance from the coast. The entire region is Mediterranean, with dry summers and mildly wet winters. The coastal zone is subtropical, with cool summers and mild winters. The intermediate valleys and foothills are temperate, with warm summers and mild winters. The climate in the mountains ranges from temperate, with warm summers and cool winters at the resort levels (5,000 - 6,000 ft), to alpine, with cool summers, and cold winters over the highest peaks (9,000 - 10,000 ft).

Precipitation characteristically occurs in the form of rainfall, although in the higher elevations, some falls as snow. In general, the quantity of precipitation increases with elevation. Normal annual precipitation ranges from 13.13 inches along the coast in Long Beach to more than 44 inches over Mt. Baden-Powell and Mt. San Antonio (Old Baldy) in the East Fork drainage of the San Gabriel River. About 90 percent of the season's total precipitation normally falls from November through April, with December-March as the wettest months. Extreme monthly precipitation totals in the drainage range from zero at every location to more than 50 inches atop the wettest mountain peaks. As can be seen by these extremes, the rainfall depth over the higher mountains is considerably greater than the corresponding depth on the coastal plains. The mountain/coastline ratios can be as high as 3 to 1 for durations of 6 hours and as high as 4 to 1 for 24 hours (USACE, 2015).

Southern California’s climate is projected to change in the foreseeable future to include changes to the historical patterns and distribution of total rainfall, intensities of storm events, and seasonal temperatures. Existing storm patterns could become more extreme with climate change, including larger and more intense storms during wet periods, and longer, hotter dry periods (USBR, 2016). Climate change is projected to affect many aspects of the Los Angeles River watershed. Four key vulnerabilities are water supply (limited long-term operational water storage capacity); water quality (increased water treatment needs); flooding (increased flash flooding and inland/coastal flooding damage); and ecosystem and habitat (adverse impact to threatened and sensitive species).

2.1.4.2 Surface Streams

Stream flow in the Los Angeles River at the project location is perennial due to upstream urban runoff and intertidal estuary. During storm events, runoff concentrates quickly from the steep slopes in the mountains and rushes through the improved Los Angeles River channel. Flood hydrographs from single storm events are typically of less than 12-hours duration and are almost always less than 48-hours duration. High rainfall rates, in combination with the effects of shallow surface soils, impervious bedrock, fan-shaped stream systems, steep gradients, and occasional denudation of the area by fire, result in intense debris laden floods. However, flood and debris flows are regulated at existing dams and debris basins. The downstream area is almost entirely developed and relatively little sediment enters the channel downstream from the dams aside from the fine material carried in suspension. At the Project location, a large portion of the contributing drainage lies downstream from dams.

2.1.4.3 Municipal Water Supply

The local community within the City of Long Beach receives its potable (drinking) water supply from two main sources, groundwater and imported water. Ownership of pumping rights allows over half of the City’s water supply needs to be produced from groundwater wells located within the City. The other portion of the potable water supply is treated surface water purchased from the Metropolitan Water District of Southern California (MWD). This water originates from two sources: the Colorado River, via the 242-mile Colorado River Aqueduct and Northern California's Bay-Delta region, via the

441-mile California Aqueduct. The area satisfies non-potable water demand through reclaimed water supplies. Reclaimed water originates from the Long Beach Water Reclamation Plant, located on the East side of the City. The water that is produced here comes from sewage water that is treated to a quality standard suitable for irrigating parks, golf courses and other outdoor landscapes (LBWD, 2018).

2.1.5 Ground Water Hydrology

Groundwater accounts for most of the region's local supply of freshwater and a priority is to conserve the maximum amount of storm water possible to recharge groundwater basins (CWH, 2012). The amount of water that is recharged annually is determined by the quality and quantity of storm water, imported water (from the Colorado River and the Owens Valley) and recycled water available for recharge, capacities of spreading grounds, and the geologic and groundwater conditions. In contrast to the neighboring San Gabriel River Watershed, much of the Los Angeles River Watershed is underlain with extensive clay layers and the most important spreading basins are in the San Fernando Valley where the underlying soils are permeable.

Four basins in the San Fernando Valley area contain substantial deep groundwater reserves and are recharged mainly through runoff and infiltration although the increase in impermeable surfaces has decreased infiltration (SWRCB, 2018). Groundwater basins in the San Gabriel Valley are not separated into distinct aquifers other than near the Whittier Narrows. Active recharge occurs in some of these areas through facilities operated by Los Angeles County. Spreading grounds recharge two basins in the coastal plain of Los Angeles west of the downtown area.

2.1.6 Geology/Soils/Soil Erosion Potential

Soils in the Los Angeles River Watershed can be generally classified as either mountain or valley (USACE, 2015). Mountain soils consist of a relatively thin mantle of residual soils, which are coarse, porous, and rocky. The valley soils, classified as recent alluvium and older alluvium, vary from coarse sand and gravel at canyon mouths to silty clay, and clay in the lower areas.

Soil erosion is the process by which soil particles are removed from the land surface, by wind, water and/or gravity. Soils are assigned to Hydrologic Soil Groups (HSGs), which are categorized according to their soil runoff potential. HSGs range from Group A (low runoff potential and rapid to very rapid subsoil permeability) to Group D (high runoff potential and very slow subsoil permeability) (NRCS, 2007).

The soils underlying the project location fall primarily into Hydrologic Soil Group (HSG) D characterized by clay loam, silty clay loam, sandy clay, silty clay or clay. This HSG has the highest runoff potential. They have very low infiltration rates when thoroughly wetted and consist chiefly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a claypan or clay layer at or near the surface and shallow soils over nearly impervious material.

However, according to the Water Quality Assessment Report (GPA, 2018) that was prepared for the Project, a Risk Level Assessment was completed to determine the sediment risk and receiving water risk of the Project. The risk determination is calculated based on the K, R, and LS Factors. The soil erodibility factor, or K factor, is a measure of the susceptibility of soil or surface material to erosion. The K factor for soils in the Project area is 0.32, as provided by the Caltrans Water Quality Planning tool (Caltrans, n.d.). A K value ranging from 0.25 to 0.45 is indicative of medium-textured soils that are moderately susceptible to particle detachment. Therefore, these soils produce runoff at moderate rates.

The erosivity factor, or R factor, is the potential for soil to wash off disturbed, devegetated earth during rain events (EPA, 2012). The R factor in the Project area is 85.04. An R factor greater than five indicates that the Project does not qualify for a waiver from NPDES permitting requirements.

The length-slope factor, or LS Factor, is the effect of topography (i.e., slope length and steepness) on erosion. The LS Factor in the Project area is 0.46.

According to the Risk Level Assessment, the sediment risk and receiving water risk are both low at the intersection of 6th Street and Golden Avenue, resulting in a combined risk of Level 1. Therefore, the Project is subject to minimum BMP and visual monitoring requirements (SWRCB, 2013).

2.2 Natural and Beneficial Floodplain Values

Natural and beneficial floodplain values include, but are not limited to fish, wildlife, plants, open space, natural beauty, scientific study, outdoor recreation, agriculture, aquaculture, forestry, natural moderation of floods, water quality maintenance, and ground water recharge.

A separate study for this project titled the Natural Environment Study (NES) (HDR, 2018) analyzed potential project impacts to biological resources. The NES consisted of a Biological Study Area (BSA) that encompassed areas of potential direct impact (Figure 2-4). The majority of the BSA consists of residential, commercial and industrial buildings and associated infrastructure. The BSA also consist of 190.86 acres of vegetation communities (see Table 2-1).

Table 2-1. Vegetation Communities Occurring within the BSA

Vegetation Community	**Total Acres**
Estuarine Subtidal Waters (Deepwater Aquatic)	10.29
Freshwater Emergent Marsh	<0.01
Developed/Disturbed/Ruderal	152.48
Park	28.09
Total	**190.86**

The LA River, despite substantial degradation, still provides some aquatic habitat and serves as a movement and/or foraging corridor for marine and bird species between the Pacific Ocean and upstream habitat areas. The Project area contains 10.29 acres of Estuarine Subtidal waters (Deepwater Aquatic), which are areas that are usually partially enclosed by land but are connected to the ocean and may be diluted by freshwater runoff. Estuarine subtidal waters are permanently inundated and can support submergent (below water) plant species. A variety of species rely on the Estuarine Subtidal (Deepwater Aquatic) habitat in the Project area for protective cover, water, food, and habitat for reproduction and nesting. In the outer harbor, marine mammals, such as harbor seals and California sea lions, rest on buoys and breakwaters.

The potential natural and beneficial values, as they specifically relate to the wetlands and waters within the BSA, are further discussed in the following sub-sections.

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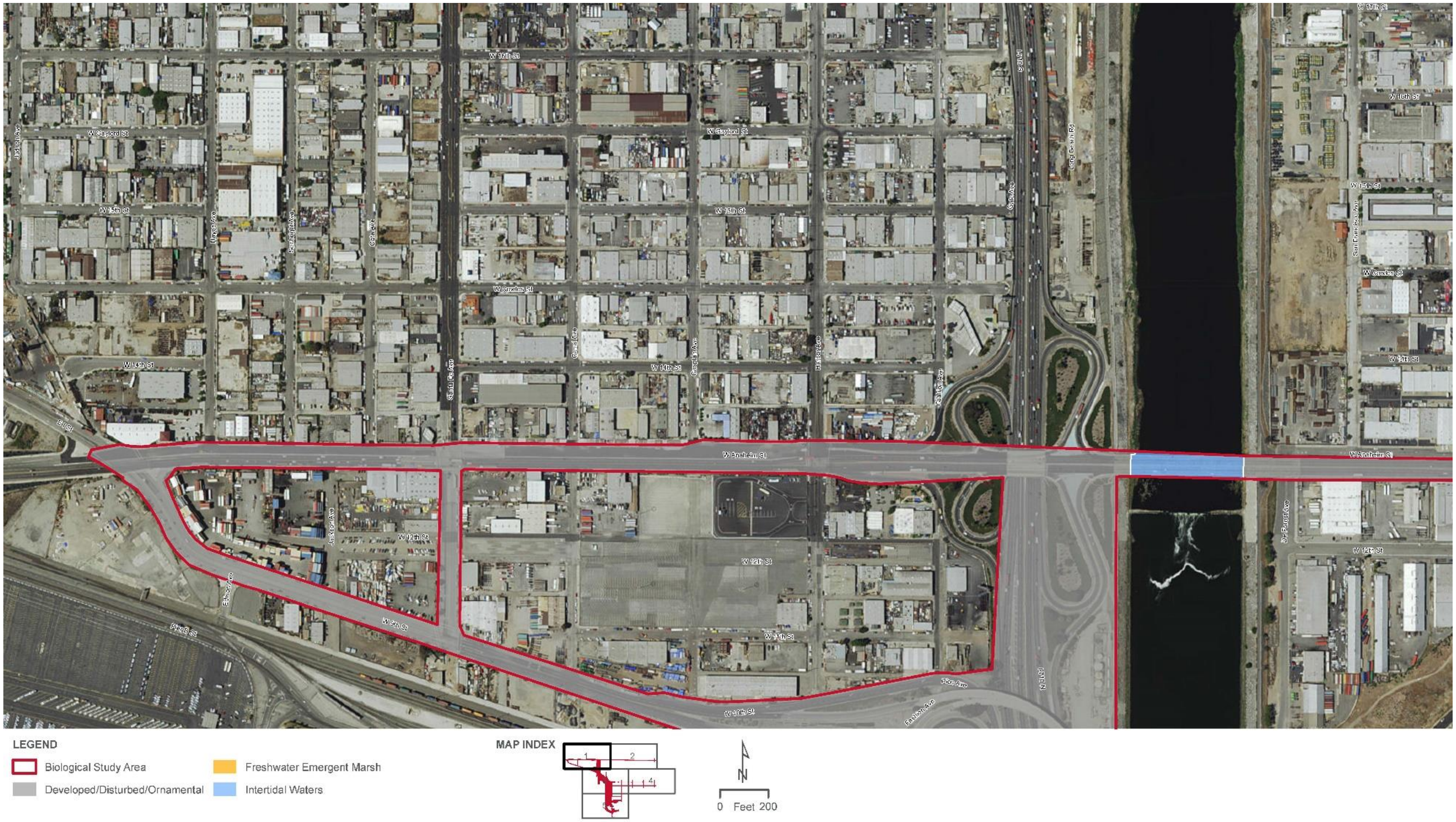

Figure 2-4. Biological Resources in BSA (Sheet 1 of 5)

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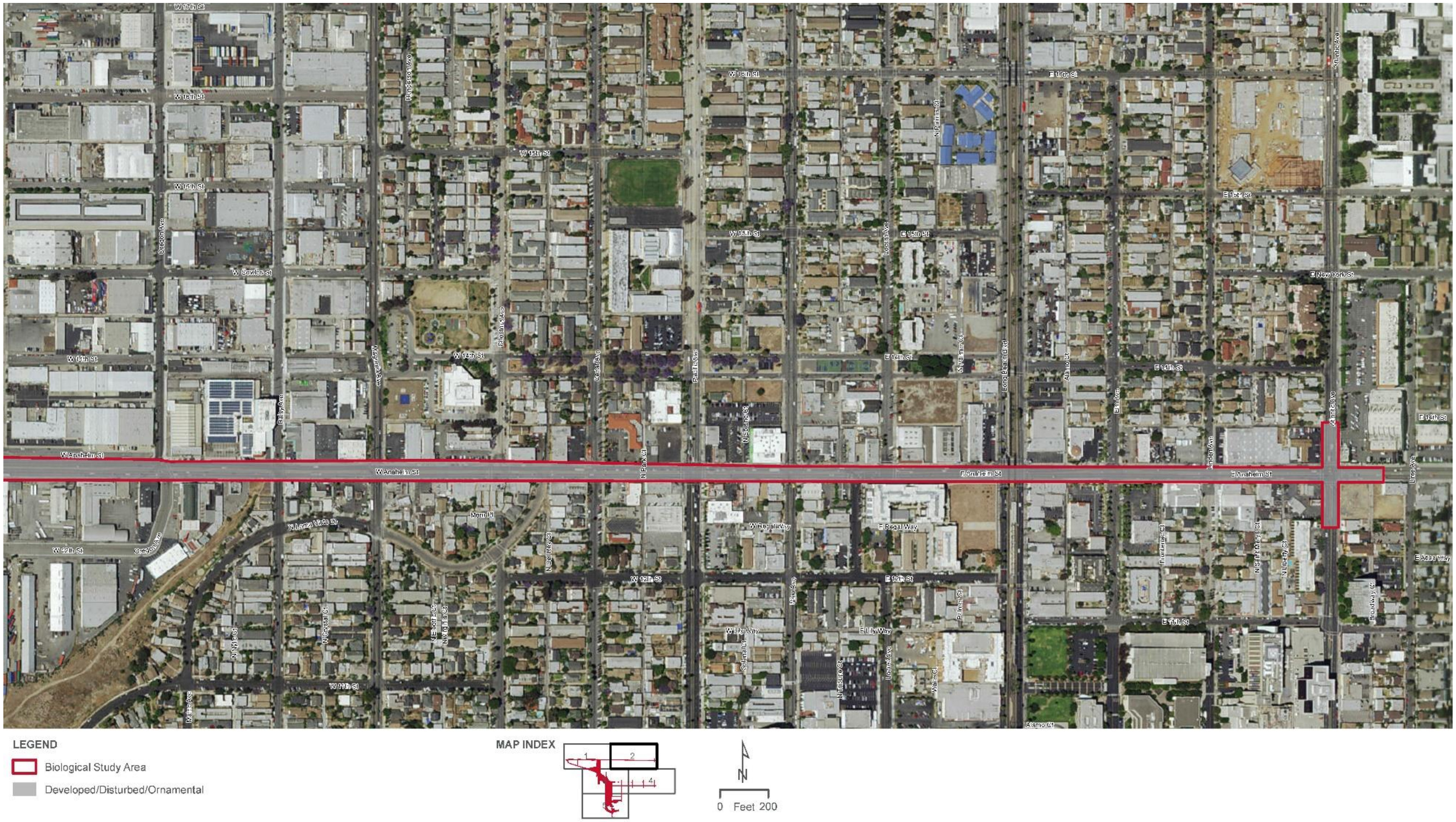

Figure 2-4. Biological Resources in BSA (Sheet 2 of 5)

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Figure 2-4. Biological Resources in BSA (Sheet 3 of 5)

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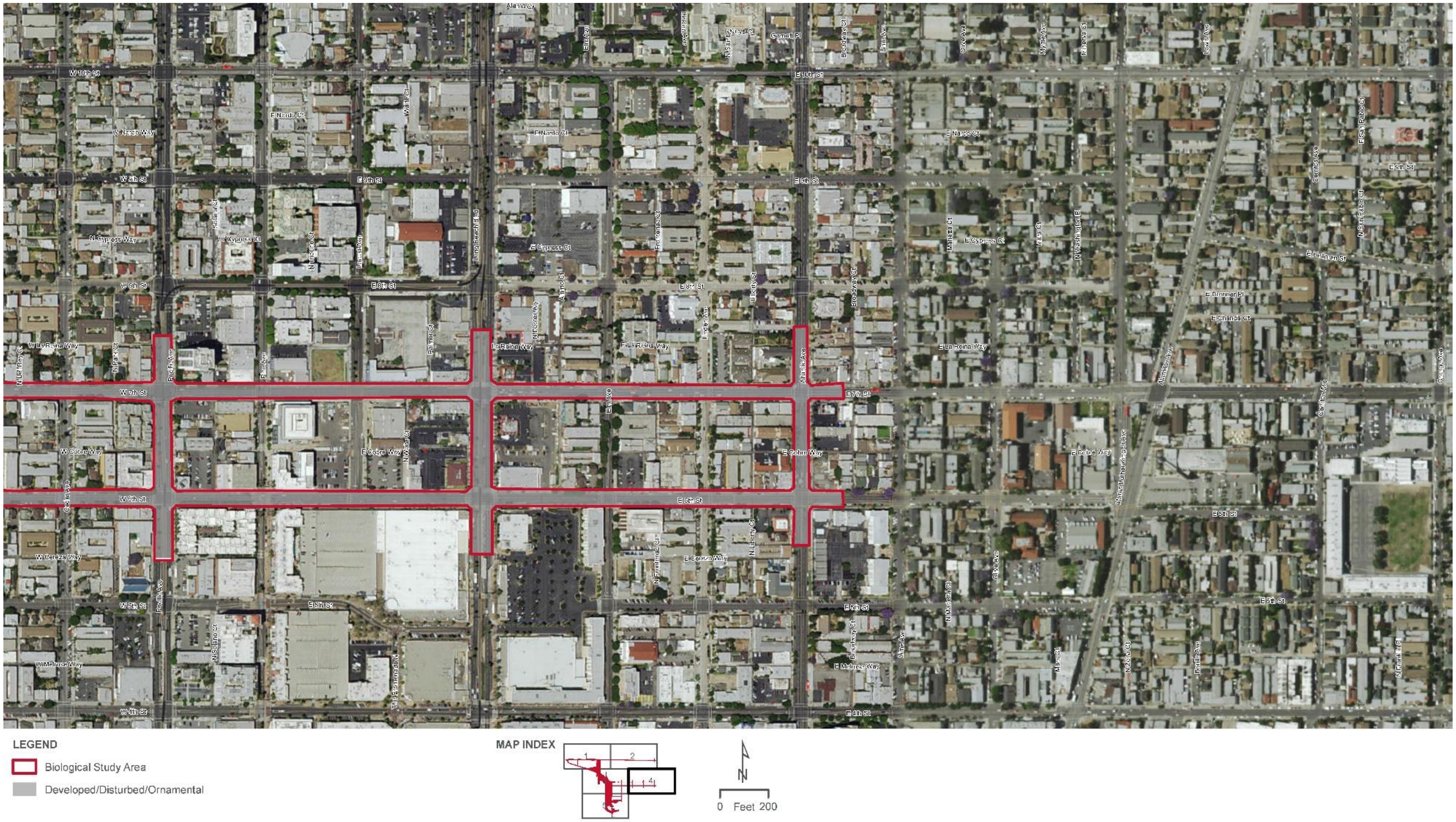

Figure 2-4. Biological Resources in BSA (Sheet 4 of 5)

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Figure 2-4. Biological Resources in BSA (Sheet 5 of 5)

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2.2.1 Fish

The LA River contains deep water and drains into the Pacific Ocean, approximately two miles south of the project area. Therefore, there is potential for fish passage in the LA River channel. The lower reaches of the LA River and the portion of the Project area in Queensway Bay are designated Essential Fish Habitat (EFH) for Coastal Pelagic Species (northern anchovy, pacific sardine, pacific (chub) mackerel, jack mackerel, and krill), and Pacific Coast Groundfish species by the National Marine Fisheries Service Habitat Division (NMFS) (NOAA, 2015). EFH is defined as habitat that includes waters and substrate necessary for fish to spawn, breed, feed, or grow to maturity (NOAA, n.d.). The Project area is only expected to support northern anchovy and Pacific sardine, and the majority of these populations are located south of the Project area in Queensway and San Pedro Bays.

2.2.2 Wildlife

A total of 31 special-status wildlife species have the potential to occur within the BSA. However, only five special-status wildlife species have the potential to utilize the Project area, they are: California least tern, California sea lion, western mastiff bat, pocketed free-tailed bat, and big free-tailed bat. Of these species, only the California least tern and California sea lion utilize aquatic habitat.

2.2.2.1 California Least Tern

The California least tern is a federally endangered colonial breeder that nests along the coast from San Francisco Bay to Baja California. California least terns nest colonially at Terminal Island in the Port of Los Angeles. Foraging birds regularly visit the LA River mouth below the Queensway Bridge and occasionally upstream. Least terns are rare away from the estuarine portions of the LA River, but have been recorded north to Interstate 5 (I-5) and off-channel ponds east of the LA River north of I-5. Least terns are typically present within the BSA from the first week of April to the first week of September. This species was not observed during surveys in the I-710 Corridor Study Area in 2009 and in the BSA in 2011.

2.2.2.2 California Sea Lion

The California sea lion is not a federally listed species or California species of special concern; however, it is protected under the Marine Mammal Protection Act (MMPA) and therefore is addressed in regard to potential harassment from the proposed Project. No other species protected under the MMPA are expected to occur in the BSA. The California sea lion is occasionally found in and adjacent to the BSA in the lower reaches of the LA River, primarily south of Ocean Boulevard. Individuals occasionally stray upstream as far north as Willow Street (e.g., one was seen during surveys for the I-710 Corridor Project north of Pacific Coast Highway on September 4, 2009). However, the generally shallow depth and the lack of suitable sites sea lions can used to haul themselves out of the water (e.g., low-lying docks, piers, platforms, or sandy shoreline beaches) limit their occurrence in the BSA. These “haul-out” sites are necessary for seals for mating and giving birth, but not all haul-out sites are for reproduction. Other benefits of haul-out sites may include predator avoidance, thermal regulation, social activity, parasite reduction, and rest.

2.2.2.3 Bat Species of Interest

Special-status bat species with the potential to occur in the BSA include western mastiff bat, pocketed free-tailed bat, and big free-tailed bat. A bat habitat suitability assessment was conducted in 2009 for the I-710 Corridor Project. It was determined at that time, that there is a low probability of bats utilizing the Shoemaker Bridge for day and/or night-roosting. Night surveys were not conducted at locations with low potential for bat roosting, including Shoemaker Bridge. However, none of the species listed above was observed in the I-710 Corridor Study Area during the 2009 surveys.

2.2.3 Plants

The southern tarplant is the only special-status plant species that has marginally suitable habitat within the BSA and is discussed below.

2.2.3.1 Southern Tarplant

Southern tarplant occurs in seasonally wet saline or alkaline soils of the Southern California coast. This native is an annual herb that is often found in areas where competition from other plants is limited by alkalinity, seasonal soil saturation, or the impacts of human disturbance. It is typically found in grassland and disturbed areas near marshy edges up to 1,400 feet above mean sea level in elevation. Southern tarplant tolerates disturbed conditions within or adjacent to an urban environment. Because southern tarplant is not federally and/or State-listed endangered, threatened, candidate, or fully protected species, or protected by any local or regional regulation, it is afforded no legal protection.

Southern tarplant is listed as a California Native Plant Society (CNPS) List 1B species. The BSA was not considered to support suitable southern tarplant habitat during 2009 focused surveys conducted as part of the I-710 Corridor Project. However, it was noted during the January 21, 2011 site visit that conditions within the BSA had changed and a small portion of the project site supported wheel ruts that may pond during rain events. This type of habitat may be suitable for southern tarplant. As a result, a focused survey was conducted on August 11, 2011, during the blooming period for southern tarplant (May–November). No southern tarplants were observed in the BSA. During the July 2016 site visit it was evident that the suitable habitat are had been recently mowed and no vegetation occurred in these areas. While southern tarplant tolerates disturbed conditions within or adjacent to an urban environment, the fact that the marginally suitable habitat for this species within the BSA is regularly maintained by weed removal indicates that even if this species was to occur in the BSA, the population would not be considered sustainable.

2.2.4 Open Space

The area within the Project limits does not contain any designated Open Space areas, per the City's General Plan Land Use Map (City of Long Beach, 2012).

2.2.5 Natural Beauty

2.2.5.1 Stream and Riparian Habitats

In the Project area, the LA River channel has riprap sides. The hard substrate provides rocky intertidal habitat for macroinvertebrates and sessile marine animals and plants, which provide food sources for fishes and birds. The portion of the LA River channel in the Project area also has a natural bottom that shifts perennially because of tidal influences. The channel bottom likely consists of mud and silt and supports benthic invertebrate species. The deep water in the LA River channel in the Project area contains deep water that does not support emergent vegetation (plants that grow in wetlands). The area in the Project limits contains a small Freshwater Emergent Marsh, on the south side of the LA River, which supports habitat for fish and wildlife species.

2.2.5.2 Wetlands

As defined in 33 CFR 328.3(b), wetlands are "areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support… a prevalence of vegetation typically adapted for life in saturate soil conditions." The Project area contains less than 0.01 acre of Freshwater Emergent Marsh, which is a wetland habitat. The Freshwater Emergent Marsh is located along the south side of the LA River in the Project area. This community consists of accumulated sediment along the top of the riprap banks, which is dominated by California Bulrush (*Schoenoplectus Californicus*). Freshwater Emergent Marsh provides productive habitat for a variety of aquatic and terrestrial life.

2.2.6 Outdoor Recreation

According to the Community Impact Assessment (HDR, 2018), existing parks and recreational areas located in the Project area include Cesar E. Chavez Park, Los Angeles and Rio Hondo (LARIO) Trail, Golden Shore RV Park, and Santa Cruz Park. The Long Beach Municipal Urban Stormwater Treatment (LB MUST) Facility, a planned stormwater treatment project that includes pedestrian and bicycle trails, is also located within the Project area. These park and recreational resources do not include aquatic habitat.

- **Cesar E. Chavez Park, 401 Golden Avenue:** Cesar E. Chavez Park is approximately 33 acres in size and features basketball courts, a community center, a playground, a weight room, restrooms, and picnic areas. The park also includes a teen and senior center.
- **LARIO Trail:** The LARIO Trail is a Class 1 bike way that extends north-south for 29.1 miles along the east bank of the LA River and through the Downtown marina. The path connects to the shoreline pedestrian/bicycle path.
- **Golden Shore RV Park, 101 Golden Avenue:** Golden Shore RV Park is approximately 5.16 acres in size. It features 77 spaces with full hook-ups, 30/50 amplifier services, large picnic areas with tables, a pool and spa, a recreation/club room with a small kitchen facility, video games, a sand volleyball court, horseshoes, shuffleboard, a children's playground, hot showers, a laundry room, a convenience store, barbecue pits, a phone hook-up, and restrooms.
- **Santa Cruz Park, Cedar Avenue to Golden Avenue:** This park is 1.9 acres in size. Amenities include a green space, as well as park benches.
- **LB MUST Facility:** The LB MUST Facility is a planned capital improvement project to treat stormwater runoff, and is intended to improve water quality associated with urban runoff in the Project vicinity, which ultimately flows into the LA River. The LB MUST Facility will be located along the east bank of the LA River, immediately north of the existing Shoemaker Bridge. The project would be integrated with the Drake/Chavez Park Master Plan improvements by providing pedestrian and bicycle access to the LA River and coastal post detention basins. These detention basins would be located just south of the existing bridge, and would surround the eastern terminus support structure of the proposed Shoemaker Bridge. The LB MUST project is slated to be completed prior to the Shoemaker Bridge Replacement Project. Construction is tentatively scheduled for 2018 with a completion year of 2021.

2.2.7 Agriculture

No agricultural resources exist within the Project limits.

2.2.8 Forestry

No forestry resources exist within the Project limits.

2.2.9 Natural Moderation of Floods

The FEMA Flood Insurance Rate Map (FIRM) for Los Angeles County (Map Numbers 06037C1964F, 06037C1962F, and 06037C1965F) indicates that the Project limits is in the following flood zones (see Figure 2-5 and Appendix A):

- Zone A: This zone is defined as a special flood hazard area subject to inundation by the 1% annual chance flood and no base flood elevations were determined. The portion of the Project limits that includes the bridge, the LA River, and the area to the west of the LA River is in Zone A.
- Zone AH: This zone is defined as a special flood hazard area and subject to inundation by the 1% annual chance flood and includes flood depths of 1 to 3 feet. Base flood elevations are determined. The northeastern portion of the Project limits along Anaheim Street to the west of the LA River is in Zone AH.
- Shaded Zone X: This zoned is defined as an area of 0.2% annual chance flood, an area of 1% annual chance flood with average depths of less than 1 foot or with a drainage area less than 1 square mile; and an area protected by levees from 1% annual chance flood. The central portion of the Project limits directly east and west of the LA River is in Shaded Zone X.
- Zone X: This zone is defined as an area determined to be outside the 0.2% annual chance floodplain. The eastern portion of the Project limits is in Zone X.

In addition, although Zone AE is not located within the Project limits, it is located in close proximity to the Project limits. Zone AE is defined below.

- Zone AE: This zone is defined as a special flood hazard area subject to inundation by the 1% annual chance flood with a base flood elevation of 10 feet. Zone AE is located southwest of the bridge and within a portion of the LA River, south of Ocean Boulevard.

According to the FEMA FIRM, the portion of the Project limits that includes the bridge and the LA River, the area to the west of the LA River, and the area along Anaheim Street to the east of the LA River are in Zone A or Zone AH, which are defined as areas within the 100-year floodplain. A separate flood prevention project being proposed by the City is the Long Beach Municipal Urban Stormwater Treatment (LB MUST) Facility, would accommodate stormwater flows from the northern portion of the Project area above West Broadway. The LB MUST facility includes facilities intended to improve water quality associated with urban runoff that ultimately flows into the LA River.

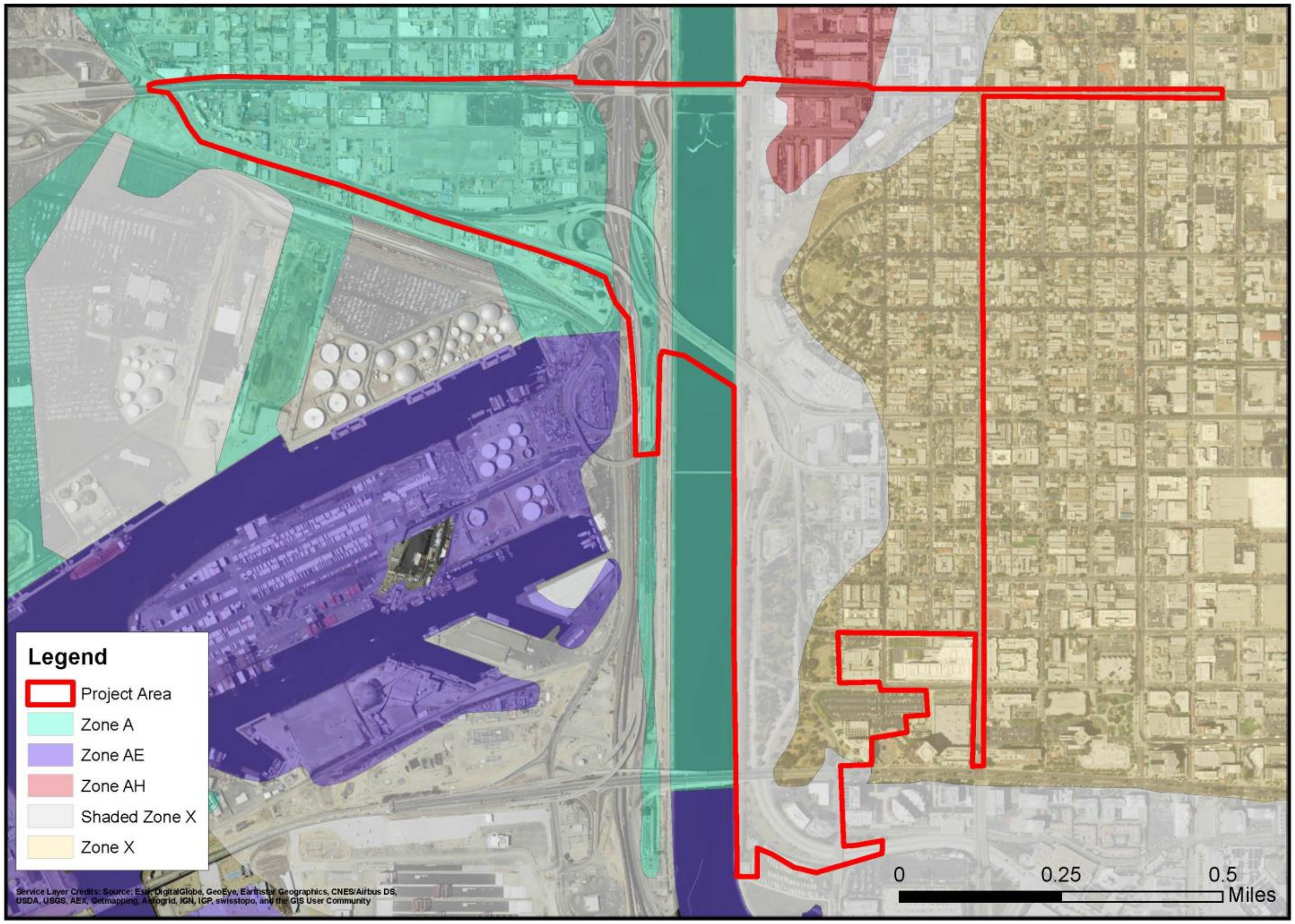

Figure 2-5. Designated Flood Zones

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2.2.10 Water Quality Maintenance

During construction, the total disturbed soil area would be approximately 39.52 acres of soil area under the Roundabout Design Option and 39.49 acres of soil area under the "Y" Intersection Design Option. Accidental discharge of waste products, trash left at the construction site, and petroleum hydrocarbons that have spilled in the construction area could be sources of oil, grease, and chemical pollutants that can have a detrimental effect on water quality. However, the Project will be required to comply with the NPDES Construction General Permit (NPDES No. CAS000002, SWRCB Order No. 2009-0009-DWQ, adopted on November 16, 2010 and amended by Order No. 2010-0014-DWQ and Order No. 2012-0006-DWQ). The permit requires preparation of a Stormwater Pollution Prevention Plan (SWPPP) and implementation of construction Best Management Practices (BMP). The SWPPP would be prepared prior to construction and would be implemented to prevent pollutants from entering the LA River. Therefore, no substantial changes to the levels of oil, grease, and chemical pollutants are anticipated.

During operation, oil, grease, and chemical pollutants could be discharged into the LA River in stormwater runoff as a result of incidental drippings from vehicles, and accidental spills during maintenance activities, such as bridge painting and surface treatments. The Project would result in a net decrease in impervious surface area under each alternative and design option, as shown in Table 2-2, which could result in a decrease in surface runoff. In addition, the Project would be designed to allow surface runoff to flow directly into the nearest stormwater channel, where it would be conveyed to a detention basin or the LB MUST Facility. The Project also includes modifications that would not increase the capacity of the bridge or roadways (e.g., additional street lighting, re-striping, turn lanes, bicycle, pedestrian, and streetscape improvements). In addition, ongoing maintenance to remove excess grease and other chemical pollutants would be implemented to prevent these pollutants from entering the LA River. Therefore, no substantial changes to the levels of oil, grease, and chemical pollutants are anticipated during Project operation.

Table 2-2. Changes in Impervious Surfaces in the Project Area

	New Impervious Area (acres)	Existing Impervious Area to be Removed (acres)	Net New Impervious Area (NNI) (acres)
Alternative 2			
Design Option A (Roundabout)	6.81	15.46	-8.65
Design Option B ("Y" Intersection)	6.23	16.04	-9.81
Alternative 3			
Design Option A (Roundabout)	6.81	15.96	-9.15
Design Option B ("Y" Intersection)	6.23	16.54	-10.31

Source: HDR, Inc., 2018e

2.2.11 Groundwater Recharge

The Project area is located in the South Coast Hydrologic Region (HR), which is bordered near the Ventura-Santa Barbara County line to the west, the Transverse Ranges to the north, the San Jacinto Mountains and Peninsular Ranges to the east, and the Mexico border to the south (California Department of Water Resources, 2003). The South Coast HR is primarily composed of Orange, San Diego, and Los Angeles Counties, but also extends into parts of Riverside, San Bernardino, Ventura, Kern, and Santa Barbara Counties. There are 56 groundwater basins in the South Coast HR, and the project area is located in the Coastal Plain of Los Angeles groundwater basin. The Coastal Plain of Los Angeles is further divided into subbasins, including the Central Subbasin and West Coast Subbasin, which supply groundwater to the City. Though the project area is underlain by the West Coast Subbasin, the Central Subbasin supplements the groundwater supply in the West Coast Subbasin.

The West Coast Subbasin, bordered on the east by the Central Subbasin, encompasses approximately 140 square miles (California Department of Water Resources, 2004b). The subbasin is bounded on the north by the Baldwin Hills and the Ballona Escarpment (a bluff just south of the Ballona Creek), on the east by the Newport-Inglewood fault zone, on the south by San Pedro Bay and the Palos Verdes Hills, and on the west by Santa Monica Bay. Water recharge of the aquifers in the West Coast Subbasin comes from adjacent groundwater subbasins, including the Central Subbasin, as well as saltwater intrusion from the Pacific Ocean (California Department of Water Resources, 2004b).

Encompassing approximately 270 square miles, the Central Basin is bounded on the north by the La Brea high, the northeast by the Elysian, Repetto, Merced, and Puente Hills, on the east near the Los Angeles County/Orange County line, and on the southwest by the Newport-Inglewood fault system (California Department of Water Resources, 2004a). The Central Subbasin is divided into four divisions, which include the Los Angeles Forebay, the Montebello Forebay, the Whittier Area, and the Pressure Area. The Angeles and Montebello Forebays are water table aquifers that allow surface water to seep into the deeper aquifers to replenish the subbasins. The Whittier Area and Pressure Area are confined aquifer systems that are primarily recharged from the up-gradient forebay areas and adjacent groundwater subbasins (California Department of Water Resources, 2004a). The LA and San Gabriel Rivers flow over the Central Subbasin before emptying into the Pacific Ocean.

2.3 Watershed Characteristics and Beneficial Uses

The Project is located in the Los Angeles River Watershed, and is under the authority of the Los Angeles RWQCB. Characteristics of the Los Angeles River are discussed below.

2.3.1.1 Los Angeles River Watershed

The Los Angeles River Watershed comprises approximately 834 square miles of land that is bordered by the Santa Monica Mountains to the west and south, Simi Hills and Santa Susana Mountains to the north and west, and San Gabriel Mountains to the north and east (Los Angeles Department of Public Works, n.d.). The land use in the watershed is roughly 44 percent open space, which includes the area near the headwaters in the mountains. The remaining 56 percent of the watershed is highly developed with residential, commercial and industrial land uses. Urban runoff and illegal dumping are major contributors to impaired water quality in the watershed (Los Angeles Regional Water Quality Control Board, 1994).

According to the State Water Resources Control Board (SWRCB), other waterbodies adjacent to or near the project area include Dominguez Channel Estuary (unlined portion below Vermont Ave), Los Angeles River Reach 1 (Estuary to Carson Street), Los Angeles River Estuary (Queensway Bay), Los Angeles/Long Beach Inner Harbor, Long Beach City Beach, San Pedro Bay Near/Off Shore

Zones, Los Angeles Harbor – Consolidated Slip, and San Pedro Bay Near/Off Shore Zones. All of these waterbodies are listed as impaired waterbodies in the 2012 Integrated Report (Clean Water Act 303(d) List/305(b) Report). There is a combined total of 44 different 303(d) listed pollutants for these waterbodies. Beneficial uses for these waterbodies are listed in Table 2-3 below.

Table 2-3. Beneficial Uses for Waterbodies

Surface Water Feature	Existing Beneficial Uses	Potential Beneficial Uses
Dominguez Channel Estuary (unlined portion below Vermont Avenue)	Commercial and Sport Fishing Estuarine Habitat Marine Habitat Wildlife Habitat Preservation of Rare and Endangered Species Fish Migration Fish Spawning	Navigation
Los Angeles River Reach 1 (Estuary to Carson Street)	Groundwater Recharge Warm Freshwater Habitat Marine Habitat Wildlife Habitat Preservation of Rare and Endangered Species Fish Migration Fish Spawning Shellfish Harvesting	Municipal & Domestic Supply Industrial Service Supply Industrial Process Supply
Los Angeles River Estuary (Queensway Bay)	Industrial Service Supply Navigation Commercial and Sport Fishing Estuarine Habitat Marine Habitat Wildlife Habitat Preservation of Rare and Endangered Species Fish Migration Fish Spawning	Shellfish Harvesting
Los Angeles/Long Beach Inner Harbor	Industrial Service Supply Navigation Commercial and Sport Fishing Marine Habitat Rare, Threatened, or Endangered Species Wetlands	Shellfish Harvesting

Long Beach City Beach	Navigation Commercial and Sport Fishing Marine Habitat Preservation of Rare and Endangered Species	Fish Spawning
San Pedro Bay Near/Off Shore Zones	No information provided in the RWQCB Basin Plan	
Los Angeles Harbor – Consolidated Slip		

Source: Los Angeles RWQCB, 1994

2.4 Support of Incompatible Floodplain Development

As previously discussed, the Project area is located within a 100-year floodplain; however, no Project elements would constitute incompatible floodplain development. The hydraulic analysis (see Section 3) demonstrates that the proposed bridge replacement has sufficient horizontal and vertical clearances to not cause any significant backwater upstream of the bridge. The proposed bridge replacement will have a minimal impact on floodplains with a maximum increase in water surface elevation of 2 inches, which would not increase the floodplain extents since the existing levee walls are high enough to contain all flows within the flood control channel. No mitigation measures are required. Project design features and implementation of construction Best Management Practices would minimize any direct and indirect water quality impacts. The Project would not support probable incompatible floodplain development.

3 Hydraulic Analysis

3.1 Introduction

The Shoemaker Bridge (West Shoreline Drive) is located in the Los Angeles River tidal prism/estuary south of Compton Creek, which begins in Long Beach at Willow Street and runs approximately three miles before joining with Queensway Bay between the Port of Long Beach and the City of Long Beach. The channel has a soft bottom in this reach with concrete-lined or rock riprap sides. Queensway Bay is heavily water recreation-oriented; however, major pollutant inputs are likely more related to flows from the Los Angeles River which carries the largest storm flow of any river in southern California.

3.2 Hydraulic Analysis

A hydraulic analysis is required by Caltrans for all structures in, over, and adjacent to streams and waterways which may affect the design or construction of structures. This engineering analysis is necessary to evaluate appropriate design flood, maximum water surface elevations, backwater, freeboard, maximum flow velocities, scour depths, and floodplain impacts.

The hydraulic analysis for the Los Angeles River channel was performed using the U.S. Army Corps of Engineers (USACE) HEC-RAS model version 5.0.3 (Figure 3-1). This model was developed by the USACE – Los Angeles District in 2004 to support regulatory activity in the lower reach of the river; therefore, no changes were made here to the model geometry and modeling parameters that were outside of the project reach.

The USACE, Los Angeles District completed a hydrologic analysis for the entire Los Angeles River watershed as part of the Los Angeles County Drainage Area (LACDA) Feasibility Study (USACE, 1991) (see Appendix B). The proposed Shoemaker Bridge is located downstream of the confluence with Compton Creek, identified as control point (CP) 28 in the USACE (1991) hydrologic report (Part 1, Table 4), with a contributing drainage area of 808 square miles. The USACE recommended 133-year design channel flow at the project location is 182,000 cubic feet per second (cfs). The record flood on the Los Angeles River at Long Beach is 99,000 cfs (occurred in 1938), which is approximately on the order of a 15-year recurrence interval. Based on the discharge-frequency and channel capacity information from the USACE hydrologic report (Part 2, Table 7), the following hydrologic inputs at the project location (within the intertidal estuary) were used in this study (see Table 3-1).

Table 3-1. Los Angeles River Hydrologic Summary (from USACE, 1991)

Frequency (years)	Design Flood Q_D	Q_{100}	Q_{50}	Flood of Record
	133	100	50	15
Discharge (cubic feet per second)	182,000	174,000	144,000	99,000

It should be noted that the 100-year flood (Q_{100} = 174,000 cfs) listed in Table 3-1 is larger than the FEMA Base Flood (Q_{100} = 142,000 cfs at Compton Creek) based on the USACE hydrologic report developed for the National Economic Development (NED) levee design alternatives. The USACE 100-year flood was referenced here as being more conservative, but neither Q_{100} was used in this study for the hydraulic design of the bridge (selected design flood has a 133-year recurrence interval).

The hydraulic analysis for the 133-year design flow of Q_D = 182,000 cubic feet per second (cfs) was performed using mixed flow run since the Los Angeles River channel is predominantly concrete lined. However, the lower reach of the river has a soft bottom in subcritical regime (due to flat slope under tidal influence) and a solution below critical depth (with supercritical velocities) is not likely to be sustained due to sediment entrainment; therefore, maximum depths near Shoemaker Bridge remain above critical value and were predicted based on that assumption. The summary of hydraulic parameters used in the project reach is provided below.

Design flow = 182,000 cfs (133-year design flood per USACE NED plan)

Channel slope = 0.000 (sediment deposit with flat bottom within estuary)

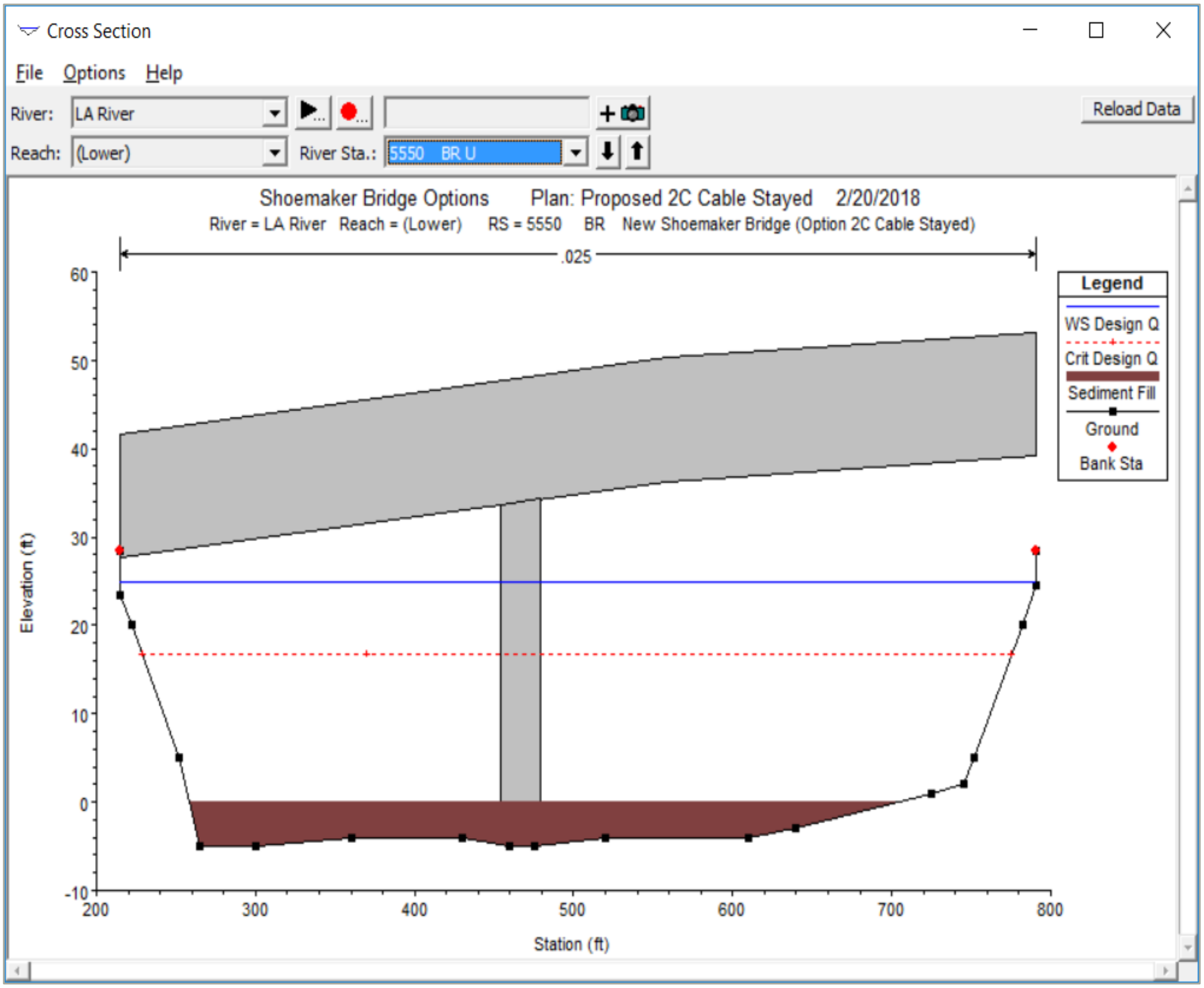
Channel friction = 0.025

The Manning's roughness coefficient within the channel was specified by USACE at 0.025 based on a clean channel with sandy deposition. The existing amount of sediment deposition (~ 5 feet) from the USACE authorized project was also assumed for proposed conditions in this lower (tidally influenced) reach of the Los Angeles River.

Structure information (deck and pier) was manually coded into the HEC-RAS model (Figure 3-2) based on the proposed cable-stayed design with a 25 feet wide tower (pier) in the center of the river, approximately 220 feet south (downstream) of the existing bridge, at the Los Angeles River Station (RS) 55+00. The Yarnell coefficient for the pier was set at 0.9 assuming semi-circular nose and tail.

Figure 3-1. Los Angeles River HEC-RAS Model Schematic

Figure 3-2. HEC-RAS Proposed Bridge Schematic (Looking Downstream)



3.3 Results of Hydraulic Analysis

The HEC-RAS proposed model results, including cross sections, floodplain isometric view, and tabular data reports, are provided in Appendix C. The Location Hydraulic Study Form and Floodplain Evaluation Report Summary are provided in Appendix D. Table 3-2 and Table 3-3 summarize the computed water surface elevations (WSE) for existing and proposed conditions, the variances in water surface elevations (ΔWSE), and levee freeboards between WSE and top of parapet walls (parapet walls extend 4 feet above the levees) for Build Alternatives 2 and 3, respectively.

The Federal Emergency Management Agency (FEMA) National Flood Insurance Program (NFIP) regulations and Standard SID 69 and 70 states that “floodway surcharge values must be between zero and 1.0 ft.” (FEMA, 2016). As indicated by the hydraulic results in Table 3-2 and Table 3-3 for Build Alternatives 2 and 3, respectively, the water surface elevation is expected to increase by a maximum of 0.14 feet (less than 2 inches) under both build alternatives, which meets FEMA NFIP regulations and Standard SID 69 and 70.

3.3.1 Build Alternative 2

Based on top of levee/wall elevations in Table 3-2, the 133-year design flow (and all flows of lower magnitude) for Build Alternative 2 is completely contained within the Los Angeles River channel, between the east and west vertical parapet walls. The levee freeboard is predominantly above 2.5 feet, as required by USACE for trapezoidal riprap channels (USACE, 1994). Two locations with less than a minimum freeboard (Sta. 58+70 and 62+00) will be improved in the next design phase by repurposing of the existing bridge (some of the existing bridge piers will be removed to increase the flow conveyance at Sta. 58+70 and farther upstream, which will provide more freeboard).

In addition, as shown in Table 3-2, the increase in ∆WSE for Build Alternative 2 extends about 2 miles upstream of the proposed bridge to Sta. 168+00 (due to a flat slope of the channel), but is not causing significant backwater. The floodplain width remains unchanged within the parapet walls of the flood control channel. The increase in ∆WSE is between 0 to 0.14 feet, and is therefore within the FEMA NFIP regulations and Standard SID 69 and 70.

Table 3-2. Hydraulic Results for Proposed Shoemaker Bridge (Build Alternative 2)

Stationing	STA 56+47	STA 58+70	STA 62+00	STA 75+00	STA 92+00	STA 125+00	STA 162+75	STA 168+00
Water Surface Elevation (WSE) for Existing Conditions (feet)	25.19	26.03	26.27	26.96	28.52	31.10	34.41	30.23
Water Surface Elevation (WSE) for Proposed Conditions (feet)	25.33	26.15	26.38	27.05	28.60	31.15	34.44	30.23
∆WSE (feet)	0.14	0.12	0.11	0.09	0.08	0.05	0.03	0.00
Top of Levee/Wall Elevation* (feet)	28.40	28.63	28.20	30.03	31.17	34.18	38.27	39.27
Levee Freeboard (feet)	3.07	2.48	1.82	2.98	2.57	3.03	3.83	9.04

* Minimum top of levee/parapet wall for east and west sides

3.3.2 Build Alternative 3

Based on top of levee/wall elevations in Table 3-3, the 133-year design flow (and all flows of lower magnitude) for Built Alternative 3 is completely contained within the Los Angeles River channel, between the east and west vertical parapet walls. The levee freeboard is above 2.5 feet, as required by USACE for trapezoidal riprap channels (USACE, 1994).

As shown in Table 3-3, the ∆WSE for Build Alternative 3 decreases from Sta. 58+70 to Sta. 162+75 by a maximum of -0.68 feet at Sta. 58+70 and a minimum of -0.12 at Sta. 162+75, and thus will not cause backwater. The ∆WSE increase at Sta. 56+47 is within the FEMA NFIP regulations and Standard SID 69 and 71. The floodplain width remains unchanged within the parapet walls of the flood control channel.

Table 3-3. Hydraulic Results for Proposed Shoemaker Bridge (Build Alternative 3)

Stationing	STA 56+47	STA 58+70	STA 62+00	STA 75+00	STA 92+00	STA 125+00	STA 162+75	STA 168+00
Water Surface Elevation (WSE) for Existing Conditions (feet)	25.19	26.03	26.27	26.96	28.52	31.10	34.41	30.23
Water Surface Elevation (WSE) for Proposed Conditions (feet)	25.33	25.35	25.62	26.39	28.10	30.83	34.29	30.23
∆WSE (feet)	0.14	-0.68	-0.65	-0.57	-0.42	-0.27	-0.12	0.00
Top of Levee/Wall Elevation* (feet)	28.40	28.63	28.20	30.03	31.17	34.18	38.27	39.27
Levee Freeboard (feet)	3.07	3.28	2.58	3.64	3.07	3.35	3.98	9.04

* Minimum top of levee/parapet wall for east and west sides

4 Risks and Impacts

4.1 Potential Risk from Longitudinal Encroachment

The proposed bridge replacement under Build Alternatives 2 and 3 will have a minimal impact on floodplains with a maximum increase in water surface elevation of 2 inches, which would not increase the floodplain extents since the existing levee walls are high enough to contain all flows within the flood control channel. In addition, the increase in surface water elevation under both Build Alternatives 2 and 3 would meet FEMA NFIP regulations and Standard SID 69 and 70. As such, the proposed Project would not pose additional risk from Longitudinal Encroachment.

4.2 Potential Risk to Life and Property

The existing and proposed inundation area is completely contained within the flood control channel and does not encroach into adjacent properties. The proposed bridge replacement under Build Alternatives 2 and 3 will have a minimal impact on floodplains with a maximum increase in water surface elevation of 2 inches, which would not increase the floodplain extents since the existing levee walls are high enough to contain all flows within the flood control channel. In addition, the increase in surface water elevation under both Build Alternatives 2 and 3 would meet FEMA NFIP regulations and Standard SID 69 and 70. The minimal change in WSE would not have any risk to life and property, and no interruption or termination of emergency service or emergency routes is anticipated.

4.3 Potential Risk to Natural and Beneficial Floodplain Values

Natural and beneficial floodplain values include, but are not limited to, fish, wildlife, plants, open space, natural beauty, scientific study, outdoor recreation, agriculture, forestry, natural moderation of floods, water quality maintenance, and groundwater recharge. According to the NES (HDR, 2018), the Project area has the potential to support fish, wildlife, and plants. Measures to minimize impacts to these biological resources is provided in Section 4.6.

The Los Angeles River in the project reach is a flood control channel in a developed urban area. The proposed Project would not result in any impact to floodplain values.

4.4 Potential Risk for Support of Incompatible Floodplain Development

The proposed bridge replacement under Build Alternatives 2 and 3 will have a minimal impact on floodplains with a maximum increase in water surface elevation of 2 inches, which would not increase the floodplain extents since the existing levee walls are high enough to contain all flows within the flood control channel. In addition, the increase in surface water elevation under both Build Alternatives 2 and 3 would meet FEMA NFIP regulations and Standard SID 69 and 70. The Project would not support probable incompatible floodplain development

4.5 Measures to Minimize Floodplain Impacts

There will not be any floodplain impacts associated with this Project (see Section 3 for results of hydraulic analysis). The maximum increase in water surface elevation is 2 inches under both Build Alternatives 2 and 3. No avoidance, minimization, and mitigation measures are required.

4.6 Measures to Restore/Preserve Natural and Beneficial Floodplain Values Impacted by the Project

4.6.1 Fish

The proposed Project would result in direct permanent and temporary impacts to Estuarine Subtidal (Deepwater Aquatic) habitat through the construction and placement of support structures for the proposed new Shoemaker Bridge (see Table 4-1). The deepwater aquatic habitat in the BSA falls under the regulatory jurisdiction of the USACE pursuant to Section 10 of the Rivers and Harbors Act and Section 404 of the Clean Water Act. Compensatory mitigation for Project impacts to deepwater aquatic habitat may be required for compliance with Section 10 of the Rivers and Harbors Act and Section 404 of the Clean Water Act. In addition, this habitat is under the jurisdiction of the NMFS as it has been designated as EFH and is suitable habitat for the northern anchovy.

Table 4-1. Summary of Impacts to Deepwater Aquatic Habitat (acres)

	Alternative 2		**Alternative 3**	
Type of Impact	**Design Option A**	**Design Option B**	**Design Option A**	**Design Option B**
Temporary	7.53	7.56	7.53	7.56
Permanent Decrease in Habitat from New Bridge Construction	0.54	0.51	0.54	0.51
Permanent Increase in Habitat from Existing Bridge Demolition	0.07	0.07	0.07	0.07
Total Net Change in Deepwater Aquatic Habitat	0.47	0.44	0.44	0.57

Consultation with the NMFS regarding impacts to EFH is necessary for potential impacts to species that may be present in the BSA and downstream. At minimum, measures BIO-1 to BIO-13 would be incorporated to avoid and minimize temporary impacts to Estuarine Subtidal (Deepwater Aquatic) habitat during construction. BIO-14 would be implemented if compensatory mitigation for Project impacts to deepwater aquatic habitat is required.

BIO-1 California Department of Transportation (Caltrans) and the City of Long Beach (City) will designate a U.S. Fish and Wildlife Service/National Marine Fisheries Service (USFWS/NMFS) approved biologist (Project biologist) who shall be responsible for overseeing compliance with protective measures for the biological resources during clearing and work activities within and adjacent to Environmentally Sensitive Areas (ESAs) during construction. The Project biologist will be familiar with the protected habitats, plants, and wildlife. The Project biologist will also maintain communications with the contractor to ensure that issues relating to biological resources are appropriately and lawfully managed. The Project biologist will review final plans, designate areas that need temporary fencing (e.g., ESA fencing), and monitor construction.

BIO-2 Reporting requirements, frequency, and duration will be established during abbreviated consultation with U.S. Fish and Wildlife Service/National Marine Fisheries Service (USFWS/NMFS), if required. The City of Long Beach's (City) Resident Engineer shall ensure that a USFWS/NMFS approved biologist (Project biologist) will provide a final report to California Department of Transportation (Caltrans) prior to submittal to USFWS/NMFS documenting compliance with avoidance and minimization measures within 60 days of the completion of work.

BIO-3 The City of Long Beach's (City) Resident Engineer shall ensure that prior to clearing or construction, highly visible barriers (such as orange construction fencing) will be installed around sensitive habitats adjacent to the project footprint to designate Environmentally Sensitive Areas (ESAs) to be preserved. No grading or fill activity of any type will be permitted within these ESAs.

BIO-4 The City of Long Beach's (City) Resident Engineer shall ensure that heavy equipment, including motor vehicles, will not be allowed to operate within the Environmentally Sensitive Areas (ESAs). All construction equipment will be operated in a manner so as to prevent accidental damage to nearby preserved areas. All equipment maintenance, staging, and dispensing of fuel, oil, or any other such activities will occur in developed or designated nonsensitive upland habitat areas. The designated upland areas will be located in such a manner as to prevent the runoff from any spills from entering waters of the U.S.

BIO-5 The City of Long Beach's (City) Resident Engineer shall ensure that preconstruction surveys for the invasive seaweed (*Caulerpa taxifolia*) will be conducted by the National Marine Fisheries Service/California Department of Fish and Wildlife (NMFS/CDFW) Certified Field Surveyors prior to bottom-disturbing activities taking place in the Los Angeles River (LA River) to ensure that the Biological Study Area (BSA) is not infested with this nonnative invasive seaweed.

BIO-6 If invasive seaweed (*Caulerpa taxifolia*) is found within the Biological Study Area (BSA), the City of Long Beach's Resident Engineer shall ensure that a management plan will be prepared according to guidelines in the National Marine Fisheries Service (NMFS) Caulerpa Control Protocol, or other approved protocol, and submitted to U.S. Fish and Wildlife Service (USFWS) for approval prior to the start of construction. Construction activities will not begin prior to approval of this plan, if needed.

BIO-7 The City of Long Beach (City) shall ensure that an employee education program for all construction personnel will be developed and implemented by the biological monitor prior to construction. At a minimum, the program will include the following topics: (1) responsibilities of the biological monitor; (2) delineation and flagging of adjacent sensitive habitat; (3) limitations on all movement of those employed on site, including ingress and egress of equipment and personnel, to designated construction zones (personnel will not be allowed access to adjacent sensitive habitats); (4) on-site pet prohibitions; (5) use of trash containers for disposal and removal of trash; and (6) project features designed to reduce the impacts to listed species and habitat and promote continued successful occupation of adjacent habitat areas.

BIO-8 The City of Long Beach's (City) Resident Engineer shall ensure that project construction will be carried out under standard best management practices (BMP) (e.g., no staging or vehicle repair in sensitive areas, implementation of erosion control measures, and fuel spill cleanup). The City's Resident Engineer or designated contractor shall ensure that during project construction, the proper use and disposal of oil, gasoline, diesel fuel, antifreeze, lead paint, and other toxic substances will be enforced and that construction materials, equipment, debris, or waste will be placed or stored where it may accidentally deposit fill material or be subject to tidal erosion and dispersion. Construction materials will not be stored in contact with the soil.

BIO-9 During construction, the City of Long Beach's (City) Resident Engineer or designated contractor shall ensure that all soils and material, including contaminated topsoil and lead-based paint from demolished bridges, will be removed from the Biological Study Area (BSA) and disposed of properly. Floating booms will be used to contain debris discharged, and any debris discharged will be removed no later than the end of each day.

BIO-10 The City of Long Beach's (City) Resident Engineer shall ensure that the use of rodenticides, herbicides, insecticides, or other chemicals that could potentially harm listed species will be prohibited in and around the Los Angeles River (LA River).

BIO-11 During construction, the City of Long Beach's (City) Resident Engineer or designated contractor shall ensure that any deliberate feeding of wildlife will be prohibited.

BIO-12 During construction, the City of Long Beach's (City) Resident Engineer or designated contractor shall ensure that turbidity curtains be used in lieu of silt curtains, which are less effective at trapping sediment in tidal channels.

BIO-13 During construction, the City of Long Beach's (City) Resident Engineer or designated contractor shall ensure compliance with the provisions of the National Pollutant Discharge Elimination System (NPDES) General Permit for Storm Water Discharges Associated with Construction and Land Disturbance Activities (Construction General Permit) (Order No. 2009-0009-DWQ, NPDES No. CAS000002), and any subsequent amendments (Order No. 2010-0014-DWQ and Order No. 2012-0006-DWQ), as they relate to construction activities for the project. This will include submission of the Permit Registration Documents, including a Notice of Intent, risk assessment, site map, Storm Water Pollution Prevention Plan (SWPPP), annual fee, and signed certification statement to the State Water Resources Control Board (SWRCB) via the Storm Water Multi-Application and Report Tracking System at least seven days prior to the start of construction. Construction activities will not commence until a Waste Discharger Identification number is received from the Storm Water Multi-Application and Report Tracking System. The SWPPP will be prepared by a Qualified SWPPP Developer will meet the requirements of the Construction General Permit and will identify potential pollutant sources associated with construction activities; identify non-storm water discharges; develop a water quality monitoring and sampling plan; and identify, implement, and maintain Best Management Practices (BMP) to reduce or eliminate pollutants associated with the construction site. BMPs will include, but not be limited to, Good Housekeeping, Erosion Control, and Sediment Control BMPs. The BMPs identified in the SWPPP will be implemented during project construction. Caltrans and City will comply with the Risk Level 1 sampling and reporting requirements of the Construction General Permit. A Rain Event Action Plan will be prepared and implemented by a Qualified SWPPP Developer within 48 hours prior to a rain event of 50 percent or greater probability of precipitation according to the National Oceanic and Atmospheric Administration (NOAA). A Notice of Termination will be submitted to the SWRCB within 90 days of completion of construction and stabilization of the site.

BIO-14 Typically, waters subject to Corps jurisdiction are mitigated at a minimum mitigation-to-impact ratio of 2:1 for permanent impacts and 1:1 for temporary impacts, based on Corps standards. Compensatory mitigation may be in the form of habitat restoration and/or enhancement in on- and/or off-site areas where similar estuarine habitat exists.

If mitigation is required, a Habitat Mitigation and Monitoring Plan (HMMP) would need to be developed in coordination with the Corps, RWQCB, and CDFW and would ensure no net loss of estuarine habitat value or acreage. The HMMP would comply with all terms and conditions set forth in the permits and opinions issued by the resource agencies and would typically include the following provisions:

- Prior to construction, the City of Long Beach (City) will ensure that a Habitat Mitigation and Monitoring Plan (HMMP) will be developed in coordination with the U.S. Army Corps of Engineers (USACE), the Regional Water Quality Control Board (RWQCB), and the California Department of Fish and Wildlife (CDFW) and will ensure no net loss of estuarine habitat value or acreage. The HMMP will comply with all terms and conditions set forth in the permits and opinions issued by the resource agencies and will typically include the following provisions:
- Permanent impacts to the Los Angeles River (LA River) will be replaced on or off site at a minimum 2:1 ratio. Temporary direct impacts to the LA River will be replaced at a minimum

1:1 ratio with in-kind habitat restored in place within the Biological Study Area (BSA). If off-site restoration is conducted, it will be undertaken within the LA River Watershed, if feasible.

Further criteria specified in the HMMP will include an establishment period for the replacement habitat, if applicable; regular trash removal; and regular maintenance and monitoring activities to ensure the success of the mitigation plan. After construction, annual summary reports of biological monitoring will be provided to USACE, RWQCB, and CDFW that document the monitoring effort. The duration of the monitoring and reporting will be established by resource agency permit conditions.

Final details for compensatory mitigation will be evaluated through coordination between Caltrans, the City and the resource agencies.

4.6.2 Wildlife

4.6.2.1 California Least Tern

The proposed Project is not expected to directly impact any California least terns due to the lack of suitable nesting habitat. Foraging California least terns are expected to move out of the BSA during construction. This may indirectly and temporarily limit foraging habitat for California least terns during construction. However, these potential impacts will cease upon the completion of construction. The following avoidance and minimization measure below in BIO-15 will be implemented. No mitigation measures would be required.

BIO-15 To protect bird species that fly up and down the Los Angeles River (LA River), the new Shoemaker Bridge will be designed to ensure bird safety. During construction, the City of Long Beach's (City) Resident Engineer or designated contractor shall ensure that at a minimum, suitable fencing at least 14 feet high will be installed to direct flying birds up and out of the way of traffic to prevent birds from being struck by passing vehicles. Fencing will also restrict materials from falling from the bridges onto wildlife or aquatic habitat below. Because nesting habitat for the California least tern absent and this species will be able to move away from Project activities, no additional avoidance and minimization efforts are needed.

4.6.2.2 California Sea Lion

Because California sea lions occur in the deepwater aquatic habitat, avoidance and minimization efforts for the deepwater aquatic habitat described in Section 4.6.1, BIO-1 to BIO-13, is expected to adequately address California sea lions as well. No mitigation measures would be required.

4.6.2.3 Bat Species of Interest

The following measures, BIO-16 to BIO-18, will be incorporated to avoid and minimize impacts to the bridge and crevice dwelling animal species. No mitigation measures would be required.

BIO-16 If demolition of the existing Shoemaker Bridge will occur, the City of Long Beach's (City) Resident Engineer shall ensure that a qualified bat biologist will survey the Project area in the month of June, which falls prior to the demolition of the existing Shoemaker Bridge, to assess the potential for its use as a maternity roost since maternity roosts are generally formed in late spring. The qualified bat biologist will also perform preconstruction surveys since bat roosts can change seasonally. The surveys will include a combination of structure inspection, sampling, exit counts, and acoustic surveys.

BIO-17 To avoid direct mortality to bats roosting under the existing Shoemaker Bridge, the City of Long Beach's (City) Resident Engineer shall ensure that if bats are found during subsequent surveys, temporary bat exclusion devices will be installed under the supervision of a qualified bat biologist prior to the initiation of demolition activities. Exclusion should be conducted during the fall

(September or October) to avoid trapping flightless young inside during the summer months or hibernating individuals during the winter. Such exclusion efforts must be continued to keep the structures free of bats until the completion of the demolition. All bat exclusion techniques will be coordinated among the City, a California Department of Transportation (Caltrans) District Biologist, and the resource agencies. Any placement of exclusions outside the months of September and October will be coordinated between the District Biologist, the City, and resource agencies.

BIO-18 If bats are found to be present during construction, the City of Long Beach's (City) Resident Engineer or designated contractor shall ensure that all work conducted on bridges will take place during the day to the best extent feasible. If this is not feasible, impacts will be minimized by directing lighting and noise away from potential night roosting areas as much as possible.

4.6.3 Plants

Because southern tarplant is considered absent from the BSA, no avoidance and minimization measures are required. However, if a substantial population of southern tarplant is found during subsequent surveys and construction cannot feasibly avoid a substantial population, the seed bank may be translocated into an appropriate conservation area, with coordination between Caltrans and CDFW.

4.6.4 Open Space

Because the area within the Project limits does not contain any designated open space areas, no avoidance, minimization, and mitigation measures are required.

4.6.5 Natural Beauty

The Project area contains less than 0.01 acre of Freshwater Emergent Marsh, which is a wetland habitat. The Freshwater Emergent Marsh is located along the south side of the LA River in the Project area. The Project would not impact any wetlands and therefore, no avoidance, minimization, and mitigation measures are required.

4.6.6 Outdoor Recreation

The Project would result in temporary and permanent impacts to Cesar E. Chavez Park, LARIO Trail, and the LB MUST Facility. Measure LU-1 would be implemented for all three park and recreational resources to address for permanent land use impacts. Specific measures to avoid and minimize impacts to Cesar E. Chavez Park (PR-1 to PR-10), LARIO Trail (PR-11 to PR-19), and the LB MUST Facility (PR-20 to PR-28) are further discussed below.

LU-1 During the final design phase, the City of Long Beach (City) shall ensure that the Project will comply with the City's General Plan, Open Space and Recreation Element, Table OSR-7 Open Space for Outdoor Recreation Implementation Programs (Program 4.5), which states that conversion of any parkland for non-park use must be replaced amenity-for-amenity and acre-for-acre at a 2:1 ratio. One acre of replacement land shall be located in the park service area where the land was converted and an additional acre of replacement land shall be located in a park service area needing parkland, as determined by the City's Recreation Commission.

4.6.6.1 Cesar E. Chavez Park

The Project would require temporary use of this park for grading, temporary access roads, and staging. However, following construction, these areas would be revegetatated and improved as usable park space. The Project would also result in permanent impacts, which would include converting parkland into roadway improvements, a new access configuration to the SCE Seabright substation, a permanent slope easement, and new bike trails being added to provide access to the LARIO Trail. The Project would also convert roadways into parkland because of roadway closures. The conversion of roadways into parkland would result in a new increase in parkland at Cesar E. Chavez Park. Avoidance and minimization measures to address impacts to Cesar E. Chavez Park are provided below (see PR-1 to PR-10).

PR-1 The City of Long Beach (City) will continue to identify and incorporate design refinements to avoid or minimize the permanent incorporation of land from Cesar E. Chavez Park in the final design of the build alternatives.

PR-2 During final design, the City of Long Beach (City) will define the final boundaries of Cesar E. Chavez Park that will be the basis for the transfer of land from the public street right-of-way (ROW) for Shoreline Drive through Cesar E. Chavez Park (currently owned by the City) to within the boundary of the park. This shall be an internal transfer within the City of Long Beach, as the City currently owns the land for both Shoreline Drive and Cesar E. Chavez Park.

After the City has identified the new boundaries of Cesar E. Chavez Park, including the consolidation of the six discontinuous parcels into three larger parcels, Caltrans will coordinate with the City of Long Beach to:

- Identify park improvements for the new areas added to the park, including removal of pavement and other materials from Shoreline Drive, the landscaping of those areas, and the provision of sidewalks and bicycle paths, as appropriate, connecting the consolidated parcels.
- Develop a plan for public access to the northwest portion of the park for passive activities, such as wildlife viewing and walking.

PR-3 During construction, the City of Long Beach (City) will require the construction contractor to maintain vehicular and pedestrian access to recreational areas within the construction area throughout the construction period. If existing access points are disrupted, alternative access shall be provided. Appropriate signage and temporary sidewalks shall be provided as needed throughout construction, and the construction contractor shall provide and maintain appropriate signage to direct both pedestrian and vehicular traffic to recreational areas via alternate routes. Disabled access shall also be maintained during construction.

PR-4 The City of Long Beach (City) will require the project construction contractor to identify all proposed closures of areas within Cesar E. Chavez Park (including streets), no less than 90 days prior to when each closure would begin.

PR-5 No less than 90 days prior to when a closure would begin, the City of Long Beach (City) will require the project construction contractor to provide the following to the City of Long Beach Parks, Recreation and Marine Department and the Long Beach Unified School District:

- A map of each proposed closure, clearly showing each park area proposed to be closed temporarily, including identification of any street closures;
- A plan for providing signing and notifications through other public information outlets to inform the public and recreational visitors of upcoming closures of areas within the park;
- Estimation of the duration of each closure;
- Identification of alternative vehicle and trail routes to/through and/or around the park, as appropriate; and
- Identification of park features that would be unavailable to the public during the closure.

PR-6 The City of Long Beach (City) will provide written approval of each proposed closure to the construction contractor no less than 45 days prior to when the closure would begin.

PR-7 The City of Long Beach (City) will require the construction contractor to provide an information telephone number that park visitors can use to contact the contractor for more information regarding individual closures. The contractor may also provide an information website. The contact number and website information are to be provided at the construction site, at/around each closed area, and on information signs discussing the individual closures. The construction contractor will also be required to provide this information to the City of Long Beach Parks, Recreation and Marine Department and the Long Beach Unified School District.

PR-8 The City of Long Beach (City) will require the construction contractor to return areas of the park temporarily during construction to their original, or better, conditions after completion of construction, and those temporarily closed areas will be respectively returned to the City of Long Beach Parks, Recreation and Marine Department and the Long Beach Unified School District.

PR-9 At the completion of construction in the temporary occupancy areas at Cesar E. Chavez Park, the City of Long Beach (City) will require the construction contractor to return the areas to a condition as good as, or better than, prior to its use for the temporary occupancy. The required improvements for the rehabilitation of those areas will be determined in consultation among the City of Long Beach Parks, Recreation and Marine Department, the Long Beach Unified School District, and the construction contractor.

PR-10 For Temporary Construction Easements (TCE) currently vegetated in native and mixed native/nonnative plant materials, those land areas will be revegetated at the completion of construction and returned to the original property owners. The City of Long Beach (City) will develop the revegetation plans in consultation with the property owners to ensure the compatibility of the new vegetation with the existing vegetation in the vicinity of those for the affected properties.

4.6.6.2 Los Angeles and Rio Hondo Trail

The Project would require a temporary construction easement on multiple portions of the LARIO Trail. In addition, the Project would require a new permanent aerial easement within the road right-of-way over the trail. Avoidance and minimization measures to address impacts to the LARIO Trail are provided below (see PR-11 to PR-19).

PR-11 If a build alternative is selected, the City of Long Beach (City) will continue to identify and incorporate design refinements to avoid or minimize the temporary occupancy of land from the Los Angeles and Rio Hondo (LARIO) Trail in the final design of the build alternatives.

PR-12 During construction, the City of Long Beach will require the construction contractor to maintain vehicular and pedestrian access to recreational areas within the construction area throughout the construction period. If existing access points are disrupted, alternative access shall be provided. Appropriate signage and temporary sidewalks shall be provided as needed throughout construction, and the construction contractor shall provide and maintain appropriate signage to direct both pedestrian and vehicular traffic to recreational areas via alternate routes. Disabled access shall also be maintained during construction.

PR-13 The City of Long Beach (City) will require the project construction contractor to identify all proposed closures of areas within the Los Angeles and Rio Hondo (LARIO) Trail (including streets), no less than 90 days prior to when each closure would begin.

PR-14 No less than 90 days prior to when a closure would begin, the City of Long Beach (City) will require the project construction contractor to provide the following to the Los Angeles County Public Works Department and the Los Angeles County Parks and Recreation Department:

- A map of each proposed closure, clearly showing each recreational area proposed to be closed temporarily, including identification of any street closures;

- A plan for providing signing and notifications through other public information outlets to inform the public and recreational visitors of upcoming closures of areas within the recreational area;
- Estimation of the duration of each closure;
- Identification of alternative vehicle and trail routes to/through and/or around the recreational area, as appropriate; and
- Identification of recreational features that would be unavailable to the public during the closure.

PR-15 The County of Los Angeles (County) will provide written approval of each proposed closure to the construction contractor no less than 45 days prior to when the closure would begin.

PR-16 The City of Long Beach (City) will require the construction contractor to provide an information telephone number that recreational visitors can use to contact the contractor for more information regarding individual closures. The contractor may also provide an information website. The contact number and website information are to be provided at the construction site, at/around each closed area, and on information signs discussing the individual closures. The construction contractor will also be required to provide this information to the Los Angeles County Public Works Department and the Los Angeles County Parks and Recreation Department.

PR-17 The City of Long Beach (City) will require the construction contractor to return areas of the recreational area closed temporarily during construction to their original, or better, conditions after completion of construction, and those temporarily closed areas will be respectively returned to the Los Angeles County Public Works Department and the Los Angeles County Parks and Recreation Department.

PR-18 At the completion of construction in the temporary occupancy areas at the Los Angeles and Rio Hondo (LARIO) Trail, the City of Long Beach (City) will require the construction contractor to return the areas to a condition as good as, or better than, prior to its use for the temporary occupancy. The required improvements for the rehabilitation of those areas will be determined in consultation among the Los Angeles County Public Works Department, the Los Angeles County Parks and Recreation Department, and the construction contractor.

PR-19 For Temporary Construction Easements (TCE) currently vegetated in native and mixed native/nonnative plant materials, those land areas will be revegetated at the completion of construction and returned to the original property owners. The City of Long Beach (City) will develop the revegetation plans in consultation with the property owners to ensure the compatibility of the new vegetation with the existing vegetation in the vicinity of those for the affected properties.

4.6.6.3 Long Beach Municipal Urban Stormwater Treatment Facility

The proposed Project would construct columns, retaining walls, and abutments, as well as use the area of the pump station as a staging area as the eastern terminus is constructed. Therefore, the trails and open space areas of the LB MUST Facility would be temporarily closed for at least 2 years out of the 3-year construction period. Additionally, the Project would require a permanent aerial easement and access agreement beneath the aerial structure. This would constitute a permanent use of a portion of the LB MUST Facility. Avoidance and minimization measures to address impacts to the LB MUST Facility are provided below (see PR-20 to PR-28).

PR-20 If a build alternative is selected, the City of Long Beach (City) will continue to identify and incorporate design refinements to avoid or minimize the temporary occupancy of land from the Long Beach Municipal Urban Stormwater Treatment (LB MUST) Facility in the final design of the build alternatives.

PR-21 During construction, the City of Long Beach (City) will require the construction contractor to maintain vehicular and pedestrian access to recreational areas within the construction area throughout the construction period. If existing access points are disrupted, alternative access shall be provided. Appropriate signage and temporary sidewalks shall be provided as needed throughout construction, and the construction contractor shall provide and maintain appropriate signage to direct both pedestrian and vehicular traffic to recreational areas via alternate routes. Disabled access shall also be maintained during construction.

PR-22 The City of Long Beach (City) will require the project construction contractor to identify all proposed closures of areas within the Long Beach Municipal Urban Stormwater Treatment (LB MUST) Facility (including streets), no less than 90 days prior to when each closure would begin.

PR-23 No less than 90 days prior to when a closure would begin, the City of Long Beach (City) will require the project construction contractor to provide the following to the Long Beach Municipal Urban Stormwater Treatment (LB MUST) Facility:

- A map of each proposed closure, clearly showing each recreational area proposed to be closed temporarily, including identification of any street closures;
- A plan for providing signing and notifications through other public information outlets to inform the public and recreational visitors of upcoming closures of areas within the recreational area;
- Estimation of the duration of each closure;
- Identification of alternative vehicle and trail routes to/through and/or around the recreational area, as appropriate; and
- Identification of recreational features that would be unavailable to the public during the closure.

PR-24 The Long Beach Municipal Urban Stormwater Treatment (LB MUST) Facility will provide written approval of each proposed closure to the construction contractor no less than 45 days prior to when the closure would begin.

PR-25 The City of Long Beach (City) will require the construction contractor to provide an information telephone number that recreational visitors can use to contact the contractor for more information regarding individual closures. The contractor may also provide an information website. The contact number and website information are to be provided at the construction site, at/around each closed area, and on information signs discussing the individual closures. The construction contractor will also be required to provide this information to the Long Beach Municipal Urban Stormwater Treatment (LB MUST) Facility.

PR-26 The City of Long Beach (City) will require the construction contractor to return areas of the recreational area closed temporarily during construction to their original, or better, conditions after completion of construction, and those temporarily closed areas will be respectively returned to the Long Beach Municipal Urban Stormwater Treatment (LB MUST) Facility.

PR-27 At the completion of construction in the temporary occupancy areas at the Long Beach Municipal Urban Stormwater Treatment (LB MUST) Facility, the City of Long Beach (City) will require the construction contractor to return the areas to a condition as good as, or better than, prior to its use for the temporary occupancy. The required improvements for the rehabilitation of those areas will be determined in consultation among the City, the LB MUST Facility, and the construction contractor.

PR-28 For Temporary Construction Easements (TCE) currently vegetated in native and mixed native/nonnative plant materials, those land areas will be revegetated at the completion of construction and returned to the original property owners. The City of Long Beach (City) will develop the revegetation plans in consultation with the Long Beach Municipal Urban Stormwater Treatment

(LB MUST) Facility to ensure the compatibility of the new vegetation with the existing vegetation in the vicinity of those for the affected properties.

4.6.7 Agriculture

Because the area within the Project limits does not contain any agricultural resources, no avoidance, minimization, and mitigation measures are required.

4.6.8 Forestry

Because the area within the Project limits does not contain any forestry resources, no avoidance, minimization, and mitigation measures are required.

4.6.9 Natural Moderation of Floods

As stated previously in Section 2.2.9, a portion of the Project is located within floodplains. However, there will not be any floodplain impacts associated with this Project (see Section 3 for results of hydraulic analysis). The maximum increase in water surface elevation is 2 inches under both Build Alternatives 2 and 3. No avoidance, minimization, and mitigation measures are required.

4.6.10 Water Quality Maintenance

The Project will be required to comply with the NPDES Construction General Permit (NPDES No. CAS000002, SWRCB Order No. 2009-0009-DWQ, adopted on November 16, 2010 and amended by Order No. 2010-0014-DWQ and Order No. 2012-0006-DWQ). The permit requires preparation of a Stormwater Pollution Prevention Plan (SWPPP) and implementation of construction Best Management Practices (BMP). The SWPPP would be prepared prior to construction and would be implemented to prevent pollutants from entering the LA River. Therefore, no substantial changes to the levels of oil, grease, and chemical pollutants are anticipated.

The Project would result in a net decrease in impervious surface area, which could result in a decrease in surface runoff. In addition, the Project would be designed to allow surface runoff to flow directly into the nearest stormwater channel, where it would be conveyed to a detention basin or the LB MUST Facility. The Project also includes modifications that would not increase the capacity of the bridge or roadways (e.g., additional street lighting, re-striping, turn lanes, bicycle, pedestrian, and streetscape improvements). In addition, ongoing maintenance to remove excess grease and other chemical pollutants would be implemented to prevent these pollutants from entering the LA River. Therefore, no substantial changes to the levels of oil, grease, and chemical pollutants are anticipated during Project operation.

In summary, Project design features, BMPs, and standard measures would be implemented to avoid and minimize potential water quality impacts.

4.6.11 Groundwater Recharge

Support structures would be constructed with either the cast-in-drilled-hole method or cast-in-steel-shell method. In the cast-in-drilled-hole method, a hole is drilled, then filled with slurry (semiliquid mixture of fine particles) to prevent cave-ins. The hole is then pumped with concrete, which displaces the slurry and is reused. During this process, any groundwater that fills the hole prior to filling with slurry and concrete would be removed and disposed of properly. Construction is not expected to affect groundwater movement because the slurry would prevent groundwater movement, and no active dewatering, other than emptying the hole prior to filling it with slurry, would be conducted. Therefore, no substantial changes to groundwater recharge are anticipated.

Project operation would not result in an increase in the transport of pollutants into the groundwater through infiltration. Because the Project would result in a net decrease in impervious surface area, no substantial net gain or loss in infiltration is anticipated.

Because no substantial changes to groundwater recharge is anticipated, no avoidance and minimization measures are required.

4.7 Assessment of Level of Risk

The completed Caltrans Location Hydraulic Study Form is provided in Appendix D. Location Hydraulic Study Form. The contents are based on the analysis described above, and the risk level for the proposed Project is low.

5 Conclusion

This report evaluated the existing and proposed conditions for the Los Angeles River channel at the Shoemaker Bridge (West Shoreline Drive) crossing. The proposed bridge replacement will have a minimal impact on the 133-year design flood water surface of less than 2 inches and that impact does not increase the base floodplain extents since the entire flow is contained within the flood control channel between the levee parapet walls. The floodplain will have an impact from grading at the proposed bridge replacement; however, the existing channel is not open to the public and does not have beneficial uses except for flood control.

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Appendix A. FEMA Flood Insurance Rate Maps

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NOTES TO USERS

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size. The **community map repository** should be consulted for possible updated or additional flood hazard information.

To obtain more detailed information in areas where **Base Flood Elevations** (BFEs) and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles and Floodway Data and/or Summary of Stillwater Elevations tables contained within the Flood Insurance Study (FIS) report that accompanies this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS report should be utilized in conjunction with the FIRM for purposes of construction and/or floodplain management.

Coastal Base Flood Elevations shown on this map apply only landward of 0.0' North American Vertical Datum of 1988 (NAVD 88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations table in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations table should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study report for this jurisdiction.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures.** Refer to Section 2.4 "Flood Protection Measures" of the Flood Insurance Study report for information on flood control structures for this jurisdiction.

The **projection** used in the preparation of this map was Universal Transverse Mercator (UTM) zone 11. The **horizontal datum** was NAD83, GRS1980 spheroid. Differences in datum, spheroid, projection or UTM zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

Flood elevations on this map are referenced to the North American Vertical Datum of 1988. These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum.** For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at http://www.ngs.noaa.gov/ or contact the National Geodetic Survey at the following address:

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC–3, #9202
1315 East–West Highway
Silver Spring, MD 20910–3282

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at **(301) 713–3242,** or visit its website at http://www.ngs.noaa.gov/.

Base map information shown on this FIRM was derived from U.S. Geological Survey Digital Orthophoto Quadrangles produced at a scale of 1:12,000 from photography dated 1994 or later and from National Geospatial Intelligence Agency imagery produced at a scale of 1:4,000 from photography dated 2003 or later.

This map reflects more detailed and up–to–date **stream channel configurations** than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables *in the Flood Insurance Study report (which contains authoritative hydraulic data*) may reflect stream channel distances that differ from what is shown on this map.

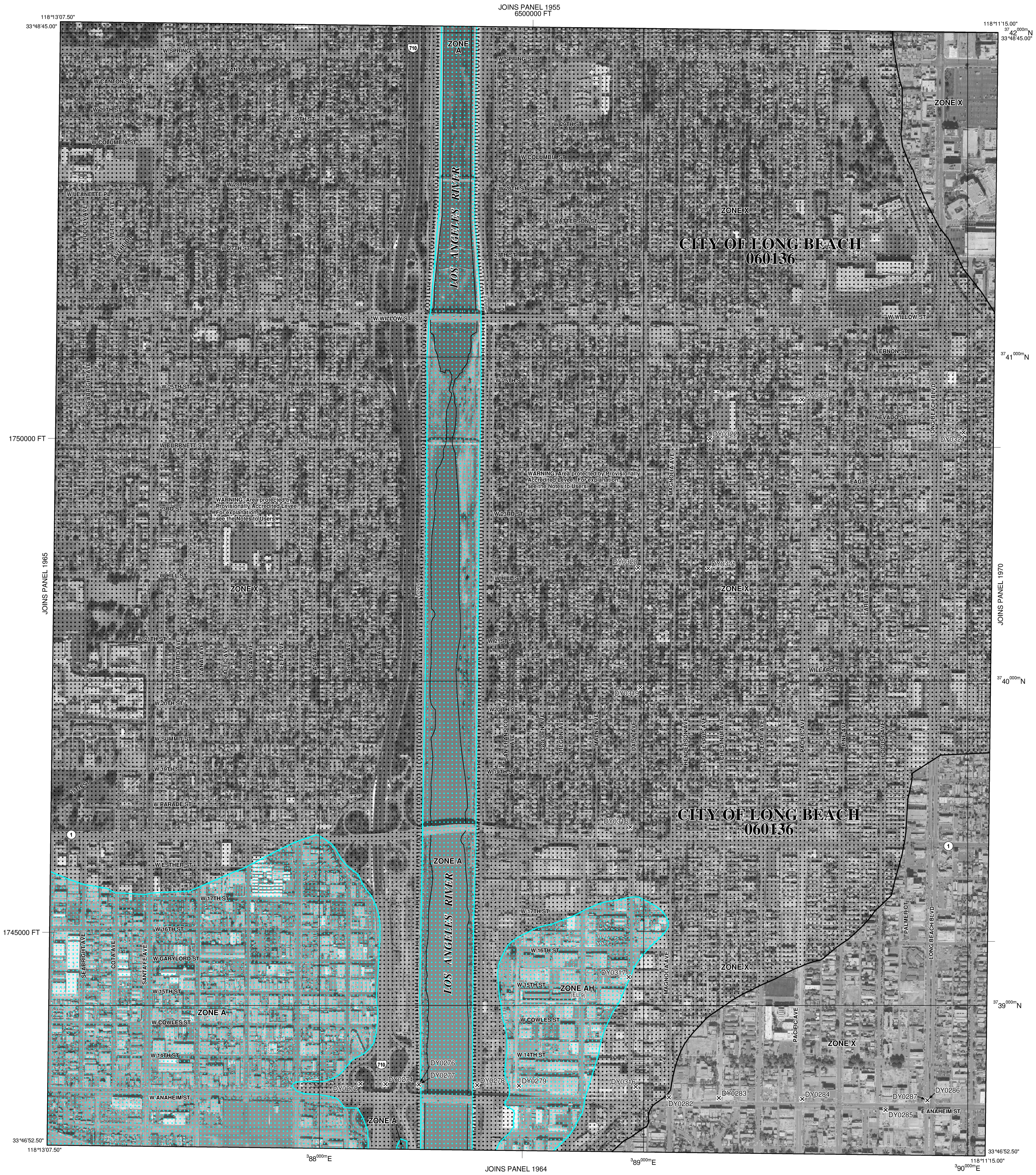
Corporate limits shown on this map are based on the best data available at the time of publication. Because changes due to annexations or de–annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels; community map repository addresses; and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which each community is located.

Contact the **FEMA Map Service Center** at 1–800–358–9616 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, *a Flood Insurance Study report*, and/or digital versions of this map. The FEMA Map Service Center may also be reached by Fax at 1–800–358–9620 and its website at http://www.msc.fema.gov/.

If you have **questions about this map** or questions concerning the National Flood Insurance Program in general, please call **1–877–FEMA MAP** (1–877–336–2627) or visit the FEMA website at http://www.fema.gov/.

WARNING: This levee, dike, or other structure has been provisionally accredited and mapped as providing protection from the 1-percent-annual-chance flood. To maintain accreditation, the levee owner or community is required to submit documentation necessary to comply with 44 CFR Section 65.10 by October 16, 2009. Because of the risk of overtopping or failure of the structure, communities should take proper precautions to protect lives and minimize damages in these areas, such as issuing an evacuation plan and encouraging property owners to purchase flood insurance.



LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A No Base Flood Elevations determined.

ZONE AE Base Flood Elevations determined.

ZONE AH Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.

ZONE AO Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.

ZONE AR Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.

ZONE A99 Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.

ZONE V Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.

ZONE VE Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X Areas determined to be outside the 0.2% annual chance floodplain.

ZONE D Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

1% annual chance floodplain boundary
0.2% annual chance floodplain boundary
Floodway boundary
Zone D boundary
CBRS and OPA boundary
Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.

513 — Base Flood Elevation line and value; elevation in feet*

(EL 987) — Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the North American Vertical Datum of 1988 (NAVD 88)

A — A Cross section line

23 - - - 23 Transect line

97°07'30", 32°22'30" Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)

$^{42}75^{000m}N$ 1000-meter Universal Transverse Mercator grid values, zone 11

6000000 FT 5000-foot grid ticks: California State Plane coordinate system, V zone (FIPSZONE 0405), Lambert Conformal Conic

DX5510 × Bench mark (see explanation in Notes to Users section of this FIRM panel)

• M1.5 River Mile

MAP REPOSITORIES
Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
September 26, 2008
EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

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

MAP SCALE 1" = 500'

250 0 500 1000 FEET

150 0 150 300 METERS

NFIP

PANEL 1962F

NATIONAL FLOOD INSURANCE PROGRAM

FIRM

FLOOD INSURANCE RATE MAP

LOS ANGELES COUNTY, CALIFORNIA

AND INCORPORATED AREAS

PANEL 1962 OF 2350

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
LONG BEACH, CITY OF	060136	1962	F

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER 06037C1962F

EFFECTIVE DATE SEPTEMBER 26, 2008

Federal Emergency Management Agency

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NOTES TO USERS

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To obtain more detailed information in areas where **Base Flood Elevations** (BFEs) and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles and Floodway Data and/or Summary of Stillwater Elevations tables contained within the Flood Insurance Study (FIS) report that accompanies this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole–foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS report should be utilized in conjunction with the FIRM for purposes of construction and/or floodplain management.

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Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures.** Refer to Section 2.4 "Flood Protection Measures" of the Flood Insurance Study report for information on flood control structures for this jurisdiction.

The **projection** used in the preparation of this map was Universal Transverse Mercator (UTM) zone 11. The **horizontal datum** was NAD83, GRS1980 spheroid. Differences in datum, spheroid, projection or UTM zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

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NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC–3, #9202
1315 East–West Highway
Silver Spring, MD 20910–3282

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This map reflects more detailed and up–to–date **stream channel configurations** than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables *in the Flood Insurance Study report (which contains authoritative hydraulic data*) may reflect stream channel distances that differ from what is shown on this map.

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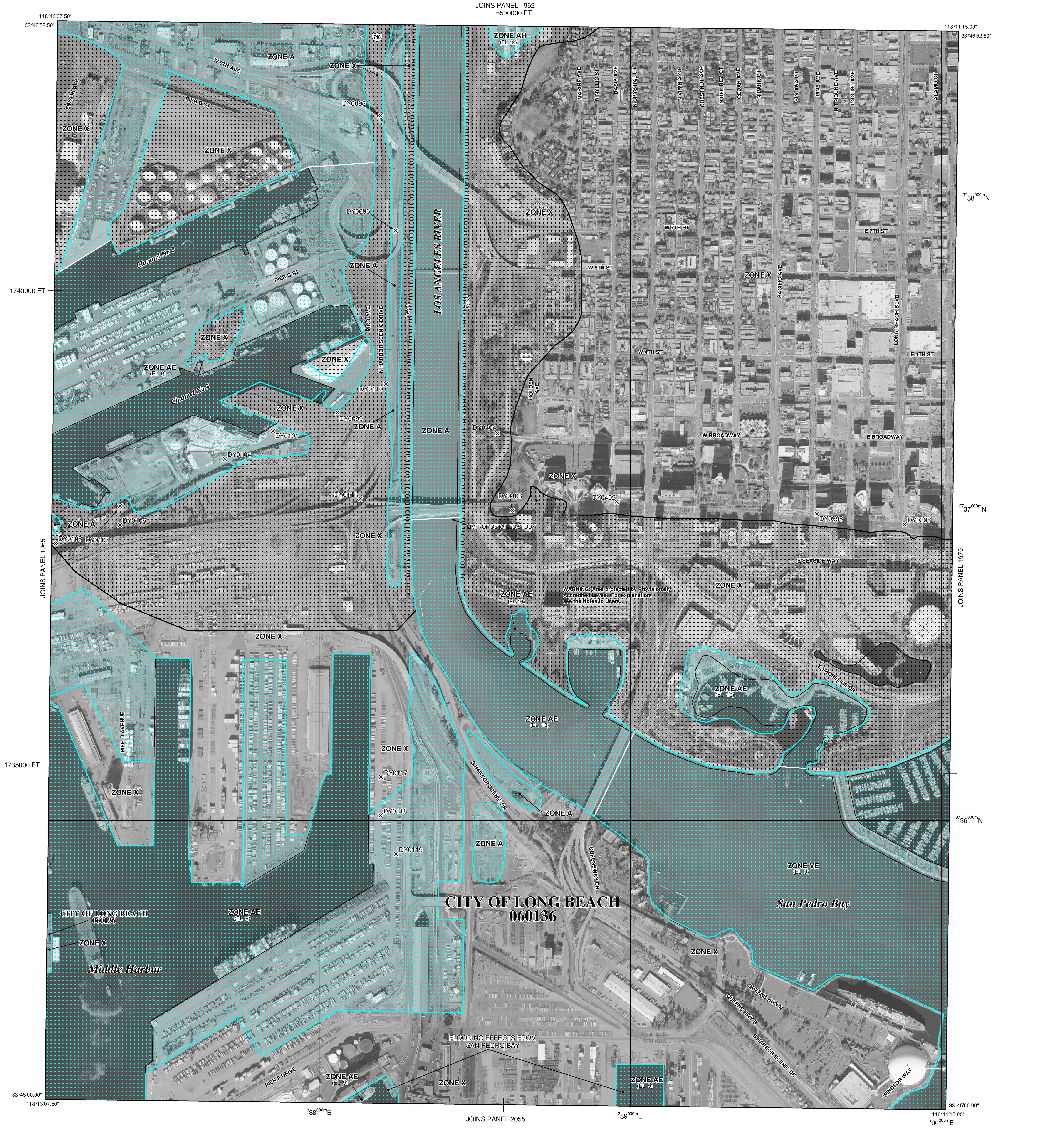
Contact the **FEMA Map Service Center** at 1–800–358–9616 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, *a Flood Insurance Study report*, and/or digital versions of this map. The FEMA Map Service Center may also be reached by Fax at 1–800–358–9620 and its website at http://www.msc.fema.gov/.

If you have **questions about this map** or questions concerning the National Flood Insurance Program in general, please call **1–877–FEMA MAP** (1–877–336–2627) or visit the FEMA website at http://www.fema.gov/.

WARNING: This levee, dike, or other structure has been provisionally accredited and mapped as providing protection from the 1-percent-annual-chance flood. To maintain accreditation, the levee owner or community is required to submit documentation necessary to comply with 44 CFR Section 65.10 by October 16, 2009. Because of the risk of overtopping or failure of the structure, communities should take proper precautions to protect lives and minimize damages in these areas, such as issuing an evacuation plan and encouraging property owners to purchase flood insurance.



LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A No Base Flood Elevations determined.

ZONE AE Base Flood Elevations determined.

ZONE AH Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.

ZONE AO Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.

ZONE AR Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.

ZONE A99 Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.

ZONE V Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.

ZONE VE Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

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1% annual chance floodplain boundary
0.2% annual chance floodplain boundary
Floodway boundary
Zone D boundary
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Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.

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A — A	Cross section line
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DX5510 ×	Bench mark (see explanation in Notes to Users section of this FIRM panel)
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N

MAP SCALE 1" = 500'

250 0 500 1000 FEET

150 0 150 300 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 1964F

FIRM

FLOOD INSURANCE RATE MAP

LOS ANGELES COUNTY, CALIFORNIA

AND INCORPORATED AREAS

PANEL 1964 OF 2350

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
LONG BEACH, CITY OF	060136	1964	F

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MAP NUMBER
06037C1964F

EFFECTIVE DATE
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Federal Emergency Management Agency

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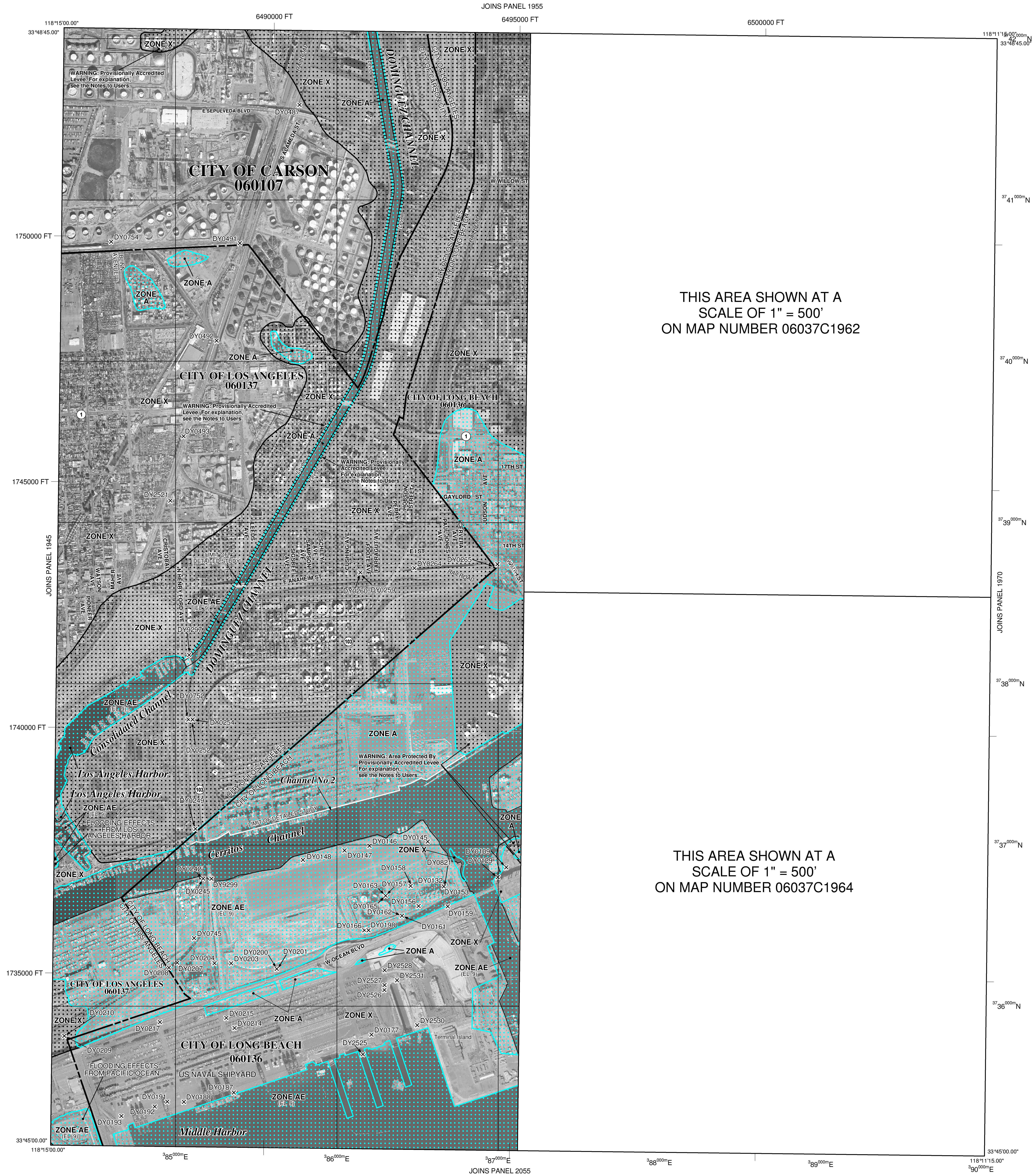

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N

MAP SCALE 1" = 1000'

500 0 1000 2000 FEET
300 0 300 600 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 1965F

FIRM
FLOOD INSURANCE RATE MAP
LOS ANGELES COUNTY, CALIFORNIA
AND INCORPORATED AREAS

PANEL 1965 OF 2350
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
CARSON, CITY OF	060107	1965	F
LONG BEACH, CITY OF	060136	1965	F
LOS ANGELES, CITY OF	060137	1965	F

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
06037C1965F

EFFECTIVE DATE
SEPTEMBER 26, 2008

Federal Emergency Management Agency

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Appendix B. Los Angeles County Drainage Area Hydrology Technical Report

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LOS ANGELES COUNTY DRAINAGE AREA

FINAL FEASIBILITY INTERIM REPORT

PART I HYDROLOGY TECHNICAL REPORT

BASE CONDITIONS

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

DECEMBER 1991

LOS ANGELES COUNTY DRAINAGE AREA, CALIFORNIA

BASE CONDITIONS HYDROLOGY

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LOS ANGELES COUNTY DRAINAGE AREA

BASE CONDITIONS HYDROLOGY

1 INTRODUCTION.

1.1 PURPOSE.

This report presents hydrology in support of feasibility studies for flood control and allied purposes in the Los Angeles County Drainage Area (LACDA), Los Angeles County, California. The drainage area and a location map are shown on plate 1. The study, as requested by local interests, has been limited to the Los Angeles River (LAR) and San Gabriel River (SGR) and their tributaries (the LACDA system of flood control dams and channels is shown on plate 2). This report has the following major objectives: (a) to present the meteorologic and hydrologic characteristics of the study region; (b) to outline methods and techniques used to model the rainfall-runoff process; (c) to present base condition discharge-frequency values for present conditions for mainstem Los Angeles and San Gabriel River locations, as well as Tujunga Wash and the Rio Hondo (without changes to existing projects or their operation); (d) to identify possible deficiencies in performance within the LACDA system; and (e) to serve as a planning tool for formulation of project alternatives. The present conditions "base" will subsequently be compared to project alternatives in Part II hydrology, to ultimately determine flood control benefits of each alternative.

1.2 SCOPE.

Discharge-frequency analyses were conducted in accordance with Water Resource Council (WRC) guidelines for uncontrolled gauged sites.

Subsequently, adjustments were made to frequency discharges to account for the effect of urbanization in areas unaffected by reservoir operation. Finally, for areas downstream of reservoirs, frequency discharges were determined by simulating reservoir response to runoff events and combining the results with intermediate tributary inflow. This final step, determination of frequency discharges throughout the LACDA system, required an approach which not only accounted for reservoir inflow and ensuing releases, but tributary flow (both regulated and unregulated) as well. An additional requirement was built-in flexibility to model proposed operational modifications and structural changes during evaluation of projects. The HEC-5 "Simulation of Flood Control and Conservation Systems" computer program (Version = H5ALA, H5BLA, updated March 1987) was able to meet the system operation requirement and provide a flexible base for alternative project analysis. Use of this reservoir simulation program to compute frequency discharges necessitates the inclusion of hydrographs in the input job stream of the data model. An efficient, systematic method of calculating runoff at the concentration points in the system was needed, which maintained the flexibility to adapt to changing project alternatives. All of these above limitations and requirements made the use of a rainfall-runoff model to compute reservoir inflow and simultaneous runoff in downstream subareas not only desirable, but almost a necessity. Furthermore, the development of the HEC Data Storage System (HECDSS; a software system which allows creation and storage of a data base, and provides both read and write access via other HEC programs, e.g., HEC-5 and HEC-1, plus management and display capability through utility programs such as DSSIN, DSSUTL, and DSPLAY) allowed reading subarea hydrographs directly to HEC-5, and indirectly linking HEC-5 with HEC-1 ("Flood Hydrograph Package", a computer program which can convert rainfall to runoff). Accordingly, the present conditions discharge-frequency analysis was conducted in the following steps:

(1) Reconstitution of selected flood events to determine rainfall-runoff parameters, e.g., loss rates, lag time, and S-graphs, for gauged subareas within the LACDA study area which are not affected by upstream reservoir

operations; these parameters were developed for typical hydrologic regions within the LACDA basin: mountain, foothill, and valley (urbanized).

(2) Determination of n-year, 24-hour frequency rainfall depths for each subarea, and the time distribution of the rainfall.

(3) Computation of n-year subarea hydrographs resulting from use of the n-year, 24-hour rainfall with a rainfall-runoff model (in this case HEC-1).

(4) Development of n-year frequency discharges at selected major control or concentration points in the LACDA system, utilizing a data model of the LAR-SGR system (see plate 3) and executing that data via the HEC-5 reservoir routing program. Component hydrographs were input to the HEC-5 program by reading them from HECDSS.

Establishment of the present condition frequency discharges was an iterative process. The initial results of this phase of the analysis were based upon the assumption that all Corps of Engineers (COE) flood control dams operate for their immediate downstream channel only, and that all flows remain within the channels or river reaches. The issues of breakouts, overtopping of channels, bridges, levees and other structures, or failure of structures were next jointly addressed by Hydraulics Section as well as the Hydrologic Engineering Section. Results of this study were then incorporated into more refined hydrologic models of the LACDA system and adjusted "present condition" frequency discharges were determined. More than one iteration was necessary in some reaches. "Future condition" frequency discharges, while not a focal point of this study, were computed in an identical manner to present conditions, using estimated future impervious cover in determining subarea hydrographs.

The subject of interior drainage in the LACDA system was addressed in a screening study of 10 "problem" drains spatially distributed throughout the existing project. The study was limited to 10 because of several factors:

(1) as discussed in section 1.5.3, Urban Growth, there is already an elaborate stormwater collection system in place, which has generally been designed for a high degree of protection based upon a "Capital Storm" concept (approximately 50-year rainfall).

(2) the problems documented for these "problem drains" could be quantified to determine whether additional studies would be required.

(3) it was anticipated that the magnitude of the mainstem flooding problem would completely overshadow that of interior flood control.

(4) and finally, the results were to be extrapolated to the Plan Formulation phase of the follow-up alternatives analysis.

1.3 RESULTS.

The discharge-frequency analysis presented herein indicates that, in general, the San Gabriel River has considerably more protection than the Los Angeles River. Protection is defined herein as the frequency at which flow reaches the bottom of freeboard. Also, tributary channels of the mainstem rivers, except the Rio Hondo Diversion Channel, are typically more adequate than the mainstem rivers, i.e., LAR-SGR. Protection along the Los Angeles River ranges from more than 50-year near the Big Tujunga confluence, 25- to 50-year protection between Verdugo Wash and Compton Creek, and slightly more than 25-year below Compton Creek. San Gabriel River protection is 500-year above Whittier Narrows Dam (WNRS) and between 100-year and 200-year below Whittier Narrows. During the hydraulic analysis of the Rio Hondo Diversion Channel, restrictions were determined to exist at Beverly Boulevard Bridge and Stewart and Gray Road Bridge which reduced the channel capacity to 36,500 cubic feet per second (ft^3/s) from the design capacities of 40,000 ft^3/s and 42,500 ft^3/s, respectively. However, even with maximum outflow from Whittier Narrows Dam limited to 36,500 ft^3/s, thus increasing the frequency of uncontrolled spillway flow to the San Gabriel River, local inflow from storm sewer connections could result in flow above channel capacity for events as frequent as 25-years at both locations. Levels of protection shown on plate 4 indicate at what frequency flows exceed channel capacity at specific concentration points; while channel flow may be conveyed safely through a given reach, flow from upstream breakouts may be causing flooding outside the channel walls. Inundation area maps for the four discrete flood events which had damaging overflows - 50-, 100-, 200-, and 500-year - are shown on plates 5 through 8 to amplify this situation. Discharge-frequency results at major control or concentration points (CP's) are listed in table 1. Tributary component frequency discharges are presented in table 2. Tables 3 and 4 contain the names and locations of the concentration points or control points listed in tables 1 and 2. The locations of subareas and concentration points referred to in tables 1 - 4 are displayed on plate 9. Future conditions runoff was established as essentially equivalent to "base" or "existing" conditions runoff along the overflow boundaries, and was thus not detailed for presentation.

Since the tributary channels generally exhibited a high degree of protection (greater than 100-year), and since the vast majority of the damages resulting from flood flows would occur in the mainstem channels, the focus of the overflow study was directed to these mainstem watercourses.

Preliminary analysis indicates a system operation of COE LAR-SGR flood control reservoirs could increase protection in the upper Los Angeles River mainstem and tributaries to 100-year above Verdugo Wash, and 50-year between Verdugo Wash and the Pacific Ocean. Such an operation would require re-regulation of Hansen, Sepulveda, Santa Fe, and Whittier Narrows Dams to reduce the impact of high tributary inflows to the Los Angeles River. This re-regulation may result in a decrease in protection along the San Gabriel River, and during large flood events could result in more total damage than the base operation. An analysis to evaluate the hydrologic-hydraulic consequences of a system operation is currently being conducted.

TABLE 1: DISCHARGE-FREQUENCY RESULTS -- BASE CONDITIONS

C.P.	D.A. (mi²)	FREQUENCY (yrs) 10	25	50	100	200	500	RDCC
2 Infl		6350	13,800	33,500	47,900	64,000	76,500	
Outflow	152	2820	9850	15,800	18,900	21,100	25,000	21,000
611	158	2950	10,000	16,000	19,200	21,500	25,500	20,800
6	211	7500	14,500	20,200	28,300	37,100	37,200	26,900
8	225	8780	15,100	22,200	32,600	38,800	39,600	27,000
9	229	10,900	15,900	25,400	37,100	42,500	44,400	29,000
10 Infl		34,300	47,300	54,900	82,500	94,700	109,000	
Outflow	152	12,800	14,800	15,700	17,000	37,500	75,400	16,900
11	174	16,200	20,200	22,000	27,400	35,000	61,000	20,300
12	403	27,000	34,900	47,400	64,500	72,900	88,500	48,700
171	465	40,300	53,900	63,400	83,900	96,300	105,000	40,000
17	493	48,200	65,800	77,500	94,600	109,000	125,000	59,000
20	514	49,400	69,600	82,000	93,800	106,000	118,000	83,700
21	561	53,600	79,800	94,400	109,000	124,000	141,000	104,000
22	620	54,900	80,700	95,900	109,000	115,000	128,000	110,000
25	752	89,400	123,000	126,000	140,000	151,000	156,000	132,000
27	766	90,100	123,000	128,000	135,000	136,000	134,000	133,000
28	808	92,900	127,000	133,000	142,000	144,000	143,000	129,000
29	824	93,200	128,000	129,000	125,000	132,000	130,000	133,000
35 Infl		5200	8000	29,000	53,200	80,300	111,000	
Outflow	237	3750	6710	27,800	32,800	38,500	41,000	41,000
Spill		0	0	0	0	0	29,700	
36	244	3610	6290	27,700	32,800	38,500	41,300	41,000
44	347	17,300	24,900	40,800	49,000	56,200	62,700	62,700
47	430	27,300	38,400	57,900	70,700	82,100	94,000	98,000
55 Infl		47,000	69,200	99,700	132,000	159,000	178,000	
Outflow to SGR	437	5000	5000	5000	5000	47,500	86,900	13,500
56	459	8660	9820	10,800	12,200	31,900	63,200	19,500
58	475	10,700	12,900	14,400	17,200	20,000	49,000	20,000
63	625	27,200	36,700	44,400	55,900	64,300	74,000	55,000
64	635	26,600	36,600	44,100	55,100	45,900	52,400	55,600
55 Infl		47,000	69,200	99,700	132,000	159,000	178,000	
Outflow to RH	110	33,500	36,500	36,500	36,500	36,500	36,500	36,500
23	113	33,800	37,200	37,500	38,000	38,200	38,400	36,500
24	132	35,600	41,200	41,000	39,300	39,100	40,200	36,500

RDCC = Revised Design Channel Capacity (see section 5.2.2).
Discharges in cubic feet per second.
See plate 9 for locations of CP's.

TABLE 2: TRIBUTARY COMPONENT DISCHARGE-FREQUENCY RESULTS BASE CONDITIONS

C.P.	D.A. (mi^2)	FREQUENCY (yrs) 10	25	50	100	200	500	RDCC
Big Dalton Wash								
40	41.5	8520	11,600	20,000	23,600	29,900	33,200	25,500
Walnut Creek								
43	103	14,400	19,500	28,900	34,800	39,800	42,400	40,000
San Jose Creek								
46	83.4	11,700	15,600	19,700	25,400	30,400	35,700	43,000
Rio Hondo								
51	31.3	6020	10,200	19,700	23,700	31,600	34,900	26,000
53	85.2	16,400	25,700	41,600	58,400	70,500	75,900	45,000
Alhambra Wash								
54	15.2	3810	5020	6030	9260	10,500	12,000	12,400
Coyote Creek								
62	150	16,500	23,900	29,900	38,800	45,200	52,500	49,000
Pacoima Wash								
5	53.2	5650	7980	9470	14,100	16,100	19,200	17,000
Project 85								
7	6.4	1340	1850	2120	3700	3700	3700	4070
Verdugo Wash								
16	28.8	8720	12,700	15,100	23,200	26,500	30,300	42,900
Arroyo Seco								
199	47.4	4190	10,200	12,500	17,700	22,200	26,400	43,000
Compton Creek								
26	41.2	7580	9880	11,800	16,400	18,900	21,700	13,750

RDCC = Revised Design Channel Capacity (see section 5.2.2).
Discharges in cubic feet per second.
See plate 9 for locations of CP's.

TABLE 3: CONCENTRATION POINT LOCATION GUIDE -- SAN GABRIEL RIVER

(With Channel Capacities)

C.P	LOCATION	CHAR. SYMBOL	CHANNEL CAPACITY REVISED* DESIGN (ft^3/s)	CHANNEL CAPACITY ORIG.* DESIGN (ft^3/s)	D.A. (mi^2)
31	Cogswell Dam Outflow	COGS	3000	3000	39.2
32	San Gabriel Dam Outflow	SGAB	95,000	95,000	201
33	Morris Dam Outflow	MORS	98,000	98,000	209
34	San Gabriel River below Fish Creek	SGBLFC	98,000	98,000	226
35	Santa Fe Dam Outflow	SNFE	41,000	41,000	237
36	San Gabriel River above Walnut Creek	SGABWC	41,000	41,000	244
37	San Dimas Dam Outflow	SDIM	8700	8700	16.2
38	Puddingstone Diversion Dam	PSDD	7000	7000	19.9
39	Big Dalton Dam Outflow	BIGD	7000	7000	4.5
40	Big Dalton Wash above Walnut Creek	BDABWC	25,500	25,500	41.5
401	San Dimas Wash below Puddingstone Diversion Dam (break out)	SDIM BKOUT	9900	9900	24.0
41	Live Oak Canyon Dam Outflow	LOAK	10,500	10,500	2.3
42	Puddingstone Reservoir Outflow	PDST	770	770	33.2
43	Walnut Creek above San Gabriel River	WCABSG	40,000	40,000	103
44	San Gabriel River below Walnut Creek	SGBLWC	60,000	60,000	347
45	Thompson Creek Dam Outflow	THOM	1500	1500	3.5
46	San Jose Creek above San Gabriel River	SJABSG	43,000	43,000	83.4
47	San Gabriel River below San Jose Creek	SGBLSJ	98,000	98,000	430
48	Santa Anita Dam Outflow	SNAN	12,000	12,000	10.8
49	Sawpit Wash Dam Outflow	SWPT	5000	5000	3.2
50	Quarry	QRRY	-	-	0
51	Rio Hondo below Santa Anita Wash	RHBLSA	26,000	26,000	31.3
52	Eaton Wash Dam Outflow	EATN	6600	6600	12.4
53	Rio Hondo above Whittier Narrows	RHABWN	45,000	45,000	85.2
54	Alhambra Wash above Whittier Narrows	ALABWN	12,400	12,400	15.2
55	Whittier Narrows Outflow (To San Gabriel River)	WNRS	13,000	13,000	437
555	San Gabriel River below Whittier Narrows	SGBLWN	13,500	13,500	437
56	San Gabriel River below Railroad Tracks	SGBLRR	19,500	19,500	459
58	San Gabriel River above Coyote Creek	SGABCO	20,000	20,000	475
59	Loftus Diversion Channel (Inflow to Fullerton Dam)	LOFT	2000	2000	1.8
60	Fullerton Dam Outflow	FLTN	600	600	5.0
61	Brea Dam Outflow	BREA	2200	2200	23.8
62	Coyote Creek above San Gabriel River	COABSG	49,000	49,000	150
63	San Gabriel River below Coyote Creek	SGBLCO	55,000	60,000	625
64	San Gabriel River at Pacific Ocean	SGATPO	55,600	60,000	635

* For reservoirs, channel capacity is immediately downstream .

See plate 9 for locations of CP's.

TABLE 4: CONCENTRATION POINT LOCATION GUIDE -- LOS ANGELES RIVER

(With Channel Capacities)

C.P.	LOCATION	CHAR. SYMBOL	CHANNEL CAPACITY REVISED* DESIGN (ft^3/s)	CHANNEL CAPACITY ORIG.* DESIGN (ft^3/s)	D.A. (mi^2)
10	Sepulveda Dam Outflow	SPDA	16,900	17,000	152
100	Los Angeles River below Sepulveda Dam	LABLSPDA	16,900	17,000	152
808	Los Angeles River at Hazeltine	HAZELTINE	18,400	19,000	164
11	Los Angeles River above Tujunga Wash	LAABTJ	20,300	24,000	174
1	Big Tujunga Dam Outflow	BIGT	36,000	36,000	82.3
2	Hansen Dam Outflow	HNSN	21,000	22,000	152
3	Pacoima Dam Outflow	PCMA	6800	6800	28.2
4	Lopez Dam Outflow	LOPZ	11,000	11,000	34.0
200	Tujunga Wash Below Hansen Dam	TJBLHNSN	20,800	22,000	152
611	Tujunga Wash above Pacoima Creek	TJABPC	20,800	22,000	158
5	Pacoima Creek above Tujunga Wash	PCABTJ	17,000	17,000	53.2
6	Tujunga Wash below Pacoima Creek	TJBLPC	26,900	29,000	211
7	Project 85	PROJ85	4070	4070	6.4
8	Tujunga Wash at Project 85	TJAT85	27,000	29,000	225
9	Tujunga Wash above Los Angeles River	TJABLA	29,000	30,000	229
12	Los Angeles River below Tujunga Wash	LABLTJ	48,700	52,000	403
125	Los Angeles River at Barham Blvd.	LAAB171	83,000	55,000	434
171	Los Angeles River above Verdugo Wash	LAABVW	40,000	40,000	464
13	Sycamore Canyon	SYCCYN	4770	4770	1.5
14	Scholl Canyon	SCHCYN	1825	1825	3.2
15	Scholl Diversion	SCHDIV	4850	4850	4.7
16	Verdugo Wash above Los Angeles River	VWABLA	42,900	42,900	28.8
17	Los Angeles River below Verdugo Wash	LABLVW	59,000	78,000	493
201	Los Angeles River at Sycamore Wash	LAATSW	80,800	78,000	507
20	Los Angeles River above Arroyo Seco	LABAAS	83,700	83,700	514
18	Devil's Gate Dam Outflow	DVGT	13,000	13,000	31.9
19	Arroyo Seco midway between Devil's Gate Dam and Los Angeles River	ASMIDWAY	43,000	43,000	38.6
199	Arroyo Seco above Los Angeles River	ASABLA	43,000	43,000	47.4
21	Los Angeles River below Arroyo Seco	LABLAS	104,000	104,000	561
95	Los Angeles River at 26th Street	LAAT26	108,000	104,000	590
215	Los Angeles River at Randolph	RANDOLPH	110,000	110,000	600
22	Los Angeles River above Rio Hondo	LAABRH	110,000	110,000	620
23	Rio Hondo below Whittier Narrows	RHBLWN	36,500	40,500	113
24	Rio Hondo above Los Angeles River	RHABLA	36,500	42,500	132
25	Los Angeles River below Rio Hondo	LABLRH	132,000	140,000	752
26	Compton Creek above Los Angeles River	COABLA	13,750	13,750	41.2
27	Los Angeles River above Compton Creek	LAABCO	133,000	140,000	766
28	Los Angeles River below Compton Creek	LABLCO	129,000	146,000	808
29	Los Angeles River at Pacific Ocean	LAATPO	133,000	146,000	824

* For reservoirs, channel capacity is immediately downstream.
See plate 9 for locations of CP's.

LOS ANGELES COUNTY DRAINAGE AREA

(LACDA)

REVIEW

LOS ANGELES COUNTY, CALIFORNIA

PART II HYDROLOGY REPORT

PROJECT ALTERNATIVES

U.S. ARMY CORPS OF ENGINEERS

LOS ANGELES DISTRICT

DECEMBER 1991

LOS ANGELES COUNTY DRAINAGE AREA, CALIFORNIA

PROJECT ALTERNATIVES

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LOS ANGELES COUNTY DRAINAGE AREA

PROJECT ALTERNATIVES

1 INTRODUCTION.

1.1 PURPOSE.

Part II hydrology is an extension of the LACDA Review study (presented in Los Angeles County Drainage Area (LACDA) Review, Part I Hydrology Report, Base Conditions) and discusses development of the National Economic Development (NED) Plan (Recommended Project) and its evaluation for feasibility purposes. In addition this report documents the hydrologic methods used to determine the NED Plan, as well as the residual flooding remaining after implementation of that plan.

1.2 SCOPE.

The basis for all evaluations of project alternatives was the hydrology - synthetic runoff hydrographs for each subarea for discrete frequencies, reservoir operations for all existing structures, combining and routing procedures for each channel and tributary, and overflow and breakout characteristics of each channel - presented in Part I. This hydrology was modified by adding proposed storage and conveyance and tracked downstream from locations of added protection to provide information to aid in costing the alternative projects and attributing benefits.

While the hydrologic analysis of project alternatives encompassed numerous proposals, not all of these were evaluated at a comparable level of detail. Some alternatives were eliminated based on excessive cost using only abbreviated evaluations, i.e., both from frequency considerations and spatial extent. For example, an alternative may have been culled as a consequence of an evaluation of its impact on the 100-year flood in a single reach of the LACDA system. Because so many alternatives were evaluated on this selected impact basis, these will be mentioned but not discussed in detail.

The hydrology leading to the final selection of the NED Plan will be presented in detail, as well as the residual flooding remaining after implementation of that plan. Interior drainage problems have not been included in the residual flooding analysis based upon a screen of the existing problem - while that screen indicated interior flooding problems do exist, the mainstem solutions recommended in the NED Plan do not appear to increase the interior drainage problem significantly. See Chapter 3 for a more detailed discussion of interior drainage. In some reaches the NED Plan will, in fact, allow more local runoff to enter the channels via lower water surfaces, e.g., Los Angeles River (LAR) from Compton Creek to the Pacific Ocean. Moreover, while most of the overflows are prevented or reduced from Base Conditions, the screen of interior drainage problems suggests that residual flooding remaining will still be greater than or mask the interior flooding. An analysis of the adverse impacts, if any, of the NED Plan on interior drainage will be conducted during the Pre-construction, Engineering, and Design (PED) phase of this project.

1.3 RESULTS.

The plan selected to meet NED requirements included enlarging the Rio Hondo Diversion Channel (RHDC) from Whittier Narrows Dam (WNRS) to the Los Angeles River and subsequently the Los Angeles River to the Pacific Ocean (plate 1). Also included in this plan is increasing the maximum Whittier Narrows release from 36,500 cubic feet per second (ft^3/s) for Base Conditions to 40,000 ft^3/s, and raising bridges which restrict design flow in both the Rio Hondo Diversion Channel and Los Angeles River below the Rio Hondo.

Discharge-frequency results for Recommended Project conditions at major concentration points (CP's) are presented in table 1. Tributary component discharges for Recommended Project conditions are shown in table 2. Channel capacities for the NED Plan are compared to Base Condition capacities in table 3. Locations of concentration points can be found on plate 2.

All inflow hydrographs to the Recommended Project line-of-protection are unchanged from Base Conditions (i.e., upper Los Angeles River outflow, Whittier Narrows inflow, local flow from Whittier Narrows to the Pacific Ocean, and Compton Creek). Discharge-frequency relationships below the Recommended Project initiation are considerably altered - the San Gabriel River (SGR) downstream from Whittier Narrows Dam is also impacted by the Recommended Project, because the maximum release from Whittier Narrows Dam to the Rio Hondo Diversion Channel has been increased, thus resulting in reduced spills.

The NED Plan channels are sized to convey all flow - including Whittier Narrows Dam scheduled releases, local inflow to Rio Hondo Diversion Channel, inflow from the Los Angeles River above the Rio Hondo Diversion Channel (LAABRH), and local inflow to the Los Angeles River from Rio Hondo Diversion Channel confluence (LABLRH) to the Pacific Ocean (LAATPO) - resulting from a flood whose exceedance frequency is 133-years. During this design event, flows in the upper Los Angeles River (ULAR - above RHDC) and tributaries exceed existing channel capacities, and overflow or break out at various locations.

Tributary flow and local runoff is expected to reach the mainstem Los Angeles River through drains, or overland when in excess of drain capacity. Compton Creek, which drains 41.2 mi^2 of the LACDA system and enters the LAR south of Artesia Freeway from the west, is affected by tailwater conditions generated in the Los Angeles River. As a result, not all of the runoff from the Compton Creek drainage area can be conveyed to the Los Angeles River. A discussion of the drainage problem in Compton Creek is included in the residual flooding analysis (section 2.4).

TABLE 1: DISCHARGE-FREQUENCY RESULTS RECOMMENDED PROJECT CONDITIONS

C.P.	D.A. (mi^2)	FREQUENCY (yrs) 50	100	133	200	500	CHANNEL CAPACITY[a] (ft^3/s)
2 Infl		33,500	47,900	51,100	64,000	76,500	
Outflow	152	15,800	18,900	19,700	21,100	25,000	21,000
611	158	16,000	19,200	20,000	21,500	25,500	20,800
6	211	20,200	28,300	31,000	37,100	37,200	26,900
8	225	22,200	32,600	34,600	38,800	39,600	27,000
9	229	25,400	37,100	38,800	42,500	44,400	29,000
10 Infl		54,900	82,500	86,800	94,700	109,000	
Outflow	152	15,700	17,000	24,000	37,500	75,400	16,900
11	174	22,000	27,400	28,500	35,000	61,000	20,300
12	403	47,400	64,500	67,300	72,900	88,500	48,700
171	465	63,400	83,900	88,500	96,300	105,000	40,000
17	493	77,500	94,600	99,000	109,000	125,000	59,000
20	514	82,000	93,800	97,700	106,000	118,000	83,700
21	561	94,400	109,000	114,000	124,000	141,000	104,000
22	620	95,900	109,000	114,000	115,000	128,000	110,000
25	752	138,000	153,000	158,000	166,000	178,000	200,000
2555	752	138,000	153,000	158,000	166,000	169,000	169,000
2777	766	140,000	158,000	164,000	164,000	164,000	164,000
27	766	140,000	158,000	164,000	164,000	164,000	164,000
28	808	144,000	168,000	173,000	173,000	174,000	182,000
29	824	146,000	170,000	175,000	176,000	179,000	182,000
35 Infl		29,000	53,200	62,400	80,300	111,000	
Outflow	237	27,800	32,800	38,500	38,500	41,000	41,000
Spill		0	0	0	0	29,700	
36	244	27,700	32,800	34,600	38,500	41,300	41,000
44	347	40,800	49,000	54,700	56,200	62,700	62,700
47	430	57,900	70,700	74,800	82,100	94,000	98,000
55 Infl		99,700	132,000	139,000	159,000	178,000	
Outflow to SGR	437	5000	5000	5000	47,500	86,900	13,500
56	459	10,800	12,200	12,600	25,100	48,700	19,500
58	475	14,500	17,200	17,800	20,000	22,800	20,000
63	625	44,300	55,900	58,900	64,300	73,900	55,000
64	635	44,100	55,000	42,000	45,900	52,000	55,600
55 Infl		99,700	132,000	139,000	159,000	178,000	
Outflow to RH	110	40,000	40,000	40,000	40,000	40,000	40,000
23	113	41,000	41,500	41,500	41,700	41,900	43,500
24	132	46,400	49,800	50,300	51,200	52,900	50,300

[a] Channel Capacities include the Revised Design Channel Capacity discharges from Part I Hydrology (section 5.2.2) and the design discharges for the Recommended Project.

Discharges in cubic feet per second.
See plate 2 for locations of CP's.

TABLE 2: TRIBUTARY COMPONENT DISCHARGE-FREQUENCY RESULTS RECOMMENDED PROJECT CONDITIONS

C.P.	D.A. (mi^2)	FREQUENCY (yrs) 50	100	133	200	500	CHANNEL CAPACITY[a] (ft^3/s)
Big Dalton Wash							
40	41.5	20,000	23,600	24,800	29,900	33,200	25,500
Walnut Creek							
43	103	28,900	34,800	36,400	39,800	42,400	40,000
San Jose Creek							
46	83.4	19,700	25,400	26,700	30,400	35,700	43,000
Rio Hondo							
51	31.3	19,700	23,700	24,300	31,600	34,900	26,000
53	85.2	41,600	58,400	61,200	70,500	75,900	45,000
Alhambra Wash							
54	15.2	6030	9260	9600	10,500	12,000	12,400
Coyote Creek							
62	150	29,900	38,800	40,500	45,200	52,500	49,000
Pacoima Wash							
5	53.2	9470	14,100	14,800	16,100	19,200	17,000
Project 85							
7	6.4	2120	3700	3700	3700	3700	4070
Verdugo Wash							
16	28.8	15,100	23,200	24,300	26,500	30,300	42,900
Arroyo Seco							
199	47.4	12,500	17,700	19,400	22,200	26,400	43,000
Compton Creek[b]							
26	41.2	11,800	13,000	12,100	12,200	11,600	13,750

[a] Channel Capacities include the Revised Design Channel Capacity discharges from Part I Hydrology (section 5.2.2) and the design discharges for the Recommended Project.

[b] Compton Creek discharges affected by tailwater in Los Angeles River.

Discharges in cubic feet per second.
See plate 2 for locations of CP's.

TABLE 3: COMPARISON OF CHANNEL CAPACITIES

NED DESIGN VERSUS EXISTING CONDITIONS

LOCATION	CHANNEL CAPACITY	
	NED DESIGN	EXISTING
RHDC below Whittier Narrows	40,000	40,000
RHDC upstream of Beverly Blvd.	42,000	36,500
RHDC upstream of Union Pacific Railroad	50,300	36,500
LAR below Rio Hondo Diversion Channel	158,000	132,000
LAR upstream of Artesia Freeway	164,000	133,000
LAR downstream of Compton Creek	182,000	129,000
LAR at Pacific Ocean	182,000	133,000
Discharges in cubic feet per second.		

Based upon comparisons of the existing design to the NED design, water surface elevations in the Los Angeles River below Compton Creek (LABLCO), and consequently in Compton Creek above the Los Angeles River (COABLA), have been reduced (see plate 3). For example, a flow rate of 137,000 ft^3/s in the Los Angeles River above Compton Creek (LAABCO) would permit a simultaneous inflow of 7500 ft^3/s from Compton Creek for the existing channel, while a flow rate of 164,000 ft^3/s at LAABCO would allow 7200 ft^3/s from Compton Creek for the NED design. Both flows have approximately a 133-year exceedance frequency for LAABCO. Furthermore, the existing design capacity immediately above Compton Creek is actually 140,000 ft^3/s, which would be exceeded more frequently than once per hundred years (on-the-average), if upstream restrictions at Fernwood Ave. did not cause flow exceeding 132,000 ft^3/s to break out of the Los Angeles River; the accompanying allowable inflow from Compton Creek for that flow rate is only 6500 ft^3/s. Since the maximum flow at LAABCO is 164,000 ft^3/s for the NED design, the minimum Compton Creek inflow for the NED design is 7200 ft^3/s; the maximum flow at LAABCO is about 139,000 ft^3/s under existing conditions, while the minimum Compton Creek inflow is 6600 ft^3/s. Thus, the current design reduces upstream flooding on Compton Creek not only for the design condition, but also for the worst case scenario. A comparison of Compton Creek inflow to the Los Angeles River for various flow rates and frequencies is shown in table 4.

Since no protection is provided by the NED Plan to the Los Angeles River upstream of the Rio Hondo Diversion Channel, flooding occurs at the identical locations and magnitudes, determined in Part I Hydrology for Base Conditions, upstream of the Recommended Project line-of-protection. During events less than or equal to the 133-year flood, no flow in excess of channel capacity originates from the Rio Hondo Diversion Channel below Whittier Narrows Dam to the Los Angeles River, or from the confluence with the Los Angeles River to the Pacific Ocean except for Compton Creek where channel capacity is affected by Los Angeles River tailwater and flows exceeding channel capacity break out and pond on the north side of the creek during the 100- and 133-year events. A schematic of reaches where 100-year flows exceed channel capacity is shown on plate 9. Some flooding persists outside the NED Plan improvement confines resulting from the upstream breakout from the Los Angeles River at 26th Street during events greater than the 100-year flood.

Similarly, flooding occurs in the vicinity of Compton Creek due to tailwater restrictions during these same frequency events. Inundation area maps, plates 4-8, show the areas affected by overflow for each frequency studied. Schematics showing locations and frequency of breakouts downstream of Whittier Narrows (plates 10 & 11) provide insight into the source of the overflow in the inundated areas.

TABLE 4: COMPARISON OF TAILWATER IMPACT ON COMPTON CREEK INFLOW TO THE LOS ANGELES RIVER NED DESIGN VERSUS EXISTING CONDITIONS

	PEAK FLOW RATES			
	LAABCO		COABLA*	
FREQUENCY (years)	NED DESIGN	EXISTING CONDITIONS	NED DESIGN	EXISTING CONDITIONS
50	139,000	129,000	12,500	10,100
100	157,000	135,000	8500	8100
133	164,000	137,000	7200	7400
200	164,000	139,000	7200	6800
500	164,000	135,000	7200	8100

* Peak flow rate which can enter LAR coincident with LAABCO shown.

Discharges in cubic feet per second.

2 ANALYSIS OF PROJECT ALTERNATIVES.

2.1 BACKGROUND.

Base Conditions hydrology - the 2-, 5-, 10-, 25-, 50-, 100-, 200-, and 500-year subarea runoff hydrographs - were written to a data base, the Hydrologic Engineering Center's Data Storage System (HECDSS), which can be directly accessed by other HEC software (see Part I Hydrology, section 4.5). The subarea frequency hydrographs were computed as described in Chapter 4 of Part I Hydrology and written to HECDSS. Subsequently, the information was read into HEC-5 data models, representing alternatives to the Base Conditions, in the identical manner as in Part I Hydrology.

Since HEC-5 is linked to HECDSS via both read and write functions, complex simulations involving reservoir operation, tributary inflow, channel routing, hydrograph combination, and breakout determination, along with resulting overflow routing, which exceed the capacity of HEC-5, can be subdivided into sequential data models which write intermediate results to HECDSS that are then read into downstream models.

In general, the Base Conditions as well as project conditions analyses were conducted in this manner, using an HEC-5 program configured specifically for the LACDA study: this program, dated March 1987, had two parts, "H5ALA87" and "H5BLA87", which permitted computations for intervals of 15 minutes and was upsized to allow 80 control points, 40 reservoirs, and 40 diversions. The magnitude and complexity of the simulation can be inferred from the fact that the Base Conditions "model" was actually composed of 9 separate HEC-5 models for each frequency flood, many of which required 2-3 preliminary iterations, from which time and locations of breakouts and/or levee failures could be determined.

The 9 submodels were then able to track all flows both within and outside of channel confines using the same time frame for a given frequency flood. Project alternatives were evaluated by quantifying the project in the appropriate submodel, and writing the output for project conditions to HECDSS to be read into the downstream submodels for comparison to Base Conditions.

2.2 PROJECT ALTERNATIVES.

The alternatives investigated involved both storage and conveyance alternatives and are listed in table 5 which follows.

TABLE 5: LIST OF HYDROLOGIC ALTERNATIVES

<u>STORAGE ALTERNATIVES</u>

Enlarged Existing Flood Control Pools [a]:
- Sepulveda Dam
- Hansen Dam
- Whittier Narrows Dam
- Devil's Gate Dam

Detention Storage [b]:
- Pacoima Spreading Grounds
- Tujunga Spreading Grounds
- Taylor Railroad Yard (Los Angeles River below Arroyo Seco)
- Gravel Pits (San Gabriel River below Santa Fe Dam)

<u>CONVEYANCE ALTERNATIVES</u>

Diversion Tunnels to Pacific Ocean:
- Los Angeles River at/below Sepulveda Dam
- Tujunga Wash at/below Hansen Dam
- Pacoima Wash at Lopez Spreading Grounds [c]
- Los Angeles River above Arroyo Seco
- Los Angeles River below Arroyo Seco
- Los Angeles River below Rio Hondo

Armored Levees:
- Rio Hondo Diversion Channel
- Los Angeles River, Rio Hondo to Pacific Ocean

Enlarged Channels:
- Tujunga Wash, Hansen Dam to Los Angeles River
- Los Angeles River
- Rio Hondo Diversion Channel
- San Gabriel River, Whittier Narrows to Pacific Ocean

[a] Results could be substituted for flood control at new sites.
[b] Included intake and outlet facilities.
[c] To Hansen Dam.

The alternatives were evaluated for various sizes, e.g. a range of storage allocations or diversion capacities, as well as various objectives, e.g., 100-year protection in a given reach. Because nearly all damage from flooding during existing conditions occurs along the Rio Hondo Diversion Channel and the Los Angeles River below the Rio Hondo, and since the upstream alternatives investigated had little potential impact on these damages, none of the upstream alternatives was justifiable based upon cost versus damage prevented.

The only plans which could prevent damages at a cost supportable by a project were direct solutions - protection at the damage locations. These direct solutions (shown on plate 1) involved increased conveyance from Whittier Narrows Dam to the Los Angeles River, and from the Los Angeles River confluence with Rio Hondo to the Pacific Ocean.

2.3 DEVELOPMENT OF NED PLAN.

In Part I Hydrology a determination was made on a system-wide basis of the peak flow rates at various locations for frequencies of 10-, 25-, 50-, 100-, 200-, and 500-years, assuming that all runoff reached the channels and reservoirs, and that once the flow reached the mainstem channels it remained within the channels. (Both 2- and 5-year frequency discharges were also determined, but not reported because they were well within the capacity of the existing system.) This determination of ultimate runoff was referred to as the "infinite channel" concept (Part I Hydrology, table 31).

The results were used in the initial project alternatives phase of the study to size and cost different levels of protection for the LACDA system. However, since upstream projects, including channels, fell out as potential alternatives, the peak flow rates resulting from the "infinite channel" assumptions no longer were valid for sizing and costing downstream channels. This is a result of upstream breakouts and overflows during large events, which reduce the peak flow rate and alter the timing of the flood hydrographs delivering flow to the Los Angeles River in the Recommended Project reaches.

Comparison of peak flow rates in tables 1 and 31 (Part I Hydrology) for CP-22 (LAABRH) reveal a reduction in the peak inflow to the lower Los Angeles River (LLAR, LABLRH) of from about 3000 ft^3/s during the 50-year flood, to 52,000 ft^3/s for the 500-year flood. Hence, a design of the lower Los Angeles River channel based upon no upstream project might be significantly reduced from that proposed for "infinite channels". A summary of the differences between "infinite channel" peak flow at CP-22 and the peak flow at CP-22 with no upstream project (Base Conditions) are shown in the following table.

TABLE 6: COMPARISON OF PEAK FLOW AT CP-22 (LAABRH)

UPSTREAM PROTECTION[a] VERSUS BASE CONDITIONS

	FREQUENCY (years)				
	25	50	100	200	500
UPSTREAM PROTECTION	80,700	98,600	126,000	146,000	180,000
BASE CONDITIONS	80,700	95,900	109,000	115,000	128,000

[a] Upstream protection implies all flow is carried in channel, i.e., "infinite channel".

Discharges in cubic feet per second.

Since upstream projects were not viable, downstream projects had to be re-evaluated for size and cost based upon Base Conditions in the upper Los Angeles River. Therefore, downstream discharges for Recommended Project design were computed using a "semi-infinite channel" concept wherein all flow upstream of project origination was equivalent to Base Conditions, and all flow downstream stayed within the channel confines.

In addition, the rainfall-runoff analysis to determine upstream Base Conditions and resulting downstream channel requirements was extended to other frequencies to provide better definition of the discharge-frequency relationship in the lower Los Angeles River. These additional frequencies were the 80-, 125-, 150-, 250-, and 300-year exceedance intervals; inflows to the improved Los Angeles River associated with these and the other frequencies are shown in table 7. No information is shown for events equal to or less than the 25-year flood, since there are no damages associated with those events.

Because the damage frequency function increased steadily in the range of floods studied, the maximum net benefit computation would be driven by a break in the cost curve. That break was determined to be the flow rate at which the Artesia Freeway (Highway 91) would have to be raised. Hydraulic analysis put the existing bridge capacity at 164,000 ft^3/s at Artesia Freeway. Discharges in table 7 (refer to CP-27, LAABCO) indicated this flow rate would result from a flood whose exceedance frequency was between 125-year and 150-year.

Because of the complexity of the impact of upstream reservoir operations and overbank/breakout events in the channels below the reservoirs, the frequency of a flood exceeding 164,000 ft^3/s at Artesia Freeway was established by rainfall-runoff analysis. Another reason for this approach was to provide component hydrographs for residual flooding (section 2.4) associated with this event.

The rainfall-runoff approach was a trial-and-error process involving interpolation of existing rainfall frequency information to estimate the rainfall depths for the basin, distribution of the rainfall over each subarea, computation of subarea runoff, and combining and routing procedures documented in Part I Hydrology, Chapter 4. The rainfall frequency which produced a peak flow of 164,000 ft^3/s at the Artesia Freeway bridge (assuming upstream Base Conditions, Whittier Narrows Dam operation releasing a maximum of 40,000 ft^3/s to the Rio Hondo Diversion Channel, and 5000 ft^3/s to the SGR over the spillway) was determined to be 133-years. Twenty-four hour rainfall depths

TABLE 7: "SEMI-INFINITE CHANNEL" DISCHARGES

DEVELOPMENT OF NED DESIGN

CP	LOCATION	FREQUENCY (YEARS)								
		50	80	100	125	150	200	250	300	500
22	LAABRH	95,900	107,000	109,000	113,000	115,000	115,000	118,000	120,000	128,000
24	RHABLA	46,400	49,200	49,800	50,100	50,600	51,200	51,600	52,000	52,900
25	LABLRH	138,000	150,000	153,000	157,000	161,000	167,000	169,000	172,000	180,000
27	LAABCO	140,000	152,000	158,000	162,000	167,000	173,000	176,000	179,000	188,000
26	COABLA	11,800	15,500	16,400	17,100	17,900	18,900	19,500	20,100	21,700
28	LABLCO	144,000	167,000	174,000	179,000	184,000	191,000	194,000	198,000	208,000
29	LAATPO	146,000	168,000	176,000	181,000	187,000	193,000	197,000	201,000	211,000

NOTE: Discharges presented assume all flow downstream of CP-22 and WNRS stays within channel, and all local inflow reaches channel.

See plate 2 for location of CP's.

Discharges in cubic feet per second.

Appendix C. HEC-RAS Reports and Exhibits

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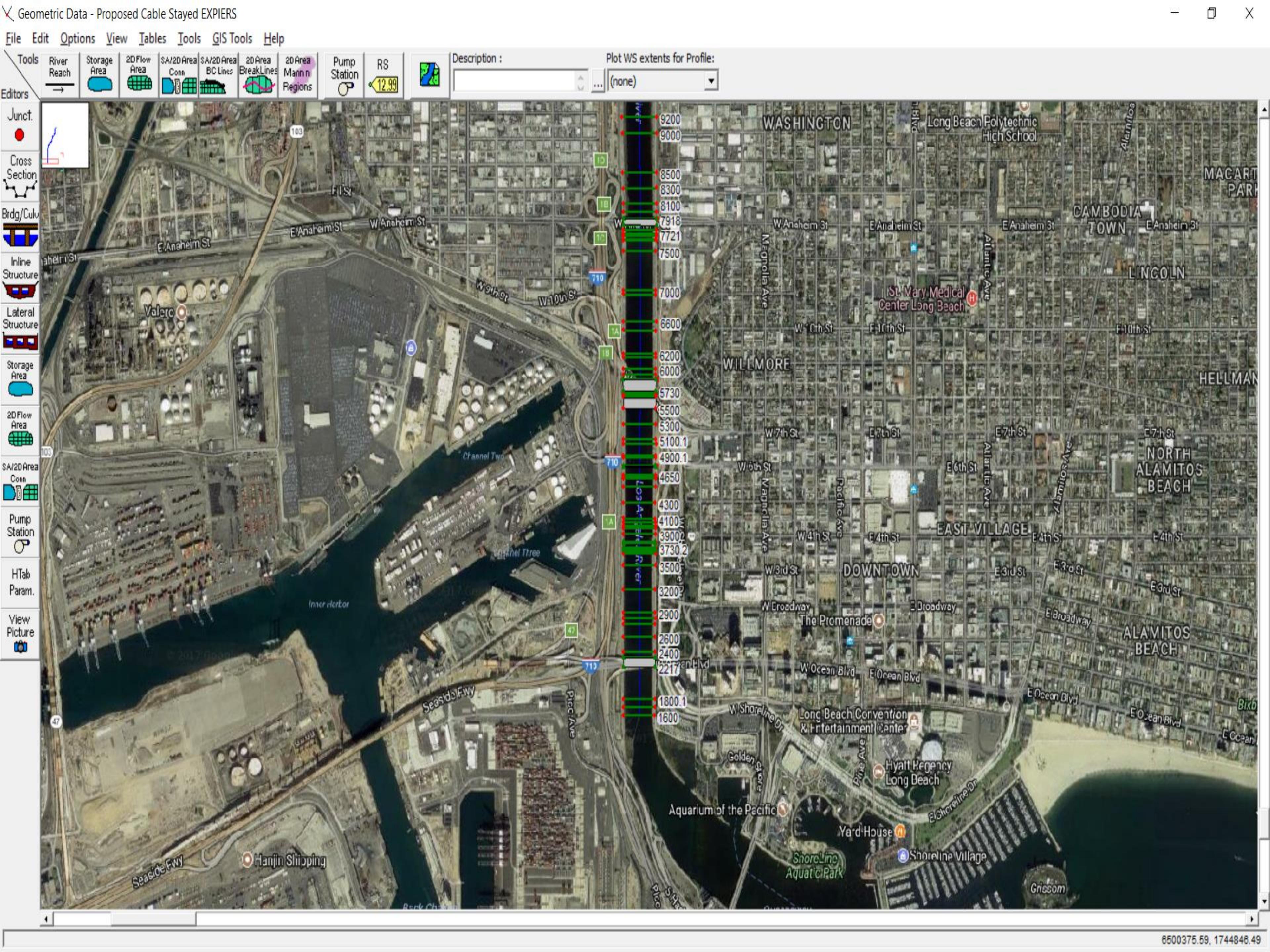
Geometric Data - Proposed Cable Stayed EXPIERS
File
Edit
Options
View
Tables
Tools
GIS Tools
Help
Tools
Editors
River Reach
Storage Area
2D Flow Area
SA/2D Area Conn
SA/2D Area BC Lines
2D Area BreakLines
2D Area Mann n Regions
Pump Station
RS
12.99
Description :
Plot WS extents for Profile:
(none)
Junct.
Cross Section
Brdg/Culv
Inline Structure
Lateral Structure
Storage Area
2D Flow Area
SA/2D Area Conn
Pump Station
HTab Param.
View Picture
9200
9000
8500
8300
8100
7918
7721
7500
7000
6600
6200
6000
5730
5500
5300
5100.1
4900.1
4650
4300
4100
3900
3730.2
3500
3200
2900
2600
2400
2217
1800.1
1600
WASHINGTON
Long Beach Polytechnic High School
MACARTHUR PARK
CAMBODIA TOWN
LINCOLN
St. Mary Medical Center Long Beach
WILLMORE
HELLMAN
NORTH ALAMITOS BEACH
EAST VILLAGE
DOWNTOWN
ALAMITOS BEACH
The Promenade
Long Beach Convention & Entertainment Center
Hyatt Regency Long Beach
Aquarium of the Pacific
Yard House
Shoreline Village
Shoreline Aquatic Park
Hanjin Shipping
Valero
W Anaheim St
E Anaheim St
W 10th St
E 10th St
W 7th St
E 7th St
W 4th St
E 4th St
W 3rd St
E 3rd St
W Broadway
E Broadway
W Ocean Blvd
E Ocean Blvd
Seaside Fwy
Magnolia Ave
Pacific Ave
Atlantic Ave
Alamitos Ave
Pico Ave
Channel Two
Channel Three
Inner Harbor
Grissom
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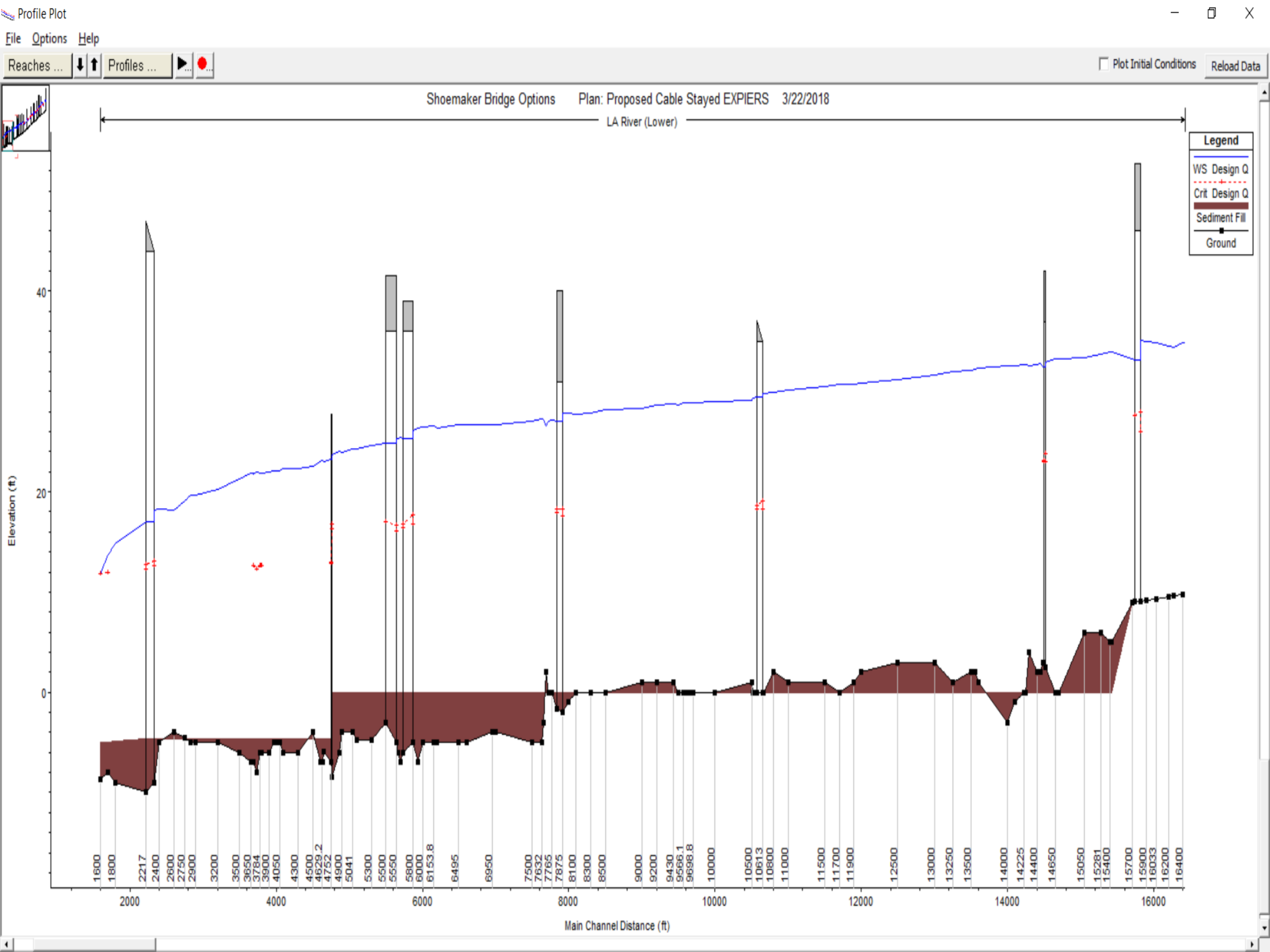

Profile Plot
File Options Help
Reaches ... Profiles ...
Plot Initial Conditions
Reload Data
Shoemaker Bridge Options Plan: Proposed Cable Stayed EXPIERS 3/22/2018
LA River (Lower)
Legend
WS Design Q
Crit Design Q
Sediment Fill
Ground
Elevation (ft)
40
20
0
1600
1800
2217
2400
2600
2750
2900
3200
3500
3650
3784
3900
4050
4300
4500
4629.2
4752
4900
5041
5300
5500
5550
5800
6000
6153.8
6495
6950
7500
7632
7765
7875
8100
8300
8500
9000
9200
9430
9566.1
9698.8
10000
10500
10613
10800
11000
11500
11700
11900
12500
13000
13250
13500
14000
14225
14400
14650
15050
15281
15400
15700
15900
16033
16200
16400
2000
4000
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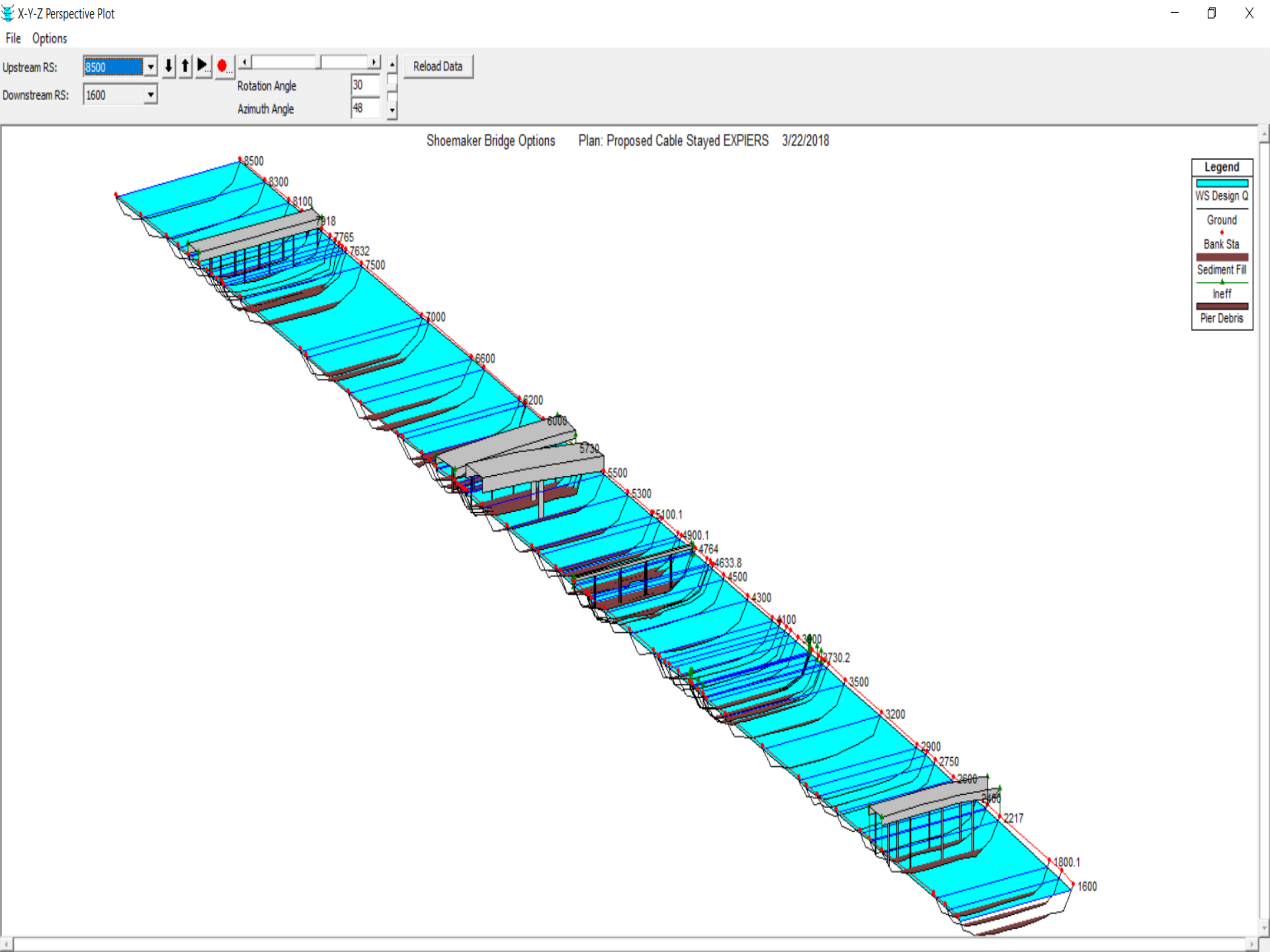
8000
10000
12000
14000
16000
Main Channel Distance (ft)



X-Y-Z Perspective Plot
File Options
Upstream RS: 8500
Downstream RS: 1600
Rotation Angle 30
Azimuth Angle 48
Reload Data
Shoemaker Bridge Options Plan: Proposed Cable Stayed EXPIERS 3/22/2018
Legend
WS Design Q
Ground
Bank Sta
Sediment Fill
Ineff
Pier Debris
8500
8300
8100
7765
7632
7500
7000
6600
6200
5500
5300
5100.1
4900.1
4764
4633.8
4500
4300
3730.2
3500
3200
2900
2750
2217
1800.1
1600

HEC-RAS Plan: PropCSEXPIERS River: LA River Reach: (Lower) Profile: Design Q

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)	
(Lower)	63815	Design Q	140000.00	79.76	105.60	97.91	108.85	0.000372	14.47	9675.49	454.91	0.55
(Lower)	63495	Design Q	140000.00	79.28	104.75		108.72	0.000474	15.98	8758.77	422.83	0.62
(Lower)	63474	Design Q	140000.00	79.25	104.75	98.21	108.71	0.000472	15.96	8770.83	422.90	0.62
(Lower)	63409		Bridge									
(Lower)	63344	Design Q	184000.00	79.06	104.23		110.94	0.000802	20.77	8857.09	426.60	0.80
(Lower)	63279	Design Q	184000.00	78.96	104.22	101.11	110.87	0.000792	20.69	8894.40	426.94	0.80
(Lower)	63104	Design Q	184000.00	78.71	101.76	100.99	110.70	0.001142	23.99	7671.26	384.50	0.95
(Lower)	62874	Design Q	184000.00	78.37	103.30		110.47	0.000834	21.48	8565.71	400.11	0.82
(Lower)	62529	Design Q	184000.00	77.85	101.41	100.53	110.14	0.001122	23.70	7762.51	394.38	0.94
(Lower)	62184	Design Q	184000.00	77.34	100.26	100.26	109.73	0.001283	24.69	7451.86	394.07	1.00
(Lower)	61814	Design Q	184000.00	76.80	97.81	99.32	109.19	0.001675	27.06	6803.56	390.22	1.14
(Lower)	61399	Design Q	184000.00	76.18	97.12	98.82	108.60	0.001723	27.18	6769.90	389.75	1.15
(Lower)	61064	Design Q	184000.00	75.69	95.48	97.87	107.89	0.001951	28.26	6510.62	389.64	1.22
(Lower)	60689	Design Q	184000.00	75.13	94.90	97.21	107.14	0.001904	28.06	6557.19	389.04	1.20
(Lower)	60224	Design Q	184000.00	74.45	96.45	96.49	105.90	0.001281	24.65	7465.18	397.66	1.00
(Lower)	59844	Design Q	184000.00	73.88	94.18	95.60	105.19	0.001623	26.62	6911.86	393.25	1.12
(Lower)	59429	Design Q	158000.00	73.27	89.40	93.46	103.96	0.002899	30.62	5160.31	369.09	1.44
(Lower)	58984	Design Q	158000.00	71.75	97.82	91.79	102.51	0.000504	17.38	9091.85	400.10	0.64
(Lower)	58509	Design Q	158000.00	71.01	97.68		102.24	0.000480	17.12	9229.98	399.40	0.63
(Lower)	58164	Design Q	158000.00	70.65	97.70		102.00	0.000439	16.65	9492.18	400.10	0.60
(Lower)	57754	Design Q	158000.00	70.22	97.70		101.75	0.000403	16.14	9788.43	403.30	0.58
(Lower)	57324	Design Q	158000.00	69.77	97.60		101.56	0.000387	15.95	9904.76	404.36	0.57
(Lower)	57181.12	Design Q	158000.00	69.62	97.37	89.48	101.37	0.000394	16.04	9850.47	404.76	0.57
(Lower)	57151.73		Bridge									
(Lower)	57122.33	Design Q	158000.00	69.56	97.05		101.14	0.000409	16.23	9735.66	405.12	0.58
(Lower)	57064.97	Design Q	158000.00	69.50	97.03	89.47	101.12	0.000409	16.22	9739.27	405.46	0.58
(Lower)	57038.54		Bridge									
(Lower)	57012.10	Design Q	158000.00	69.44	96.67		100.87	0.000427	16.44	9613.42	405.78	0.60
(Lower)	56976.86	Design Q	158000.00	69.41	96.65	89.37	100.85	0.000427	16.44	9610.05	406.00	0.60
(Lower)	56955.8		Bridge									
(Lower)	56934.74	Design Q	158000.00	69.36	96.28		100.60	0.000447	16.68	9473.12	406.24	0.61
(Lower)	56859	Design Q	158000.00	69.28	93.80		99.99	0.001125	19.95	7917.92	382.70	0.77
(Lower)	56519	Design Q	158000.00	68.93	93.55		99.50	0.001061	19.55	8081.11	384.20	0.75
(Lower)	56433	Design Q	158000.00	68.82	93.97		98.95	0.000556	17.89	8829.63	397.50	0.67
(Lower)	56359	Design Q	158000.00	68.69	93.96		98.88	0.000547	17.80	8875.21	397.50	0.66
(Lower)	56218.60	Design Q	158000.00	68.46	93.68	88.64	98.72	0.000572	18.01	8770.90	402.68	0.68
(Lower)	56176.3		Bridge									
(Lower)	56134	Design Q	158000.00	68.32	86.38	88.64	97.63	0.001958	26.91	5871.58	379.26	1.21
(Lower)	55829	Design Q	164000.00	67.81	90.24	87.99	97.11	0.000772	21.03	7799.53	397.60	0.84
(Lower)	55549	Design Q	164000.00	67.34	90.49		96.72	0.000662	20.02	8192.67	399.80	0.78
(Lower)	55239	Design Q	164000.00	66.83	88.60	87.46	96.33	0.000934	22.30	7355.48	400.12	0.92
(Lower)	54884	Design Q	164000.00	66.23	89.44		95.57	0.000661	19.85	8260.93	409.40	0.78
(Lower)	54549	Design Q	164000.00	65.67	89.26		95.33	0.000637	19.76	8299.90	402.40	0.77
(Lower)	54229	Design Q	164000.00	65.14	89.13		95.10	0.000626	19.59	8371.13	407.50	0.76
(Lower)	53969	Design Q	164000.00	64.71	88.73		94.90	0.000657	19.93	8229.76	405.75	0.78
(Lower)	53739	Design Q	164000.00	64.32	89.03	84.70	94.57	0.000568	18.88	8688.46	415.60	0.73
(Lower)	53719		Bridge									
(Lower)	53699	Design Q	164000.00	64.26	88.37	84.63	94.24	0.000623	19.44	8435.98	414.61	0.76
(Lower)	53549	Design Q	164000.00	64.00	88.49		93.93	0.000580	18.72	8761.23	432.54	0.73
(Lower)	53359	Design Q	164000.00	63.69	88.46	83.76	93.76	0.000556	18.47	8881.23	432.99	0.72
(Lower)	53264		Bridge									
(Lower)	53169	Design Q	164000.00	63.37	82.25	83.67	92.54	0.001459	25.73	6373.65	391.62	1.12
(Lower)	52928	Design Q	164000.00	62.97	81.97	83.21	92.11	0.001428	25.55	6419.86	392.20	1.11
(Lower)	52568	Design Q	164000.00	62.37	80.15	82.31	91.55	0.001698	27.08	6056.58	386.00	1.21
(Lower)	52400	Design Q	164000.00	62.08	79.93	82.03	91.27	0.001655	27.01	6070.79	380.32	1.19
(Lower)	51950	Design Q	164000.00	61.33	79.18	81.28	90.52	0.001655	27.01	6070.79	380.32	1.19
(Lower)	51551	Design Q	164000.00	60.67	78.52	80.62	89.86	0.001655	27.01	6070.71	380.31	1.19
(Lower)	51550	Design Q	164000.00	60.66	78.48	80.62	89.86	0.001663	27.06	6061.28	380.19	1.19
(Lower)	51053	Design Q	164000.00	59.84	77.66	79.76	89.04	0.001663	27.06	6061.59	380.23	1.19
(Lower)	51045	Design Q	164000.00	59.82	77.65	79.74	89.02	0.001661	27.05	6063.88	380.23	1.19
(Lower)	50800	Design Q	164000.00	59.41	81.63	79.33	88.54	0.000779	21.08	7778.20	400.00	0.84
(Lower)	50679	Design Q	164000.00	59.21	81.78		88.45	0.000738	20.72	7915.81	401.55	0.82
(Lower)	50576	Design Q	164000.00	59.04	82.49		88.37	0.000651	19.46	8426.51	425.76	0.77
(Lower)	50324	Design Q	164000.00	58.62	82.62		88.21	0.000586	18.97	8644.90	420.27	0.74
(Lower)	50279	Design Q	164000.00	58.55	82.66		88.19	0.000576	18.86	8694.31	420.51	0.73
(Lower)	50233	Design Q	164000.00	58.47	82.72	78.43	88.16	0.000567	18.72	8761.75	424.31	0.73
(Lower)	50203		Bridge									
(Lower)	50173	Design Q	164000.00	58.37	76.28	78.25	87.23	0.001654	26.55	6178.07	397.54	1.19
(Lower)	50132	Design Q	164000.00	58.30	76.23	78.22	87.19	0.001658	26.56	6175.01	397.75	1.19
(Lower)	50100	Design Q	164000.00	58.25	76.48	78.19	87.14	0.001586	26.20	6259.97	397.92	1.16
(Lower)	50099	Design Q	164000.00	58.25	76.50	78.18	87.14	0.001580	26.17	6267.91	398.00	1.16
(Lower)	50050	Design Q	164000.00	58.16	76.43	78.16	87.06	0.001596	26.15	6270.60	401.95	1.17
(Lower)	50000	Design Q	164000.00	58.08	76.79	78.00	86.99	0.001408	25.62	6400.36	384.16	1.11
(Lower)	49980	Design Q	164000.00	57.95	76.21	77.87	86.96	0.001529	26.31	6233.98	382.88	1.15
(Lower)	49961	Design Q	164000.00	57.82	75.86	77.74	86.93	0.001594	26.69	6145.53	381.18	1.17
(Lower)	49883	Design Q	164000.00	57.30	74.53	77.22	86.80	0.001868	28.10	5835.80	377.49	1.26
(Lower)	49800	Design Q	164000.00	56.74	73.38	76.66	86.64	0.002103	29.21	5614.99	374.89	1.33
(Lower)	49770	Design Q	164000.00	56.70	73.37	76.62	86.57	0.002090	29.15	5626.39	375.01	1.33
(Lower)	49650	Design Q	164000.00	56.54	73.32	76.46	86.33	0.002042	28.93	5668.69	375.56	1.31

HEC-RAS Plan: PropCSEXPIERS River: LA River Reach: (Lower) Profile: Design Q (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)	
(Lower)	49422	Design Q	164000.00	56.23	73.23	76.15	85.87	0.001954	28.52	5749.65	376.38	1.29
(Lower)	49191	Design Q	164000.00	55.92	73.11	75.83	85.44	0.001881	28.17	5822.39	377.39	1.26
(Lower)	49190	Design Q	164000.00	55.92	73.11	75.83	85.44	0.001880	28.16	5823.54	377.39	1.26
(Lower)	49100	Design Q	164000.00	55.80	73.08	75.71	85.27	0.001849	28.01	5854.53	377.69	1.25
(Lower)	48877	Design Q	164000.00	55.50	72.95	75.41	84.87	0.001786	27.70	5921.57	378.55	1.23
(Lower)	48700	Design Q	164000.00	55.27	72.88	75.18	84.57	0.001734	27.43	5979.39	379.24	1.22
(Lower)	48500	Design Q	164000.00	55.00	72.76	74.91	84.23	0.001684	27.17	6035.81	379.86	1.20
(Lower)	48199	Design Q	164000.00	54.60	77.05	74.51	83.80	0.000752	20.84	7867.77	401.01	0.83
(Lower)	48082	Design Q	164000.00	54.44	77.11		83.71	0.000727	20.61	7957.29	402.00	0.82
(Lower)	48000	Design Q	164000.00	54.33	77.15		83.65	0.000710	20.45	8017.70	402.69	0.81
(Lower)	47973	Design Q	164000.00	54.29	77.23		83.63	0.000735	20.29	8081.76	421.62	0.82
(Lower)	47773	Design Q	164000.00	54.02	77.75		83.50	0.000607	19.24	8524.01	416.32	0.75
(Lower)	47682	Design Q	164000.00	53.90	77.85		83.44	0.000578	18.98	8640.82	414.71	0.73
(Lower)	47640	Design Q	164000.00	53.85	77.90	73.57	83.42	0.000567	18.84	8703.32	415.90	0.73
(Lower)	47593		Bridge									
(Lower)	47546	Design Q	164000.00	53.72	71.43	73.43	82.51	0.001652	26.71	6141.08	390.53	1.19
(Lower)	47497	Design Q	164000.00	53.65	75.95	73.40	82.56	0.000748	20.62	7952.51	409.58	0.83
(Lower)	47454	Design Q	164000.00	53.60	75.91		82.52	0.000750	20.63	7950.52	410.12	0.83
(Lower)	47450	Design Q	164000.00	53.59	75.90		82.52	0.000753	20.65	7943.66	410.57	0.83
(Lower)	47449	Design Q	164000.00	53.59	75.90		82.52	0.000753	20.65	7943.13	410.57	0.83
(Lower)	47350	Design Q	164000.00	53.46	75.60	73.54	82.44	0.000805	20.98	7816.92	415.82	0.85
(Lower)	47349	Design Q	164000.00	53.46	75.56		82.44	0.000808	21.05	7790.60	412.66	0.85
(Lower)	47260	Design Q	164000.00	53.34	75.34		82.38	0.000804	21.28	7707.73	400.67	0.86
(Lower)	47200	Design Q	164000.00	53.26	75.26	73.15	82.33	0.000806	21.33	7688.67	398.99	0.86
(Lower)	47123	Design Q	164000.00	53.15	75.30		82.26	0.000787	21.16	7750.28	399.69	0.85
(Lower)	47100	Design Q	164000.00	53.12	75.29		82.24	0.000785	21.14	7757.34	399.77	0.85
(Lower)	46990	Design Q	164000.00	52.98	75.33		82.15	0.000763	20.94	7830.33	400.57	0.84
(Lower)	46600	Design Q	164000.00	52.45	75.54		81.87	0.000681	20.18	8125.98	402.94	0.79
(Lower)	46200	Design Q	164000.00	51.92	75.69		81.61	0.000615	19.53	8398.83	404.47	0.76
(Lower)	46113	Design Q	164000.00	51.80	75.72		81.56	0.000601	19.38	8464.14	405.85	0.75
(Lower)	45888	Design Q	164000.00	51.50	75.79		81.42	0.000571	19.04	8615.11	408.17	0.73
(Lower)	45760	Design Q	164000.00	51.33	75.78		81.33	0.000560	18.90	8679.37	410.00	0.72
(Lower)	45642	Design Q	164000.00	51.17	75.77		81.24	0.000547	18.76	8740.27	410.00	0.72
(Lower)	45612	Design Q	164000.00	51.13	75.76		81.22	0.000545	18.73	8755.09	410.42	0.72
(Lower)	45499	Design Q	164000.00	50.98	75.80	71.05	81.11	0.000530	18.50	8866.36	410.83	0.70
(Lower)	45463		Bridge									
(Lower)	45427	Design Q	164000.00	50.88	68.89	71.10	80.00	0.001603	26.73	6134.32	381.05	1.17
(Lower)	45267	Design Q	164000.00	50.67	68.64	70.89	79.81	0.001617	26.81	6116.63	380.84	1.18
(Lower)	45250	Design Q	164000.00	50.64	68.61	70.82	79.78	0.001615	26.80	6119.44	380.88	1.18
(Lower)	45249	Design Q	164000.00	50.64	68.64	70.83	79.77	0.001608	26.76	6128.16	380.99	1.18
(Lower)	45210	Design Q	164000.00	50.59	68.60	70.68	79.71	0.001604	26.74	6133.10	381.03	1.18
(Lower)	45021	Design Q	164000.00	50.34	68.48	70.18	79.42	0.001565	26.53	6182.03	381.61	1.16
(Lower)	45000	Design Q	164000.00	50.31	68.45	70.15	79.39	0.001565	26.53	6182.03	381.61	1.16
(Lower)	44950	Design Q	164000.00	50.23	68.37	70.07	79.31	0.001565	26.53	6182.69	381.62	1.16
(Lower)	44830	Design Q	164000.00	50.04	68.18	69.90	79.11	0.001564	26.52	6183.66	381.64	1.16
(Lower)	44829	Design Q	164000.00	50.03	68.14	69.89	79.12	0.001574	26.57	6171.43	381.50	1.16
(Lower)	44800	Design Q	164000.00	49.99	68.10	69.90	79.08	0.001573	26.57	6171.62	381.52	1.16
(Lower)	44750	Design Q	164000.00	49.91	68.02	69.81	79.00	0.001573	26.57	6171.99	381.51	1.16
(Lower)	44700	Design Q	164000.00	49.83	67.94	69.73	78.91	0.001573	26.57	6172.45	381.51	1.16
(Lower)	44699	Design Q	164000.00	49.82	67.90	69.72	78.92	0.001582	26.62	6160.56	381.37	1.17
(Lower)	44650	Design Q	164000.00	49.74	67.83	69.64	78.84	0.001581	26.62	6161.51	381.37	1.17
(Lower)	44400	Design Q	164000.00	49.34	67.43	69.24	78.43	0.001580	26.61	6163.26	381.39	1.17
(Lower)	43900	Design Q	164000.00	48.53	70.53	68.43	77.61	0.000796	21.36	7679.26	391.00	0.85
(Lower)	43850	Design Q	164000.00	48.45	70.57		77.57	0.000781	21.22	7728.46	391.50	0.84
(Lower)	43501	Design Q	164000.00	47.89	70.98	67.80	77.31	0.000676	20.19	8120.88	398.60	0.79
(Lower)	43500	Design Q	164000.00	47.89	68.74	68.29	77.31	0.001684	23.49	6981.77	381.82	0.97
(Lower)	43455	Design Q	164000.00	47.82	68.66	68.21	77.24	0.001687	23.50	6977.54	381.77	0.97
(Lower)	43340	Design Q	164000.00	47.63	68.46	68.02	77.05	0.001689	23.51	6975.00	381.77	0.97
(Lower)	43200	Design Q	164000.00	47.40	68.21	67.79	76.82	0.001693	23.53	6968.86	381.65	0.97
(Lower)	43199	Design Q	164000.00	47.40	68.21	67.79	76.82	0.001693	23.54	6967.61	381.64	0.97
(Lower)	43133	Design Q	164000.00	47.29	68.10	67.68	76.71	0.001694	23.54	6966.16	381.62	0.97
(Lower)	43055	Design Q	164000.00	47.17	67.96	67.56	76.58	0.001699	23.56	6960.17	381.69	0.97
(Lower)	43025	Design Q	164000.00	47.12	67.90	67.51	76.54	0.001700	23.57	6957.60	381.58	0.97
(Lower)	42946	Design Q	164000.00	46.99	67.76	67.38	76.41	0.001704	23.59	6951.35	381.45	0.97
(Lower)	42845	Design Q	164000.00	46.83	67.21	67.21	76.24	0.001808	24.10	6805.27	379.73	1.00
(Lower)	42844	Design Q	164000.00	46.83	65.78	67.08	76.24	0.002018	25.95	6320.82	376.26	1.12
(Lower)	42780	Design Q	164000.00	46.73	65.77	66.98	76.11	0.001985	25.80	6357.39	376.69	1.11
(Lower)	42779	Design Q	164000.00	46.72	68.92	66.88	76.09	0.001059	21.48	7633.98	393.88	0.86
(Lower)	42714	Design Q	164000.00	46.62	68.91	66.77	76.01	0.001044	21.38	7670.90	394.14	0.85
(Lower)	42700	Design Q	164000.00	46.60	68.89	66.75	75.99	0.001043	21.37	7673.03	394.15	0.85
(Lower)	42690	Design Q	164000.00	46.58	68.88	66.74	75.98	0.001042	21.36	7676.81	394.18	0.85
(Lower)	42689	Design Q	164000.00	46.58	69.28		75.98	0.000847	20.76	7901.07	398.07	0.82
(Lower)	42590	Design Q	164000.00	46.42	69.35		75.89	0.000818	20.52	7991.55	398.58	0.81
(Lower)	42589	Design Q	164000.00	46.42	69.64		75.89	0.000666	20.05	8179.52	402.24	0.78
(Lower)	42491	Design Q	164000.00	46.26	69.72		75.83	0.000642	19.82	8276.03	402.78	0.77
(Lower)	42230	Design Q	164000.00	45.84	69.67		75.56	0.000608	19.47	8422.00	403.62	0.75
(Lower)	42203	Design Q	164000.00	45.79	69.65	65.74	75.53	0.000599	19.46	8429.32	398.00	0.75
(Lower)	42161		Bridge									
(Lower)	42119	Design Q	164000.00	45.66	63.90	65.57	74.70	0.001535	26.36	6221.51	382.08	1.15

HEC-RAS Plan: PropCSEXPIERS River: LA River Reach: (Lower) Profile: Design Q (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)	
(Lower)	42000	Design Q	164000.00	45.47	63.71	65.33	74.51	0.001535	26.36	6221.54	382.08	1.15
(Lower)	41999	Design Q	164000.00	45.46	63.67	65.32	74.51	0.001545	26.42	6208.11	381.92	1.16
(Lower)	41749	Design Q	164000.00	45.06	63.22	64.92	74.13	0.001558	26.49	6191.49	381.73	1.16
(Lower)	41697	Design Q	164000.00	44.98	62.82	64.97	74.04	0.001646	26.87	6102.94	384.21	1.19
(Lower)	41491	Design Q	164000.00	44.64	60.88	63.95	73.66	0.002072	28.67	5719.73	388.84	1.32
(Lower)	41423	Design Q	164000.00	44.53	62.85	64.42	73.55	0.001512	26.23	6252.81	382.45	1.14
(Lower)	40800	Design Q	164000.00	43.53	61.71	63.42	72.59	0.001555	26.47	6195.95	381.78	1.16
(Lower)	40500	Design Q	164000.00	43.04	61.15	62.92	72.13	0.001574	26.58	6170.94	381.48	1.16
(Lower)	40060	Design Q	164000.00	42.33	60.40	62.21	71.43	0.001587	26.65	6153.69	381.28	1.17
(Lower)	39987	Design Q	164000.00	42.22	60.29	62.13	71.32	0.001587	26.65	6153.51	381.26	1.17
(Lower)	39900	Design Q	164000.00	42.07	60.10	61.97	71.19	0.001599	26.71	6139.25	381.11	1.17
(Lower)	39823	Design Q	164000.00	41.95	59.98	61.84	71.07	0.001599	26.71	6139.31	381.11	1.17
(Lower)	39350	Design Q	164000.00	41.19	59.22	61.08	70.31	0.001598	26.71	6140.22	381.07	1.17
(Lower)	38900	Design Q	164000.00	40.46	58.45	60.35	69.59	0.001608	26.76	6127.63	381.04	1.18
(Lower)	38700	Design Q	164000.00	39.13	57.90	60.01	69.26	0.001658	27.03	6066.95	379.99	1.19
(Lower)	38500	Design Q	164000.00	38.81	57.61	59.69	68.93	0.001649	26.99	6077.10	380.06	1.19
(Lower)	38300	Design Q	164000.00	38.49	57.31	59.37	68.60	0.001642	26.95	6085.20	380.14	1.19
(Lower)	38100	Design Q	164000.00	38.17	56.95	59.06	68.30	0.001428	27.02	6068.51	380.06	1.19
(Lower)	37900	Design Q	164000.00	37.84	56.52	58.73	68.01	0.001456	27.19	6031.06	379.57	1.20
(Lower)	37860	Design Q	164000.00	37.78	56.46	58.67	67.95	0.001455	27.19	6031.64	379.54	1.20
(Lower)	37660	Design Q	164000.00	37.46	56.08	58.31	67.66	0.001473	27.30	6007.02	379.28	1.21
(Lower)	37500	Design Q	164000.00	37.20	55.77	58.05	67.42	0.001487	27.39	5988.47	379.02	1.21
(Lower)	37300	Design Q	164000.00	36.88	55.40	57.73	67.13	0.001501	27.47	5970.36	378.84	1.22
(Lower)	37189	Design Q	164000.00	36.70	55.19	57.54	66.96	0.001509	27.52	5959.79	378.71	1.22
(Lower)	37100	Design Q	164000.00	36.55	55.01	57.39	66.83	0.001519	27.58	5947.33	378.58	1.23
(Lower)	36900	Design Q	164000.00	36.23	60.06	57.07	66.52	0.000606	20.38	8045.89	402.70	0.80
(Lower)	36858	Design Q	164000.00	36.16	60.12		66.49	0.000595	20.26	8095.86	403.26	0.80
(Lower)	36771	Design Q	164000.00	36.02	60.21		66.44	0.000573	20.02	8192.03	403.11	0.78
(Lower)	36651	Design Q	164000.00	35.83	60.32		66.37	0.000547	19.73	8313.45	404.16	0.77
(Lower)	36526	Design Q	164000.00	35.63	60.44		66.30	0.000523	19.43	8441.81	405.40	0.75
(Lower)	36505	Design Q	164000.00	35.59	60.45	56.41	66.28	0.000519	19.38	8461.74	405.60	0.75
(Lower)	36444		Bridge									
(Lower)	36383	Design Q	164000.00	35.40	59.13		65.65	0.000615	20.48	8006.67	402.32	0.81
(Lower)	36359	Design Q	164000.00	35.36	59.13		65.63	0.000611	20.44	8022.50	402.51	0.81
(Lower)	36336	Design Q	164000.00	35.32	59.14		65.60	0.000607	20.39	8042.07	402.74	0.80
(Lower)	36312	Design Q	164000.00	35.28	59.14	56.10	65.58	0.000603	20.35	8057.96	402.94	0.80
(Lower)	36251		Bridge									
(Lower)	36190	Design Q	164000.00	35.09	55.25	55.91	64.85	0.001106	24.86	6598.12	386.24	1.06
(Lower)	36181	Design Q	164000.00	35.07	55.24	55.91	64.83	0.001105	24.85	6600.47	386.26	1.06
(Lower)	36180	Design Q	164000.00	35.07	55.89	55.91	64.79	0.000985	23.93	6854.33	389.16	1.01
(Lower)	36070	Design Q	164000.00	34.89	54.85	55.73	64.68	0.001145	25.14	6522.66	385.33	1.08
(Lower)	36069	Design Q	164000.00	34.89	54.84	55.72	64.68	0.001149	25.17	6515.39	385.23	1.08
(Lower)	36000	Design Q	164000.00	34.78	54.51	55.62	64.61	0.001196	25.50	6431.83	384.30	1.10
(Lower)	35999	Design Q	164000.00	34.78	54.48	55.61	64.62	0.001394	25.54	6420.87	384.15	1.10
(Lower)	35912	Design Q	164000.00	34.64	54.29	55.47	64.49	0.001408	25.63	6399.90	383.90	1.11
(Lower)	35800	Design Q	164000.00	34.46	54.02	55.29	64.33	0.001429	25.75	6368.81	383.60	1.11
(Lower)	35663	Design Q	164000.00	34.24	53.73	55.07	64.13	0.001449	25.87	6339.13	383.20	1.12
(Lower)	35572	Design Q	164000.00	34.09	53.53	54.92	63.99	0.001679	25.95	6319.84	382.97	1.13
(Lower)	35400	Design Q	164000.00	33.82	53.31	54.66	63.71	0.001663	25.87	6340.12	383.24	1.12
(Lower)	35200	Design Q	164000.00	33.49	52.98	54.33	63.38	0.001663	25.87	6339.80	383.21	1.12
(Lower)	35050	Design Q	164000.00	33.25	52.76	54.09	63.13	0.001657	25.83	6348.01	383.29	1.12
(Lower)	34900	Design Q	164000.00	33.01	52.52	53.85	62.89	0.001657	25.83	6348.17	383.31	1.12
(Lower)	34709	Design Q	164000.00	32.71	52.27	53.55	62.58	0.001643	25.76	6365.83	383.53	1.11
(Lower)	34623	Design Q	164000.00	32.57	52.13	53.41	62.44	0.001643	25.76	6366.41	383.59	1.11
(Lower)	34500	Design Q	164000.00	32.37	51.93	53.21	62.24	0.001643	25.76	6365.46	383.49	1.11
(Lower)	34300	Design Q	164000.00	32.05	51.61	52.89	61.92	0.001643	25.77	6365.16	383.46	1.11
(Lower)	34100	Design Q	164000.00	31.73	51.29	52.57	61.60	0.001643	25.76	6365.58	383.50	1.11
(Lower)	33900	Design Q	164000.00	31.41	50.97	52.25	61.28	0.001643	25.76	6365.26	383.47	1.11
(Lower)	33791	Design Q	164000.00	31.25	50.85	52.09	61.11	0.001630	25.69	6382.64	383.73	1.11
(Lower)	33703	Design Q	164000.00	31.13	50.81	51.97	60.97	0.001606	25.57	6413.43	384.05	1.10
(Lower)	33500	Design Q	164000.00	30.84	50.56	51.68	60.67	0.001389	25.51	6428.39	384.24	1.10
(Lower)	33300	Design Q	164000.00	30.51	50.04	51.35	60.39	0.001439	25.81	6354.04	383.31	1.12
(Lower)	33100	Design Q	164000.00	30.19	49.57	51.03	60.11	0.001479	26.04	6297.45	382.75	1.13
(Lower)	32900	Design Q	164000.00	29.87	49.16	50.71	59.81	0.001504	26.19	6262.91	382.32	1.14
(Lower)	32700	Design Q	164000.00	29.55	48.71	50.39	59.53	0.001328	26.39	6214.40	381.72	1.15
(Lower)	32500	Design Q	164000.00	29.22	48.19	50.06	59.27	0.001376	26.70	6142.48	380.82	1.17
(Lower)	32300	Design Q	164000.00	28.90	47.75	49.74	59.00	0.001410	26.91	6094.85	380.35	1.19
(Lower)	32100	Design Q	164000.00	28.58	47.34	49.42	58.72	0.001434	27.06	6060.21	379.92	1.19
(Lower)	31900	Design Q	164000.00	28.26	51.57	49.10	58.37	0.000656	20.93	7835.47	400.37	0.83
(Lower)	31716	Design Q	164000.00	27.96	51.85		58.27	0.000512	20.32	8070.59	403.04	0.80
(Lower)	31566	Design Q	164000.00	27.72	52.15		58.19	0.000490	19.71	8318.75	420.48	0.78
(Lower)	31440	Design Q	164000.00	27.51	52.49		58.12	0.000431	19.04	8611.47	414.66	0.74
(Lower)	31351	Design Q	164000.00	27.37	52.60		58.09	0.000408	18.79	8725.81	410.48	0.72
(Lower)	31308	Design Q	164000.00	27.30	52.64		58.07	0.000398	18.70	8771.19	407.70	0.71
(Lower)	31244	Design Q	164000.00	27.20	52.68		58.04	0.000388	18.57	8829.50	406.18	0.70
(Lower)	31225	Design Q	164000.00	27.17	52.69	47.78	58.03	0.000386	18.54	8844.85	406.37	0.70
(Lower)	31182.5		Bridge									
(Lower)	31140	Design Q	164000.00	27.03	51.15		57.25	0.000474	19.81	8279.76	402.59	0.77
(Lower)	31116	Design Q	164000.00	26.99	51.16		57.23	0.000471	19.76	8299.65	403.29	0.77

HEC-RAS Plan: PropCSEXPIERS River: LA River Reach: (Lower) Profile: Design Q (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)	
(Lower)	31101	Design Q	164000.00	26.97	51.16		57.22	0.000471	19.74	8307.32	404.46	0.77
(Lower)	31100	Design Q	164000.00	26.97	51.16		57.22	0.000471	19.74	8306.71	404.44	0.77
(Lower)	31076	Design Q	164000.00	26.93	51.17		57.20	0.000470	19.70	8324.26	406.20	0.77
(Lower)	31075	Design Q	164000.00	26.92	51.18		57.20	0.000469	19.68	8331.81	406.23	0.77
(Lower)	30900	Design Q	164000.00	26.64	50.96		57.11	0.000480	19.89	8244.44	404.96	0.78
(Lower)	30850	Design Q	164000.00	26.56	51.02		57.09	0.000470	19.76	8301.42	405.61	0.77
(Lower)	30813	Design Q	164000.00	26.50	51.06		57.07	0.000463	19.66	8340.20	405.94	0.76
(Lower)	30748	Design Q	164000.00	26.40	51.13		57.04	0.000452	19.50	8410.08	406.79	0.76
(Lower)	30664	Design Q	164000.00	26.26	51.22		57.00	0.000437	19.28	8504.14	407.80	0.74
(Lower)	30500	Design Q	164000.00	26.00	51.37		56.93	0.000412	18.91	8671.92	409.67	0.72
(Lower)	30300	Design Q	164000.00	25.67	51.54		56.85	0.000384	18.47	8877.24	411.86	0.70
(Lower)	30100	Design Q	164000.00	25.35	51.69		56.77	0.000360	18.08	9073.01	414.11	0.68
(Lower)	30000	Design Q	164000.00	25.19	51.76		56.74	0.000349	17.89	9165.49	415.03	0.67
(Lower)	29894	Design Q	164000.00	25.02	51.83		56.70	0.000338	17.70	9265.67	416.14	0.66
(Lower)	29800	Design Q	164000.00	24.87	51.89		56.67	0.000328	17.53	9354.99	417.20	0.65
(Lower)	29785	Design Q	164000.00	24.85	51.89		56.66	0.000328	17.52	9362.04	417.18	0.65
(Lower)	29648	Design Q	164000.00	24.71	51.92		56.62	0.000321	17.39	9431.33	417.95	0.65
(Lower)	29266	Design Q	181300.00	24.31	49.65		56.46	0.000506	20.93	8660.24	409.56	0.80
(Lower)	29076	Design Q	181300.00	24.12	49.72		56.37	0.000488	20.68	8767.01	410.76	0.79
(Lower)	29074	Design Q	181300.00	24.12	49.72		56.37	0.000488	20.68	8766.31	410.75	0.79
(Lower)	28900	Design Q	181300.00	23.94	49.79		56.28	0.000471	20.45	8867.53	411.85	0.78
(Lower)	28899	Design Q	181300.00	23.93	49.80		56.28	0.000470	20.42	8876.61	411.94	0.78
(Lower)	28856	Design Q	181300.00	23.89	49.80		56.26	0.000467	20.39	8892.23	412.10	0.77
(Lower)	28825	Design Q	181300.00	23.86	49.79	46.04	56.23	0.000466	20.37	8900.53	412.22	0.77
(Lower)	28815		Bridge									
(Lower)	28805	Design Q	181300.00	23.84	49.18		55.99	0.000506	20.94	8659.51	409.54	0.80
(Lower)	28780	Design Q	181300.00	23.81	49.17	45.96	55.97	0.000504	20.92	8667.81	409.61	0.80
(Lower)	28770.5		Bridge									
(Lower)	28761	Design Q	181300.00	23.79	48.44		55.72	0.000559	21.65	8375.70	406.38	0.84
(Lower)	28716	Design Q	181300.00	23.74	48.43	45.89	55.68	0.000556	21.60	8391.72	406.57	0.84
(Lower)	28706		Bridge									
(Lower)	28696	Design Q	181300.00	23.72	45.56	45.88	55.27	0.000863	24.99	7253.49	393.75	1.03
(Lower)	28662	Design Q	181300.00	23.69	47.72	45.87	55.46	0.000612	22.31	8126.13	403.63	0.88
(Lower)	28600	Design Q	181300.00	23.62	47.70		55.40	0.000608	22.25	8147.35	403.88	0.87
(Lower)	28599	Design Q	181300.00	23.62	47.70	45.78	55.40	0.000608	22.26	8145.20	403.82	0.87
(Lower)	28540	Design Q	181300.00	23.56	47.70	45.73	55.35	0.000599	22.19	8170.45	401.68	0.87
(Lower)	28525	Design Q	182000.00	23.55	47.44	45.80	55.35	0.000628	22.56	8068.98	401.09	0.89
(Lower)	28454	Design Q	182000.00	23.47	47.49	45.72	55.30	0.000615	22.41	8123.17	401.56	0.88
(Lower)	28283	Design Q	182000.00	23.30	47.60	45.54	55.19	0.000590	22.10	8233.80	402.55	0.86
(Lower)	28254	Design Q	182000.00	23.27	47.59	45.51	55.17	0.000591	22.07	8245.38	404.95	0.86
(Lower)	28149	Design Q	182000.00	23.16	47.65	45.40	55.10	0.000577	21.90	8311.85	405.74	0.85
(Lower)	28000	Design Q	182000.00	23.00	47.74		55.01	0.000556	21.63	8413.18	406.78	0.84
(Lower)	27800	Design Q	182000.00	22.79	47.85		54.90	0.000531	21.30	8543.79	408.24	0.82
(Lower)	27600	Design Q	182000.00	22.59	47.93		54.80	0.000510	21.02	8658.51	409.52	0.81
(Lower)	27400	Design Q	182000.00	22.38	48.02		54.69	0.000489	20.73	8779.85	410.82	0.79
(Lower)	27200	Design Q	182000.00	22.17	48.10		54.60	0.000469	20.44	8902.03	412.22	0.78
(Lower)	27040	Design Q	182000.00	22.01	48.15		54.52	0.000456	20.25	8986.97	413.10	0.77
(Lower)	26843	Design Q	182000.00	21.80	48.19		54.43	0.000438	20.05	9079.43	409.25	0.75
(Lower)	26700	Design Q	182000.00	21.66	48.25		54.37	0.000426	19.85	9167.61	410.47	0.74
(Lower)	26629	Design Q	182000.00	21.58	48.27		54.34	0.000420	19.76	9210.20	410.80	0.74
(Lower)	26584	Design Q	182000.00	21.54	48.27		54.32	0.000418	19.73	9224.48	411.98	0.74
(Lower)	26499	Design Q	182000.00	21.45	48.25	43.66	54.26	0.000414	19.67	9252.79	411.20	0.73
(Lower)	26470		Bridge									
(Lower)	26441	Design Q	182000.00	21.39	47.71		53.98	0.000443	20.09	9059.27	410.97	0.75
(Lower)	26378	Design Q	182000.00	21.32	47.70		53.93	0.000441	20.03	9087.15	414.19	0.75
(Lower)	26377	Design Q	182000.00	21.32	47.70		53.93	0.000441	20.03	9087.56	414.22	0.75
(Lower)	26355	Design Q	182000.00	21.30	47.69	43.54	53.92	0.000440	20.01	9093.38	414.32	0.75
(Lower)	26326		Bridge									
(Lower)	26297	Design Q	182000.00	21.24	47.09		53.64	0.000475	20.53	8865.42	411.60	0.78
(Lower)	26251	Design Q	182000.00	21.19	47.09		53.60	0.000502	20.47	8892.90	433.41	0.80
(Lower)	26241	Design Q	182000.00	21.18	47.10		53.57	0.000496	20.41	8917.75	432.45	0.79
(Lower)	26195	Design Q	182000.00	21.13	47.12	43.31	53.50	0.000489	20.26	8982.66	435.27	0.79
(Lower)	26166		Bridge									
(Lower)	26137	Design Q	182000.00	21.07	46.47		53.14	0.000516	20.72	8782.71	428.85	0.81
(Lower)	26108	Design Q	182000.00	21.04	46.47		53.10	0.000506	20.66	8807.69	424.93	0.80
(Lower)	26080	Design Q	182000.00	21.01	46.47		53.07	0.000500	20.61	8832.74	424.00	0.80
(Lower)	26051	Design Q	182000.00	20.98	46.47	43.11	53.04	0.000488	20.57	8849.02	417.07	0.79
(Lower)	26022		Bridge									
(Lower)	25993	Design Q	182000.00	20.92	45.76		52.76	0.000535	21.21	8579.22	413.98	0.82
(Lower)	25935	Design Q	182000.00	20.86	45.83		52.62	0.000521	20.90	8707.66	420.91	0.81
(Lower)	25934	Design Q	182000.00	20.86	45.83		52.62	0.000521	20.90	8707.68	420.93	0.81
(Lower)	25910	Design Q	182000.00	20.84	45.86		52.60	0.000516	20.83	8736.52	422.03	0.81
(Lower)	25859	Design Q	182000.00	20.79	45.44		52.57	0.000547	21.43	8492.67	409.46	0.83
(Lower)	25800	Design Q	182000.00	20.72	45.46		52.53	0.000541	21.34	8529.63	410.31	0.83
(Lower)	25700	Design Q	182000.00	20.62	45.37		52.48	0.000552	21.39	8509.80	415.41	0.83
(Lower)	25525	Design Q	182000.00	20.44	44.91	42.65	52.37	0.000578	21.92	8303.97	405.60	0.85
(Lower)	25423	Design Q	182000.00	20.33	44.98		52.32	0.000563	21.73	8375.52	406.35	0.84
(Lower)	25400	Design Q	182000.00	20.31	44.97		52.30	0.000563	21.72	8380.05	406.47	0.84
(Lower)	25200	Design Q	182000.00	19.16	46.46		52.20	0.000390	19.22	9470.96	418.31	0.71

HEC-RAS Plan: PropCSEXPIERS River: LA River Reach: (Lower) Profile: Design Q (Continued)

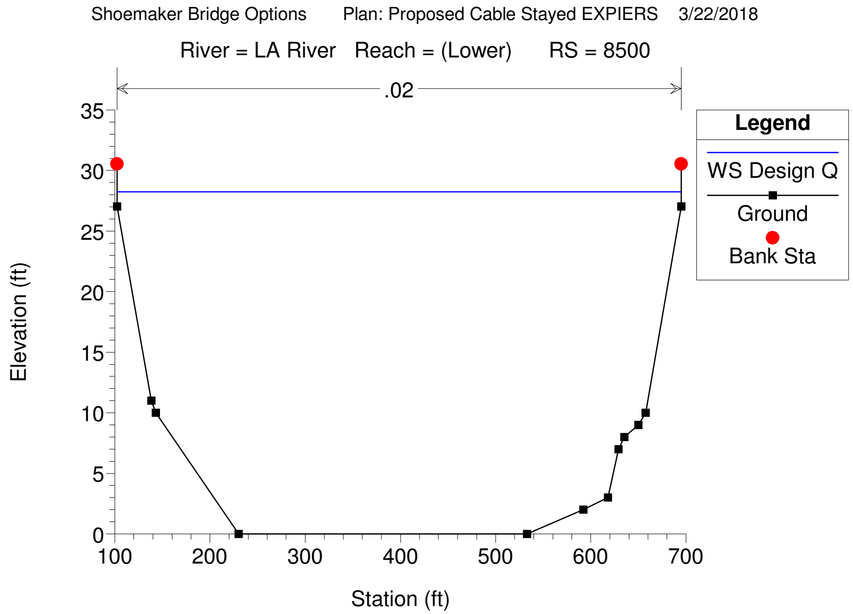
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
(Lower)	25000	Design Q	182000.00	18.94	46.53		52.12	0.000375	18.97	9592.52	419.69	0.70
(Lower)	24800	Design Q	182000.00	18.73	46.58		52.05	0.000363	18.76	9701.25	420.81	0.69
(Lower)	24670	Design Q	182000.00	18.59	46.62		52.00	0.000355	18.62	9775.54	421.62	0.68
(Lower)	24548	Design Q	182000.00	18.45	46.66		51.96	0.000347	18.48	9850.39	422.38	0.67
(Lower)	24455	Design Q	182000.00	18.36	46.67		51.93	0.000338	18.40	9889.43	416.60	0.67
(Lower)	24300	Design Q	182000.00	18.19	46.70		51.88	0.000329	18.24	9976.18	417.20	0.66
(Lower)	24144	Design Q	182000.00	18.02	46.74		51.83	0.000321	18.08	10064.82	417.90	0.65
(Lower)	24107	Design Q	182000.00	17.98	46.75		51.81	0.000319	18.04	10086.11	418.10	0.65
(Lower)	24060	Design Q	182000.00	17.93	46.75	40.14	51.79	0.000317	18.01	10104.99	418.30	0.65
(Lower)	24040		Bridge									
(Lower)	24020	Design Q	182000.00	17.89	46.24		51.48	0.000338	18.37	9909.16	418.90	0.67
(Lower)	23993	Design Q	182000.00	17.86	46.23		51.47	0.000336	18.35	9919.18	418.60	0.66
(Lower)	23967	Design Q	182000.00	17.83	46.24		51.45	0.000335	18.32	9933.58	418.80	0.66
(Lower)	23940	Design Q	182000.00	17.80	46.23	39.98	51.44	0.000334	18.31	9941.77	418.80	0.66
(Lower)	23920		Bridge									
(Lower)	23900	Design Q	182000.00	17.76	45.67		51.11	0.000359	18.71	9724.95	419.00	0.68
(Lower)	23899	Design Q	182000.00	17.76	45.66		51.11	0.000357	18.72	9720.16	416.10	0.68
(Lower)	23878	Design Q	182000.00	17.74	45.66		51.10	0.000358	18.71	9729.33	419.10	0.68
(Lower)	23842	Design Q	182000.00	17.70	45.65		51.08	0.000355	18.68	9743.70	417.30	0.68
(Lower)	23759	Design Q	182000.00	17.61	45.64	39.81	51.03	0.000351	18.62	9774.69	415.70	0.68
(Lower)	23690		Bridge									
(Lower)	23621	Design Q	182000.00	17.46	44.21		50.24	0.000419	19.70	9239.77	414.50	0.74
(Lower)	23613	Design Q	182000.00	17.45	44.21		50.23	0.000418	19.69	9243.11	413.90	0.73
(Lower)	23605	Design Q	182000.00	17.44	44.20		50.23	0.000417	19.69	9245.59	413.90	0.73
(Lower)	23597	Design Q	182000.00	17.43	44.20	39.60	50.22	0.000417	19.68	9248.07	413.90	0.73
(Lower)	23574.5		Bridge									
(Lower)	23552	Design Q	182000.00	17.39	43.11		49.73	0.000483	20.64	8817.70	411.36	0.79
(Lower)	23450	Design Q	182000.00	17.28	43.09		49.66	0.000476	20.56	8852.41	410.81	0.78
(Lower)	23435	Design Q	182000.00	17.26	43.10		49.65	0.000475	20.53	8864.04	411.00	0.78
(Lower)	23377	Design Q	182000.00	17.20	43.10		49.62	0.000469	20.47	8890.73	410.37	0.78
(Lower)	23200	Design Q	182000.00	17.01	43.18		49.53	0.000452	20.22	9000.03	411.50	0.76
(Lower)	23000	Design Q	182000.00	16.79	43.26		49.44	0.000434	19.95	9123.59	412.00	0.75
(Lower)	22799	Design Q	182000.00	16.58	43.22	38.75	49.31	0.000424	19.79	9195.87	413.00	0.74
(Lower)	22793		Bridge									
(Lower)	22787	Design Q	182000.00	16.57	42.59		49.04	0.000463	20.36	8940.13	412.00	0.77
(Lower)	22750	Design Q	182000.00	16.53	42.59		49.01	0.000461	20.33	8953.93	412.18	0.77
(Lower)	22710	Design Q	182000.00	16.48	42.60		48.99	0.000457	20.26	8981.79	412.94	0.77
(Lower)	22628	Design Q	182000.00	16.39	42.64		48.95	0.000448	20.15	9034.11	412.45	0.76
(Lower)	22550	Design Q	182000.00	16.31	42.66		48.91	0.000442	20.05	9076.19	412.74	0.75
(Lower)	22400	Design Q	182000.00	16.15	42.72		48.85	0.000429	19.86	9164.21	413.42	0.74
(Lower)	22200	Design Q	182000.00	15.94	42.78		48.76	0.000413	19.62	9278.36	414.34	0.73
(Lower)	21998	Design Q	182000.00	15.72	42.85		48.68	0.000397	19.37	9397.94	415.28	0.72
(Lower)	21947	Design Q	182000.00	15.66	42.87		48.66	0.000391	19.30	9427.77	412.10	0.71
(Lower)	21809	Design Q	182000.00	15.52	42.84	37.72	48.58	0.000385	19.21	9476.04	412.50	0.71
(Lower)	21745		Bridge									
(Lower)	21681	Design Q	182000.00	15.38	35.91	37.56	47.24	0.001480	27.00	6741.16	387.90	1.14
(Lower)	21500	Design Q	182000.00	15.18	39.92	37.36	47.20	0.000751	21.65	8407.61	401.88	0.83
(Lower)	21499	Design Q	182000.00	15.18	39.92		47.20	0.000751	21.65	8407.50	401.90	0.83
(Lower)	21314	Design Q	182000.00	14.98	39.84		47.03	0.000737	21.51	8460.36	402.92	0.83
(Lower)	21214	Design Q	182000.00	14.88	39.80		46.95	0.000737	21.44	8488.66	407.67	0.83
(Lower)	21100	Design Q	182000.00	14.76	39.75		46.85	0.000729	21.37	8518.33	408.05	0.82
(Lower)	21000	Design Q	182000.00	14.65	39.71		46.76	0.000722	21.30	8545.85	408.28	0.82
(Lower)	20800	Design Q	182000.00	14.43	39.64		46.59	0.000705	21.14	8610.72	408.97	0.81
(Lower)	20635	Design Q	182000.00	14.26	39.58		46.45	0.000695	21.04	8652.01	409.43	0.81
(Lower)	20500	Design Q	182000.00	14.11	39.83		46.21	0.000647	20.27	8976.77	425.49	0.78
(Lower)	20349	Design Q	182000.00	13.95	40.08		45.97	0.000570	19.48	9343.83	427.41	0.73
(Lower)	20197	Design Q	182000.00	13.79	38.24	35.99	45.71	0.000788	21.93	8297.88	405.45	0.85
(Lower)	20100	Design Q	182000.00	13.68	38.20	35.88	45.62	0.000780	21.85	8327.98	405.86	0.85
(Lower)	19900	Design Q	182000.00	13.47	38.10		45.44	0.000767	21.73	8374.11	406.41	0.84
(Lower)	19700	Design Q	182000.00	13.25	38.02		45.26	0.000752	21.60	8427.51	406.95	0.84
(Lower)	19500	Design Q	182000.00	13.04	37.93		45.09	0.000740	21.47	8476.72	407.53	0.83
(Lower)	19300	Design Q	182000.00	12.82	37.85		44.91	0.000725	21.33	8534.24	408.17	0.82
(Lower)	19100	Design Q	182000.00	12.61	37.76		44.75	0.000712	21.21	8582.87	408.60	0.82
(Lower)	18900	Design Q	182000.00	12.39	37.69		44.58	0.000697	21.06	8642.96	409.27	0.81
(Lower)	18700	Design Q	182000.00	12.18	37.61		44.41	0.000684	20.93	8697.73	409.91	0.80
(Lower)	18500	Design Q	182000.00	11.97	37.53		44.25	0.000671	20.79	8753.72	410.57	0.79
(Lower)	18300	Design Q	182000.00	11.75	37.47		44.09	0.000657	20.64	8817.37	411.27	0.79
(Lower)	18100	Design Q	182000.00	11.54	37.40		43.93	0.000644	20.51	8875.86	411.95	0.78
(Lower)	17900	Design Q	182000.00	11.32	37.33		43.78	0.000630	20.36	8938.49	412.49	0.77
(Lower)	17700	Design Q	182000.00	11.11	37.27		43.63	0.000618	20.22	8999.28	413.20	0.76
(Lower)	17580	Design Q	182000.00	10.99	37.23		43.54	0.000611	20.15	9032.60	413.61	0.76
(Lower)	17563	Design Q	182000.00	10.97	37.22		43.52	0.000610	20.14	9035.40	413.59	0.76
(Lower)	17478	Design Q	182000.00	10.88	37.18		43.46	0.000599	20.11	9051.27	407.30	0.75
(Lower)	17450	Design Q	182000.00	10.85	37.16		43.44	0.000596	20.11	9051.93	405.00	0.75
(Lower)	17300	Design Q	182000.00	10.69	37.15		43.32	0.000603	19.93	9133.32	420.00	0.75
(Lower)	17188	Design Q	182000.00	10.57	37.18	32.75	43.20	0.000622	19.69	9244.50	442.00	0.76
(Lower)	17178		Bridge									
(Lower)	17168	Design Q	182000.00	10.54	30.80	32.75	42.48	0.001548	27.41	6640.18	386.66	1.17
(Lower)	17000	Design Q	182000.00	10.36	30.54	32.54	42.33	0.001571	27.54	6609.60	386.32	1.17

HEC-RAS Plan: PropCSEXPIERS River: LA River Reach: (Lower) Profile: Design Q (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)	
(Lower)	16999	Design Q	182000.00	10.36	30.54	32.54	42.33	0.001571	27.54	6609.60	386.32	1.17
(Lower)	16900	Design Q	182000.00	10.26	30.39	32.45	42.25	0.001587	27.63	6587.20	386.03	1.18
(Lower)	16800	Design Q	182000.00	10.15	30.23	32.34	42.16	0.001600	27.71	6568.80	385.83	1.18
(Lower)	16776	Design Q	182000.00	10.12	34.13	32.12	41.75	0.000820	22.15	8217.43	407.74	0.87
(Lower)	16670	Design Q	182000.00	10.01	34.61		41.11	0.000672	20.45	8898.29	429.02	0.79
(Lower)	16600	Design Q	182000.00	9.94	34.86		40.77	0.000599	19.51	9327.34	442.72	0.75
(Lower)	16502	Design Q	182000.00	9.83	35.05		40.33	0.004700	18.43	9876.63	461.20	0.70
(Lower)	16400	Design Q	182000.00	9.72	34.82		39.63	0.004308	17.60	10342.58	485.99	0.67
(Lower)	16275	Design Q	182000.00	9.59	34.44		38.97	0.004051	17.09	10650.74	499.19	0.65
(Lower)	16200	Design Q	182000.00	9.51	34.56		38.74	0.000308	16.40	11100.02	524.87	0.63
(Lower)	16033	Design Q	182000.00	9.33	34.82		38.38	0.000255	15.13	12030.57	558.18	0.57
(Lower)	15900	Design Q	182000.00	9.18	35.03		38.11	0.000212	14.09	12916.42	579.19	0.53
(Lower)	15820	Design Q	182000.00	9.10	35.14	26.04	37.97	0.000191	13.50	13485.05	595.84	0.50
(Lower)	15780		Bridge									
(Lower)	15740	Design Q	182000.00	9.01	33.19		36.45	0.000236	14.48	12565.44	585.12	0.55
(Lower)	15700	Design Q	182000.00	8.97	33.26		36.41	0.000226	14.24	12785.13	591.17	0.54
(Lower)	15424	Design Q	182000.00	5.00	33.96		36.30	0.000789	12.26	14843.28	617.91	0.44
(Lower)	15400	Design Q	182000.00	5.00	33.96		36.28	0.000778	12.21	14903.04	617.00	0.44
(Lower)	15281	Design Q	182000.00	6.00	33.74		36.18	0.000824	12.53	14523.77	605.04	0.45
(Lower)	15050	Design Q	182000.00	6.00	33.38		35.98	0.000920	12.94	14064.33	607.55	0.47
(Lower)	14700	Design Q	182000.00	0.00	33.28		35.68	0.000805	12.43	14645.13	608.22	0.45
(Lower)	14650	Design Q	182000.00	0.00	33.23		35.64	0.000811	12.45	14614.40	607.92	0.45
(Lower)	14520	Design Q	182000.00	2.50	32.96	23.06	35.53	0.000906	12.87	14139.47	609.19	0.47
(Lower)	14505		Bridge									
(Lower)	14490	Design Q	182000.00	3.00	32.49	22.98	35.15	0.000957	13.09	13904.13	608.20	0.48
(Lower)	14484	Design Q	182000.00	3.00	32.48		35.14	0.000957	13.09	13900.32	608.19	0.48
(Lower)	14450	Design Q	182000.00	2.00	32.81		35.11	0.000759	12.19	14933.82	609.22	0.43
(Lower)	14400	Design Q	182000.00	2.00	32.63		35.07	0.000831	12.55	14504.69	608.72	0.45
(Lower)	14295	Design Q	182000.00	4.00	32.53		34.99	0.000836	12.57	14484.27	608.09	0.45
(Lower)	14250	Design Q	182000.00	0.00	32.69		34.95	0.000731	12.05	15101.13	610.63	0.43
(Lower)	14225	Design Q	182000.00	0.00	32.67		34.93	0.000733	12.06	15088.22	610.55	0.43
(Lower)	14100	Design Q	182000.00	0.00	32.60		34.84	0.000727	12.02	15138.43	610.38	0.43
(Lower)	14000	Design Q	182000.00	0.00	32.57		34.77	0.000703	11.91	15286.44	611.38	0.42
(Lower)	13600	Design Q	182000.00	1.00	32.29		34.49	0.000704	11.89	15306.02	610.16	0.42
(Lower)	13560	Design Q	182000.00	2.00	32.22		34.46	0.000726	12.00	15166.87	609.89	0.42
(Lower)	13500	Design Q	182000.00	2.00	32.11		34.41	0.000763	12.17	14956.29	614.76	0.43
(Lower)	13250	Design Q	182000.00	1.00	31.96		34.23	0.000736	12.07	15078.57	609.35	0.43
(Lower)	13000	Design Q	182000.00	3.00	31.60		34.03	0.000827	12.50	14555.84	609.62	0.45
(Lower)	12500	Design Q	182000.00	3.00	31.15		33.61	0.000849	12.59	14459.67	611.63	0.46
(Lower)	12000	Design Q	182000.00	2.00	30.81		33.20	0.000810	12.39	14683.74	613.75	0.45
(Lower)	11900	Design Q	182000.00	1.00	30.77		33.12	0.000796	12.30	14801.05	619.08	0.44
(Lower)	11700	Design Q	182000.00	0.00	30.71		32.96	0.000741	12.05	15107.99	616.65	0.43
(Lower)	11500	Design Q	182000.00	1.00	30.48		32.81	0.000777	12.25	14859.08	613.54	0.44
(Lower)	11000	Design Q	182000.00	1.00	30.18		32.43	0.000736	12.03	15127.53	615.30	0.43
(Lower)	10800	Design Q	182000.00	2.00	29.89		32.28	0.000813	12.39	14689.41	615.57	0.45
(Lower)	10664	Design Q	182000.00	0.00	29.85		32.11	0.000735	12.05	15105.83	612.68	0.43
(Lower)	10653	Design Q	182000.00	0.00	29.85	18.31	32.10	0.000736	12.03	15126.26	615.23	0.43
(Lower)	10613		Bridge									
(Lower)	10573	Design Q	182000.00	0.00	29.50	18.32	31.82	0.000769	12.22	14897.15	613.03	0.44
(Lower)	10571	Design Q	182000.00	0.00	29.43		31.80	0.000409	12.36	14727.83	614.70	0.45
(Lower)	10517	Design Q	182000.00	0.00	29.33		31.76	0.000423	12.50	14564.64	612.12	0.45
(Lower)	10500	Design Q	182000.00	1.00	29.09		31.70	0.000474	12.95	14052.56	610.51	0.48
(Lower)	10000	Design Q	182000.00	0.00	28.99		31.36	0.000407	12.35	14732.82	613.23	0.44
(Lower)	9698.8	Design Q	182000.00	0.00	28.90		31.21	0.000393	12.20	14917.23	615.44	0.44
(Lower)	9676.1	Design Q	182000.00	0.00	28.87		31.20	0.000399	12.26	14839.20	615.41	0.44
(Lower)	9676	Design Q	182000.00	0.00	28.87		31.20	0.000399	12.26	14839.17	615.41	0.44
(Lower)	9630.1	Design Q	182000.00	0.00	28.91		31.19	0.000378	12.11	15033.72	609.38	0.43
(Lower)	9630	Design Q	182000.00	0.00	28.91		31.19	0.000378	12.11	15033.69	609.38	0.43
(Lower)	9596.1	Design Q	182000.00	0.00	28.89		31.17	0.000383	12.11	15026.56	615.24	0.43
(Lower)	9596	Design Q	182000.00	0.00	28.89		31.17	0.000383	12.11	15026.53	615.24	0.43
(Lower)	9566.1	Design Q	182000.00	0.00	28.84		31.16	0.000395	12.24	14875.03	614.32	0.44
(Lower)	9500	Design Q	182000.00	0.00	28.60		31.13	0.000452	12.76	14258.43	612.54	0.47
(Lower)	9430	Design Q	182000.00	1.00	28.71		31.10	0.000415	12.40	14676.09	613.37	0.45
(Lower)	9200	Design Q	182000.00	1.00	28.60		31.01	0.000422	12.46	14603.11	613.36	0.45
(Lower)	9000	Design Q	182000.00	1.00	28.28		30.92	0.000477	13.04	13958.76	602.48	0.48
(Lower)	8500	Design Q	182000.00	0.00	28.23		30.70	0.000417	12.60	14447.50	592.55	0.45
(Lower)	8300	Design Q	182000.00	0.00	27.83		30.60	0.000503	13.36	13621.49	590.78	0.49
(Lower)	8100	Design Q	182000.00	0.00	27.73		30.51	0.000498	13.37	13617.04	586.24	0.49
(Lower)	8000	Design Q	182000.00	0.00	27.79		30.46	0.000465	13.10	13895.91	584.82	0.47
(Lower)	7918	Design Q	182000.00	0.00	27.81	17.53	30.42	0.000449	12.96	14041.42	584.56	0.47
(Lower)	7875		Bridge									
(Lower)	7832	Design Q	182000.00	0.00	27.07	17.89	29.91	0.000515	13.51	13468.48	582.44	0.50
(Lower)	7765	Design Q	182000.00	0.00	27.10		29.87	0.000500	13.36	13626.01	584.54	0.49
(Lower)	7721	Design Q	182000.00	0.00	27.09		29.85	0.000495	13.32	13660.24	582.66	0.49
(Lower)	7687	Design Q	182000.00	2.00	26.53		29.83	0.000660	14.57	12487.76	580.00	0.55
(Lower)	7654	Design Q	182000.00	0.00	27.15		29.81	0.000451	13.08	13910.14	570.84	0.47
(Lower)	7632	Design Q	182000.00	0.00	27.25		29.80	0.000433	12.83	14190.82	580.04	0.46
(Lower)	7500	Design Q	182000.00	0.00	27.05		29.74	0.000464	13.16	13834.33	575.82	0.47
(Lower)	7000	Design Q	182000.00	0.00	26.71		29.50	0.000496	13.40	13579.30	578.55	0.49

HEC-RAS Plan: PropCSEXPIERS River: LA River Reach: (Lower) Profile: Design Q (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)	
(Lower)	6950.1	Design Q	182000.00	0.00	26.68		29.48	0.000498	13.42	13560.14	578.21	0.49
(Lower)	6950	Design Q	182000.00	0.00	26.68		29.48	0.000498	13.42	13560.11	578.21	0.49
(Lower)	6600	Design Q	182000.00	0.00	26.71		29.31	0.000450	12.95	14051.47	583.77	0.47
(Lower)	6495	Design Q	182000.00	0.00	26.65		29.27	0.000454	12.98	14017.39	583.57	0.47
(Lower)	6200	Design Q	182000.00	0.00	26.38		29.13	0.000488	13.30	13679.61	580.19	0.48
(Lower)	6153.9	Design Q	182000.00	0.00	26.54		29.11	0.000435	12.85	14166.99	578.81	0.46
(Lower)	6153.8	Design Q	182000.00	0.00	26.54		29.11	0.000435	12.85	14166.96	578.81	0.46
(Lower)	6000	Design Q	182000.00	0.00	26.42		29.04	0.000449	12.99	14012.00	576.95	0.46
(Lower)	5933.8	Design Q	182000.00	0.00	26.35		29.01	0.000458	13.08	13909.56	575.67	0.47
(Lower)	5870	Design Q	182000.00	0.00	26.15	16.77	28.97	0.000790	13.49	13491.86	575.71	0.49
(Lower)	5800		Bridge									
(Lower)	5730	Design Q	182000.00	0.00	25.29	16.44	28.26	0.000852	13.82	13167.68	574.10	0.51
(Lower)	5700	Design Q	182000.00	0.00	25.38		28.24	0.000809	13.56	13420.50	578.20	0.50
(Lower)	5670	Design Q	182000.00	0.00	25.36		28.21	0.000809	13.56	13425.20	578.12	0.50
(Lower)	5647.1	Design Q	182000.00	0.00	25.33	16.13	28.19	0.000810	13.58	13405.47	575.79	0.50
(Lower)	5550		Bridge									
(Lower)	5500	Design Q	182000.00	0.00	24.89		27.97	0.000899	14.06	12947.07	572.83	0.52
(Lower)	5300	Design Q	182000.00	0.00	24.62		27.76	0.001168	14.23	12791.52	570.56	0.53
(Lower)	5100.1	Design Q	182000.00	0.00	24.23		27.52	0.001250	14.55	12511.61	568.90	0.55
(Lower)	5100	Design Q	182000.00	0.00	24.23		27.52	0.001253	14.55	12512.67	570.73	0.55
(Lower)	5041	Design Q	182000.00	0.00	24.30		27.45	0.001185	14.24	12779.05	575.85	0.53
(Lower)	4900.1	Design Q	182000.00	0.00	23.94		27.27	0.001285	14.66	12417.30	570.49	0.55
(Lower)	4900	Design Q	182000.00	0.00	23.94		27.27	0.001286	14.66	12417.21	570.49	0.55
(Lower)	4869	Design Q	182000.00	0.00	24.01		27.24	0.001223	14.41	12629.88	571.78	0.54
(Lower)	4764	Design Q	182000.00	0.00	23.68	16.33	27.09	0.001492	14.82	12281.25	570.36	0.56
(Lower)	4758		Bridge									
(Lower)	4752	Design Q	182000.00	-4.60	23.29	12.81	25.94	0.000996	13.07	13923.71	569.19	0.46
(Lower)	4650	Design Q	182000.00	-4.60	23.04		25.84	0.001082	13.43	13550.69	561.39	0.48
(Lower)	4633.8	Design Q	182000.00	-4.60	23.14		25.82	0.001025	13.14	13852.53	569.26	0.47
(Lower)	4629.2	Design Q	182000.00	-4.60	23.12		25.82	0.001032	13.17	13821.32	569.25	0.47
(Lower)	4600.1	Design Q	182000.00	-4.60	23.00		25.79	0.001092	13.38	13600.61	571.93	0.48
(Lower)	4600	Design Q	182000.00	-4.60	23.00		25.79	0.001092	13.38	13600.53	571.88	0.48
(Lower)	4500	Design Q	182000.00	-4.00	22.55		25.67	0.001292	14.16	12851.32	563.59	0.52
(Lower)	4300	Design Q	182000.00	-4.60	22.36		25.41	0.001250	14.02	12976.96	563.20	0.52
(Lower)	4100	Design Q	182000.00	-4.60	22.26		25.17	0.001155	13.68	13299.84	563.62	0.50
(Lower)	4050.1	Design Q	182000.00	-4.60	22.13		25.11	0.001219	13.86	13129.42	569.00	0.51
(Lower)	4050	Design Q	182000.00	-4.60	22.13		25.11	0.001219	13.86	13129.35	569.18	0.51
(Lower)	4000.1	Design Q	182000.00	-4.60	22.07		25.05	0.001219	13.86	13135.03	569.04	0.51
(Lower)	4000	Design Q	182000.00	-4.60	22.07		25.05	0.001219	13.86	13134.94	569.04	0.51
(Lower)	3968.1	Design Q	182000.00	-4.60	22.11		25.01	0.001168	13.67	13312.56	568.96	0.50
(Lower)	3900	Design Q	182000.00	-4.60	21.95		24.93	0.001200	13.87	13124.44	559.89	0.50
(Lower)	3802	Design Q	182000.00	-4.60	21.86	12.65	24.82	0.001178	13.78	13204.17	562.53	0.50
(Lower)	3794	Design Q	182000.00	-4.60	21.85	12.65	24.81	0.001179	13.79	13197.55	562.51	0.50
(Lower)	3792	Design Q	182000.00	-4.60	21.85	12.64	24.81	0.001180	13.79	13195.89	562.50	0.50
(Lower)	3784	Design Q	182000.00	-4.60	21.84	12.64	24.80	0.001182	13.80	13189.31	562.48	0.50
(Lower)	3730.2	Design Q	182000.00	-4.60	21.92	12.25	24.74	0.001102	13.47	13509.74	565.83	0.49
(Lower)	3693	Design Q	182000.00	-4.60	21.69	12.65	24.69	0.001207	13.89	13102.63	559.74	0.51
(Lower)	3682.8	Design Q	182000.00	-4.60	21.84		24.68	0.001124	13.52	13458.80	567.63	0.49
(Lower)	3650.1	Design Q	182000.00	-4.60	21.80		24.65	0.001135	13.54	13444.70	571.90	0.49
(Lower)	3650	Design Q	182000.00	-4.60	21.80		24.65	0.001135	13.54	13444.62	571.90	0.49
(Lower)	3500	Design Q	182000.00	-4.60	21.32		24.46	0.001308	14.23	12793.74	561.57	0.53
(Lower)	3200	Design Q	182000.00	-4.60	20.24		24.01	0.001749	15.57	11686.20	558.32	0.60
(Lower)	2900	Design Q	182000.00	-4.60	19.61		23.48	0.001809	15.77	11538.52	554.60	0.61
(Lower)	2830.1	Design Q	182000.00	-4.60	19.70		23.35	0.001701	15.33	11874.84	568.47	0.59
(Lower)	2830	Design Q	182000.00	-4.60	19.70		23.35	0.001701	15.33	11874.71	568.47	0.59
(Lower)	2750	Design Q	182000.00	-4.50	19.05		23.20	0.002033	16.35	11130.23	553.44	0.64
(Lower)	2600	Design Q	182000.00	-4.00	18.22		22.87	0.002435	17.30	10517.27	550.74	0.70
(Lower)	2400	Design Q	182000.00	-4.60	18.23		22.42	0.002051	16.42	11087.05	552.26	0.65
(Lower)	2326	Design Q	182000.00	-4.64	18.14	12.62	22.27	0.002011	16.30	11165.24	553.88	0.64
(Lower)	2271.5		Bridge									
(Lower)	2217	Design Q	182000.00	-4.69	16.96	12.25	21.48	0.002300	17.05	10674.14	547.09	0.68
(Lower)	1800.1	Design Q	182000.00	-4.90	14.78		20.36	0.003150	18.95	9602.38	531.25	0.79
(Lower)	1800	Design Q	182000.00	-4.90	14.78		20.36	0.003151	18.96	9599.54	530.97	0.79
(Lower)	1700	Design Q	182000.00	-4.95	13.70	11.94	20.02	0.003825	20.15	9030.27	527.93	0.86
(Lower)	1600	Design Q	182000.00	-5.00	11.84	11.84	19.63	0.003745	22.39	8128.83	525.44	1.00


Shoemaker Bridge Options Plan: Proposed Cable Stayed EXPIERS 3/22/2018
River = LA River Reach = (Lower) RS = 8500
.02
Legend
WS Design Q
Ground
Bank Sta
Elevation (ft)
Station (ft)
0
5
10
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35
100
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400
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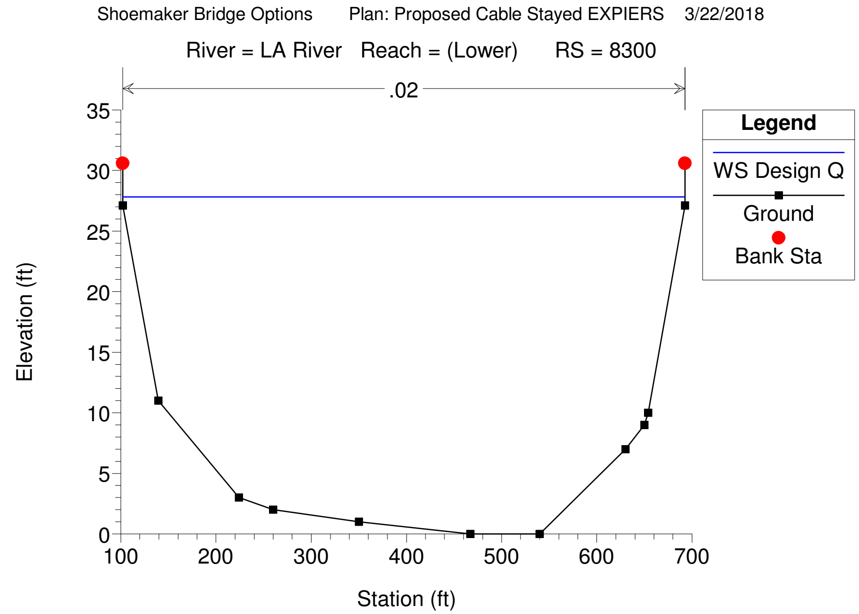
600
700


Shoemaker Bridge Options Plan: Proposed Cable Stayed EXPIERS 3/22/2018
River = LA River Reach = (Lower) RS = 8300
.02
Legend
WS Design Q
Ground
Bank Sta
Elevation (ft)
Station (ft)
0
5
10
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25
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100
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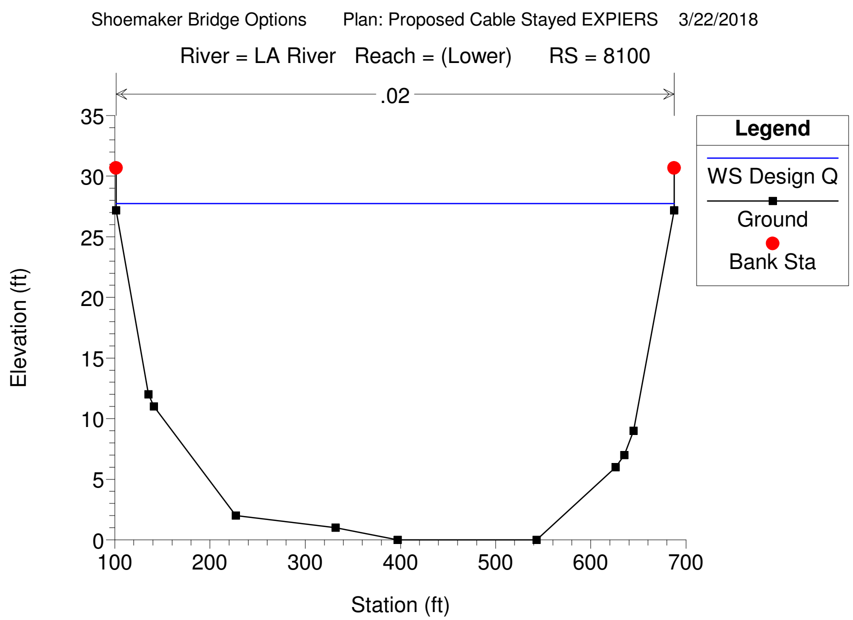
600
700


Shoemaker Bridge Options Plan: Proposed Cable Stayed EXPIERS 3/22/2018
River = LA River Reach = (Lower) RS = 8100
.02
Legend
WS Design Q
Ground
Bank Sta
Elevation (ft)
Station (ft)
0
5
10
15
20
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100
200
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400
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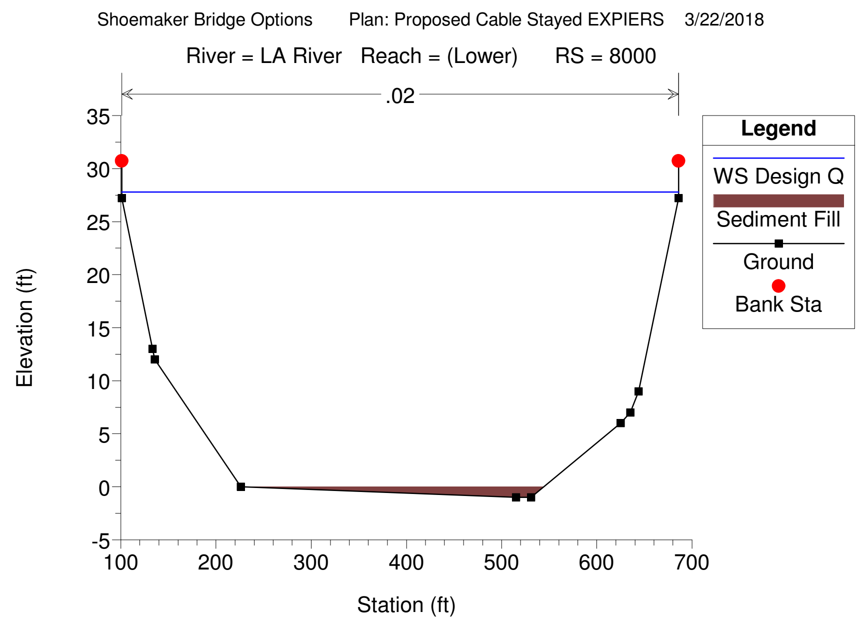
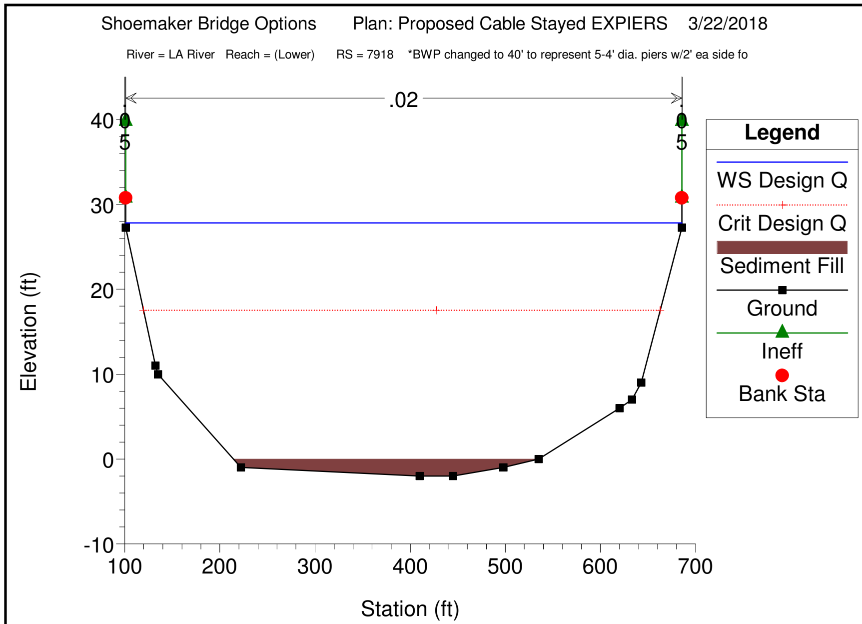
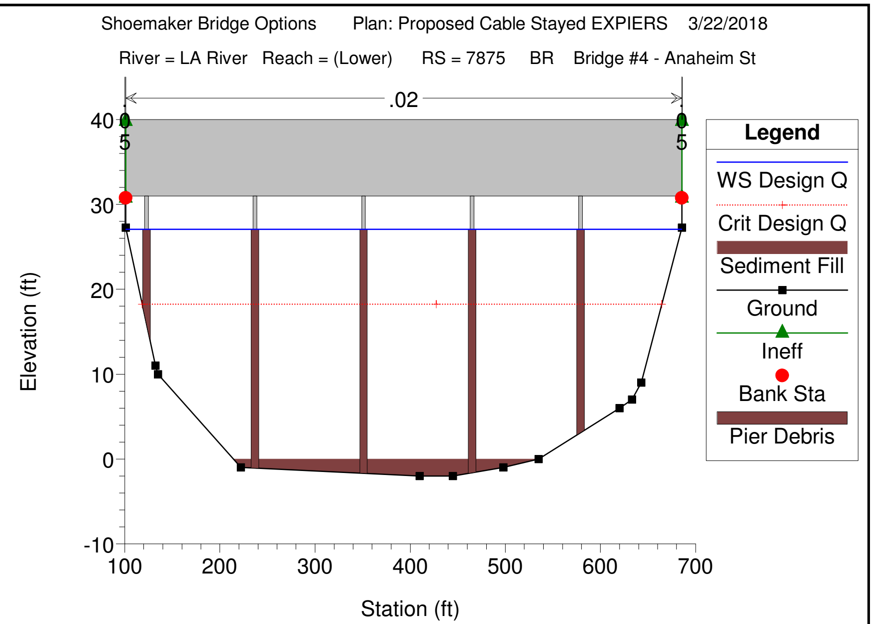
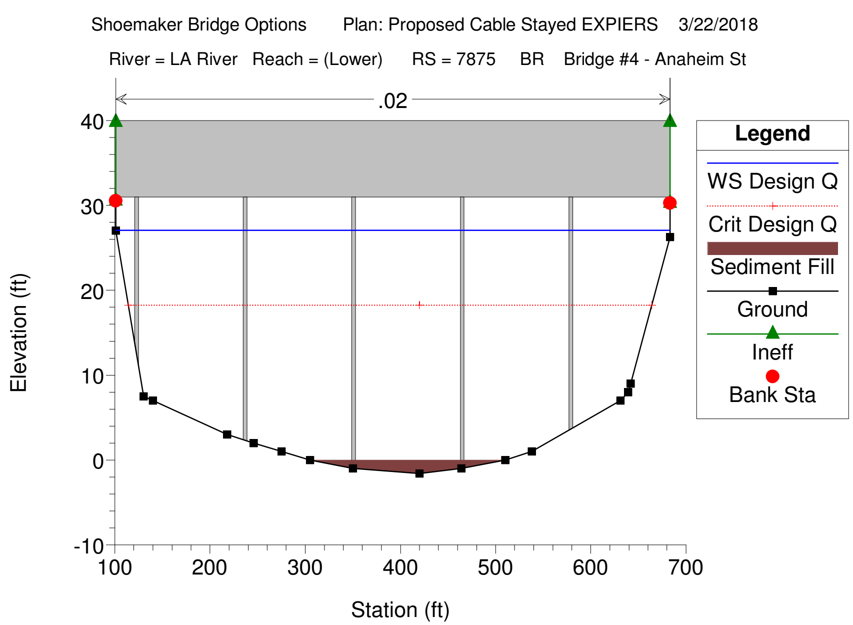
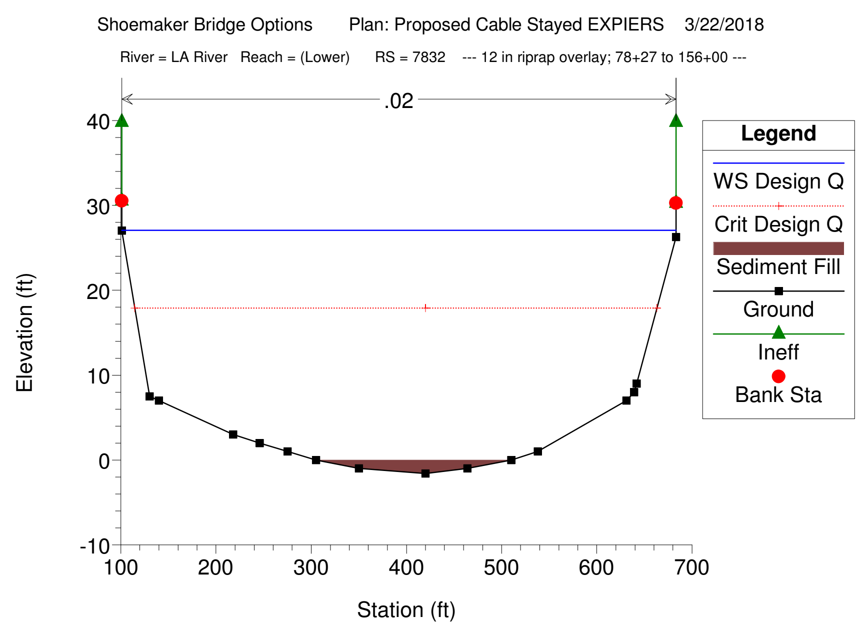
600
700

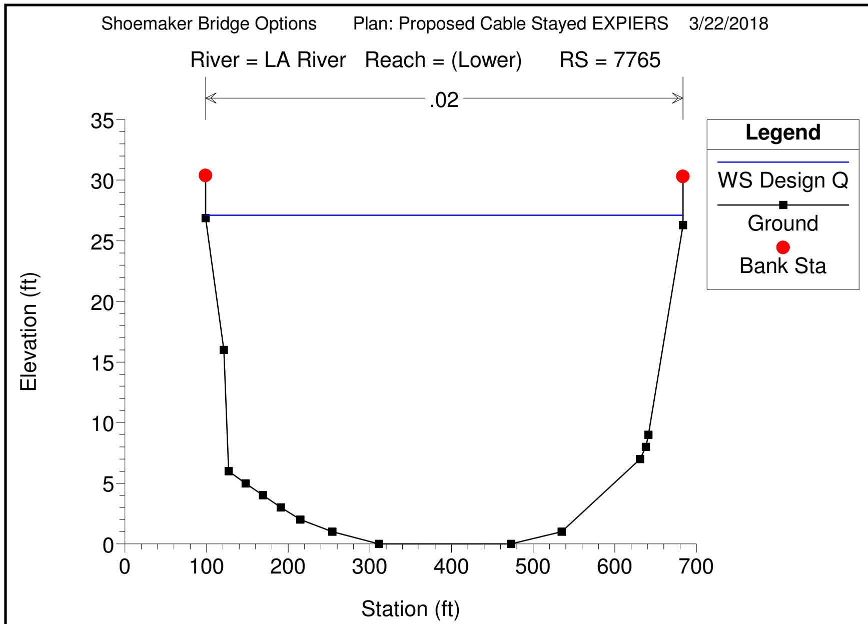

Shoemaker Bridge Options Plan: Proposed Cable Stayed EXPIERS 3/22/2018
River = LA River Reach = (Lower) RS = 8000
.02
Legend
WS Design Q
Sediment Fill
Ground
Bank Sta
Elevation (ft)
Station (ft)
-5
0
5
10
15
20
25
30
35
100
200
300
400
500
600
700

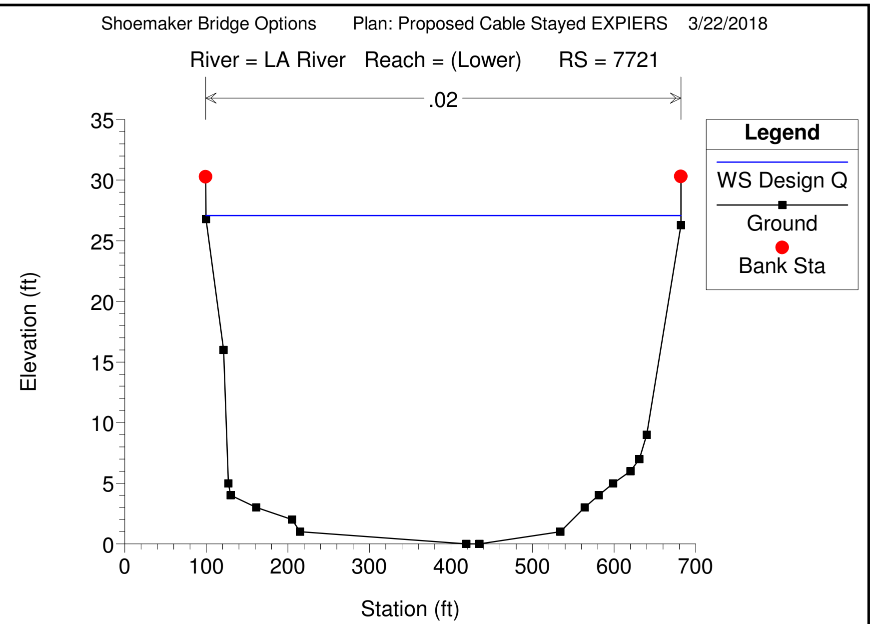

Shoemaker Bridge Options Plan: Proposed Cable Stayed EXPIERS 3/22/2018
River = LA River Reach = (Lower) RS = 7918 *BWP changed to 40' to represent 5-4' dia. piers w/2' ea side fo
.02
Elevation (ft)
Station (ft)
Legend
WS Design Q
Crit Design Q
Sediment Fill
Ground
Ineff
Bank Sta

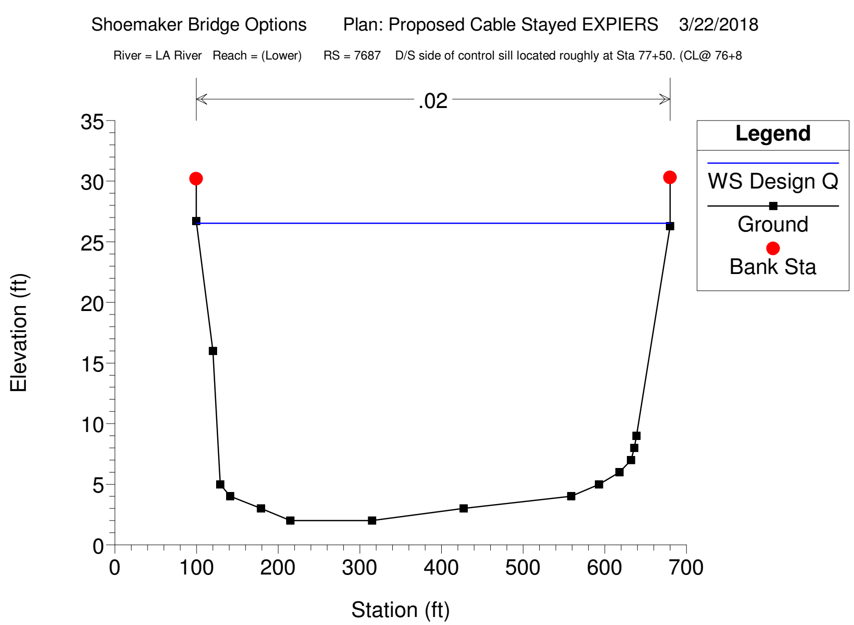

Shoemaker Bridge Options Plan: Proposed Cable Stayed EXPIERS 3/22/2018
River = LA River Reach = (Lower) RS = 7875 BR Bridge #4 - Anaheim St
.02
Elevation (ft)
Station (ft)
Legend
WS Design Q
Crit Design Q
Sediment Fill
Ground
Ineff
Bank Sta
Pier Debris

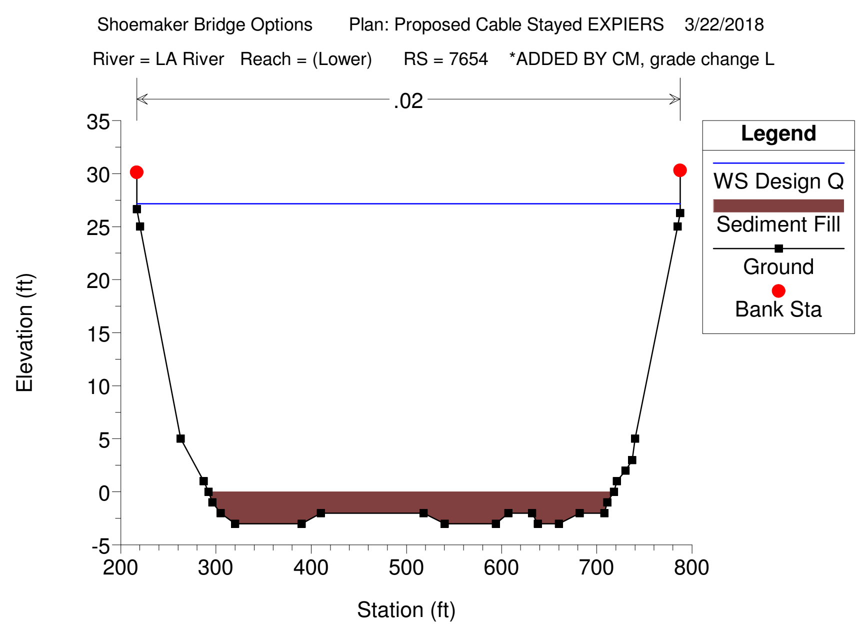

Shoemaker Bridge Options Plan: Proposed Cable Stayed EXPIERS 3/22/2018
River = LA River Reach = (Lower) RS = 7875 BR Bridge #4 - Anaheim St
.02
Elevation (ft)
Station (ft)
Legend
WS Design Q
Crit Design Q
Sediment Fill
Ground
Ineff
Bank Sta

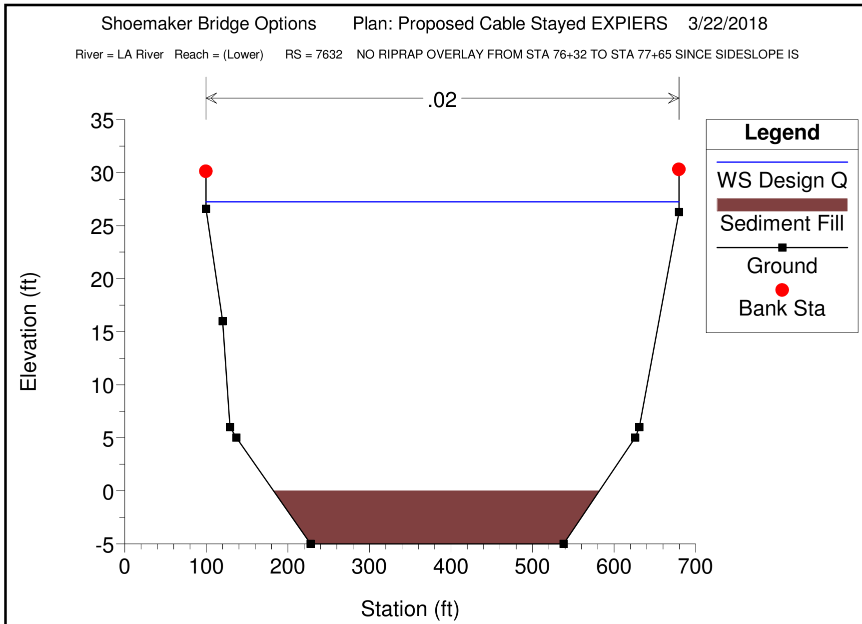

Shoemaker Bridge Options Plan: Proposed Cable Stayed EXPIERS 3/22/2018
River = LA River Reach = (Lower) RS = 7832 --- 12 in riprap overlay; 78+27 to 156+00 ---
.02
Elevation (ft)
Station (ft)
Legend
WS Design Q
Crit Design Q
Sediment Fill
Ground
Ineff
Bank Sta


Shoemaker Bridge Options Plan: Proposed Cable Stayed EXPIERS 3/22/2018
River = LA River Reach = (Lower) RS = 7765
.02
Elevation (ft)
Station (ft)
Legend
WS Design Q
Ground
Bank Sta


Shoemaker Bridge Options Plan: Proposed Cable Stayed EXPIERS 3/22/2018
River = LA River Reach = (Lower) RS = 7721
.02
Elevation (ft)
Station (ft)
Legend
WS Design Q
Ground
Bank Sta


Shoemaker Bridge Options Plan: Proposed Cable Stayed EXPIERS 3/22/2018
River = LA River Reach = (Lower) RS = 7687 D/S side of control sill located roughly at Sta 77+50. (CL@ 76+8
.02
Elevation (ft)
Station (ft)
Legend
WS Design Q
Ground
Bank Sta


Shoemaker Bridge Options Plan: Proposed Cable Stayed EXPIERS 3/22/2018
River = LA River Reach = (Lower) RS = 7654 *ADDED BY CM, grade change L
.02
Elevation (ft)
Station (ft)
Legend
WS Design Q
Sediment Fill
Ground
Bank Sta


Shoemaker Bridge Options Plan: Proposed Cable Stayed EXPIERS 3/22/2018
River = LA River Reach = (Lower) RS = 7632 NO RIPRAP OVERLAY FROM STA 76+32 TO STA 77+65 SINCE SIDESLOPE IS
.02
Legend
WS Design Q
Sediment Fill
Ground
Bank Sta
Elevation (ft)
Station (ft)
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25
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-5
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100
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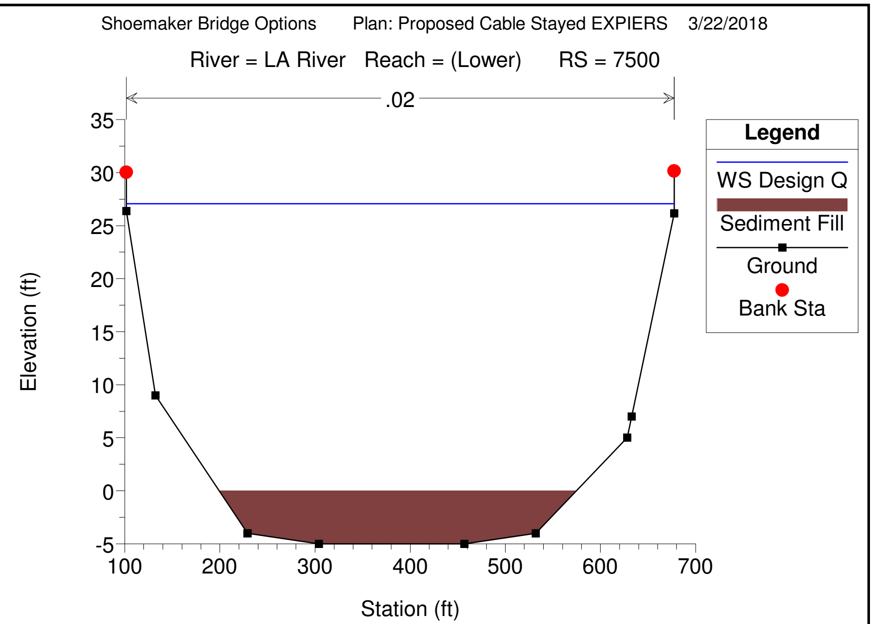
Shoemaker Bridge Options Plan: Proposed Cable Stayed EXPIERS 3/22/2018
River = LA River Reach = (Lower) RS = 7500
.02
Legend
WS Design Q
Sediment Fill
Ground
Bank Sta
Elevation (ft)
Station (ft)
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-5
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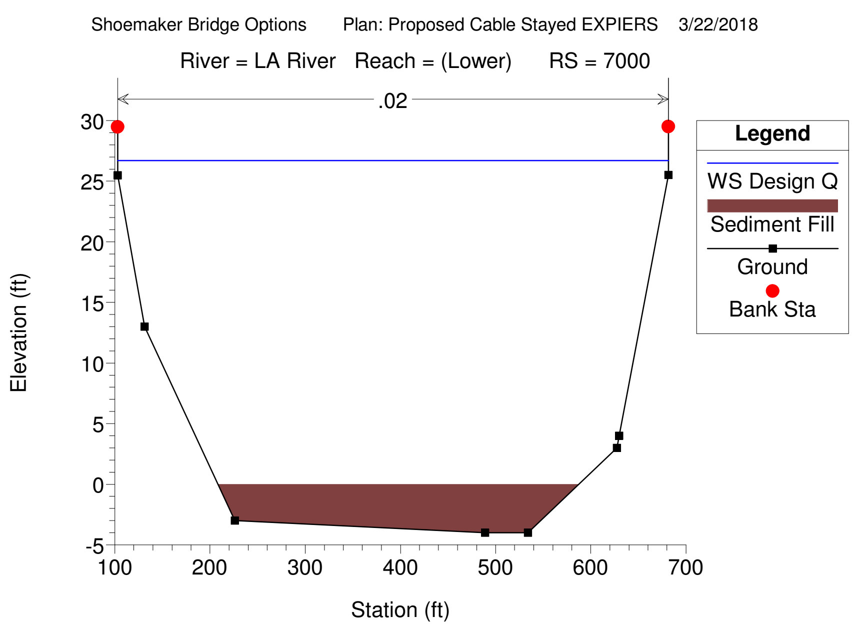
Shoemaker Bridge Options Plan: Proposed Cable Stayed EXPIERS 3/22/2018
River = LA River Reach = (Lower) RS = 7000
.02
Legend
WS Design Q
Sediment Fill
Ground
Bank Sta
Elevation (ft)
Station (ft)
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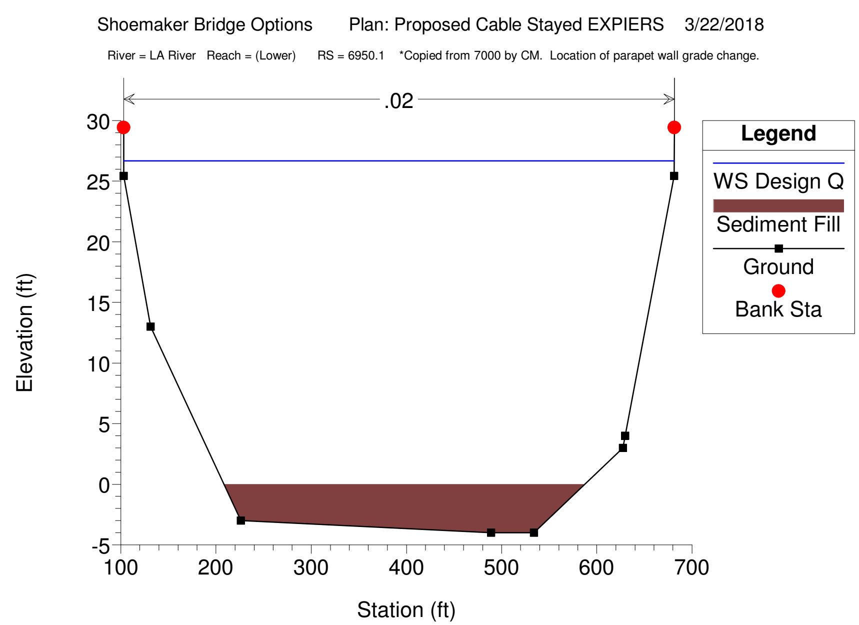
Shoemaker Bridge Options Plan: Proposed Cable Stayed EXPIERS 3/22/2018
River = LA River Reach = (Lower) RS = 6950.1 *Copied from 7000 by CM. Location of parapet wall grade change.
.02
Legend
WS Design Q
Sediment Fill
Ground
Bank Sta
Elevation (ft)
Station (ft)
30
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-5
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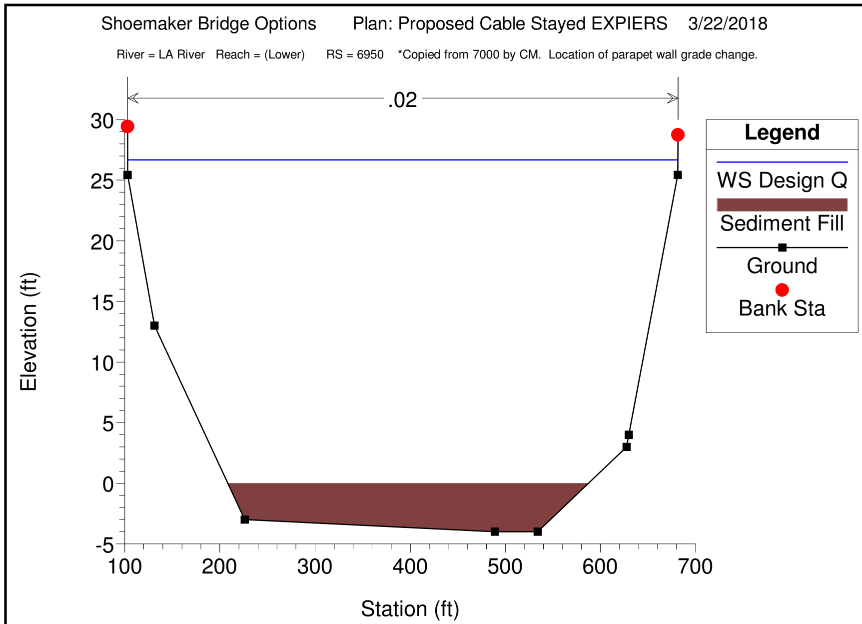
Shoemaker Bridge Options   Plan: Proposed Cable Stayed EXPIERS   3/22/2018
River = LA River   Reach = (Lower)   RS = 6950   *Copied from 7000 by CM. Location of parapet wall grade change.
.02
Legend
WS Design Q
Sediment Fill
Ground
Bank Sta
Elevation (ft)
Station (ft)
30
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-5
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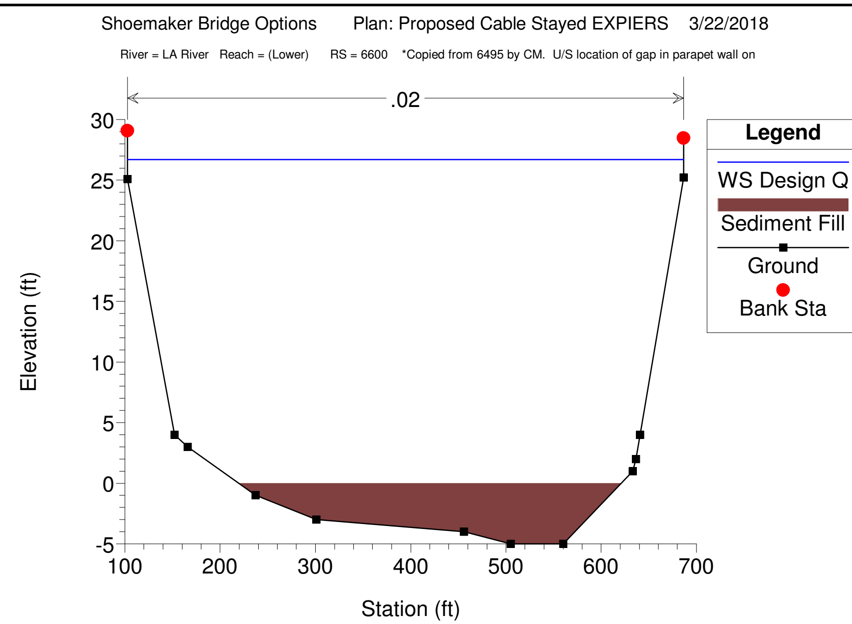
Shoemaker Bridge Options   Plan: Proposed Cable Stayed EXPIERS   3/22/2018
River = LA River   Reach = (Lower)   RS = 6600   *Copied from 6495 by CM. U/S location of gap in parapet wall on
.02
Legend
WS Design Q
Sediment Fill
Ground
Bank Sta
Elevation (ft)
Station (ft)
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-5
100
200
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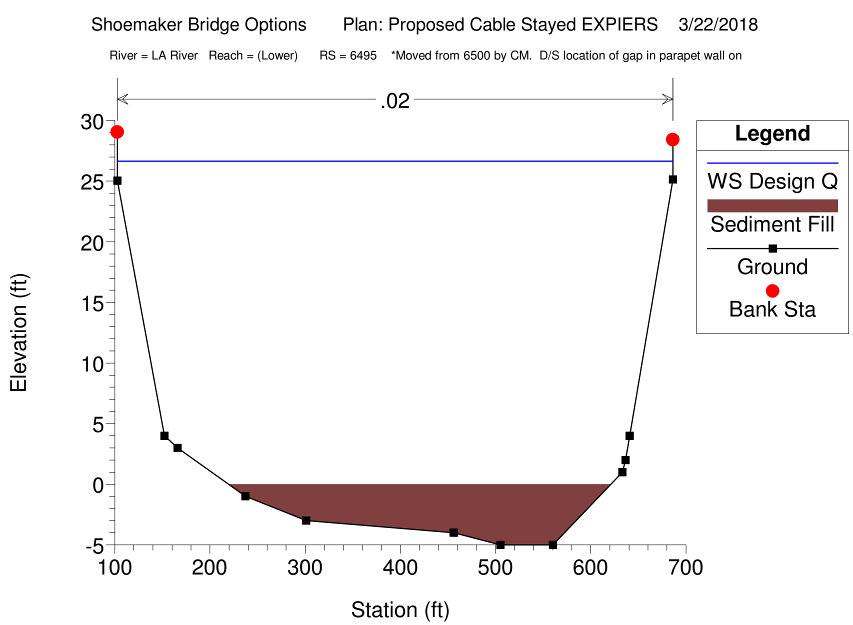
600
700


Shoemaker Bridge Options   Plan: Proposed Cable Stayed EXPIERS   3/22/2018
River = LA River   Reach = (Lower)   RS = 6495   *Moved from 6500 by CM. D/S location of gap in parapet wall on
.02
Legend
WS Design Q
Sediment Fill
Ground
Bank Sta
Elevation (ft)
Station (ft)
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-5
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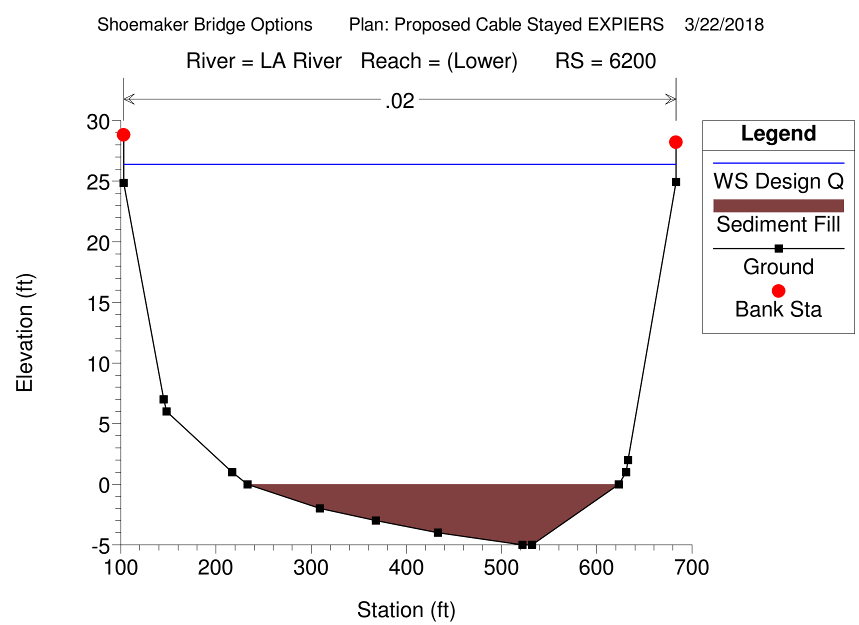
700


Shoemaker Bridge Options   Plan: Proposed Cable Stayed EXPIERS   3/22/2018
River = LA River   Reach = (Lower)   RS = 6200
.02
Legend
WS Design Q
Sediment Fill
Ground
Bank Sta
Elevation (ft)
Station (ft)
30
25
20
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-5
100
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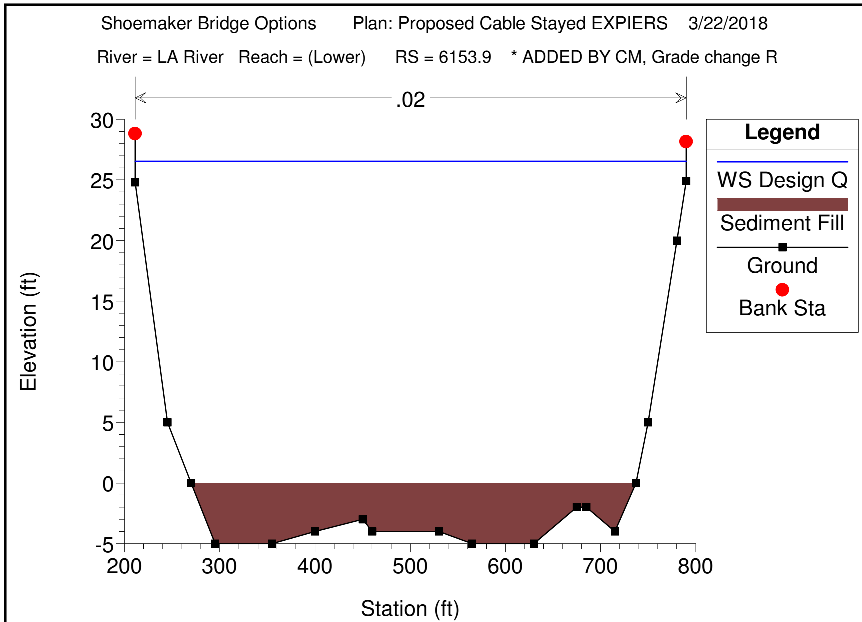
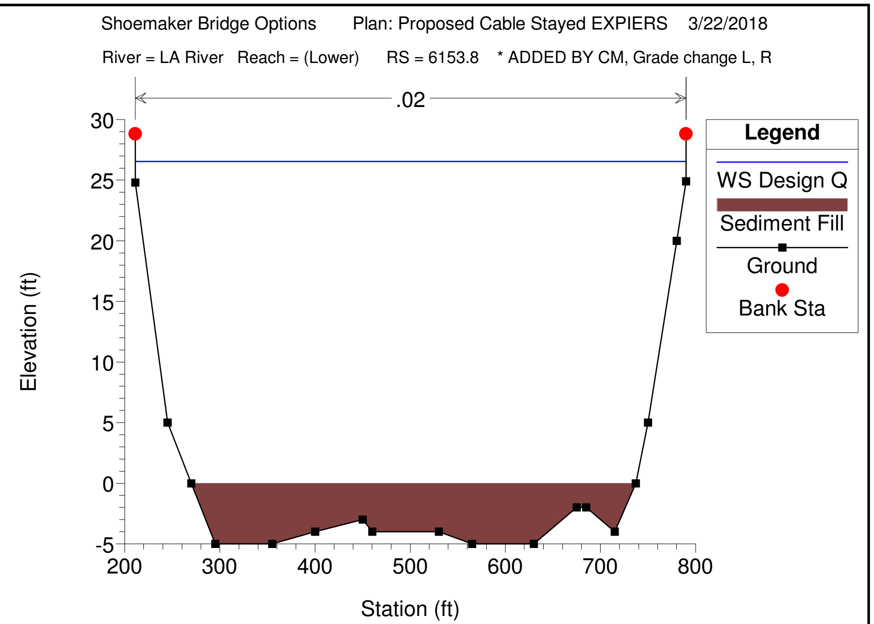
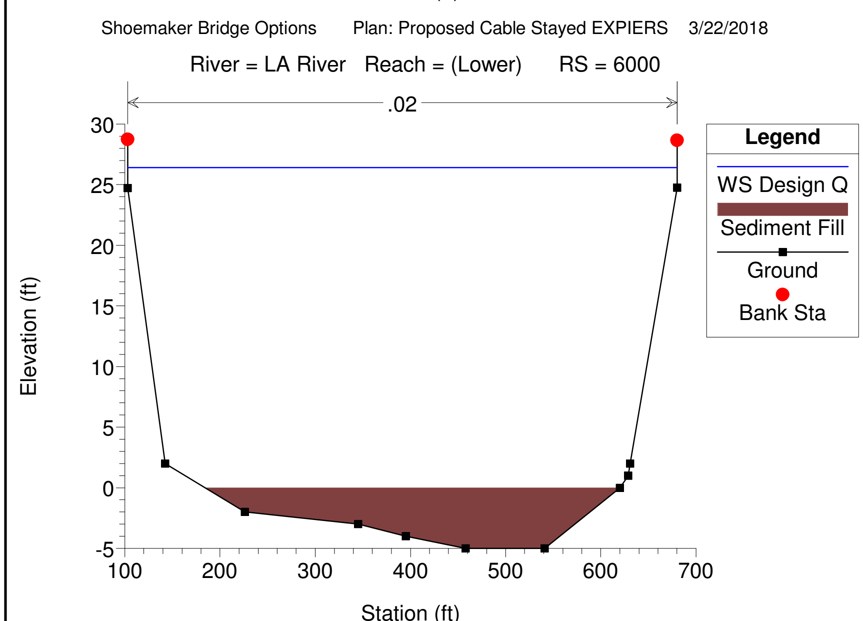
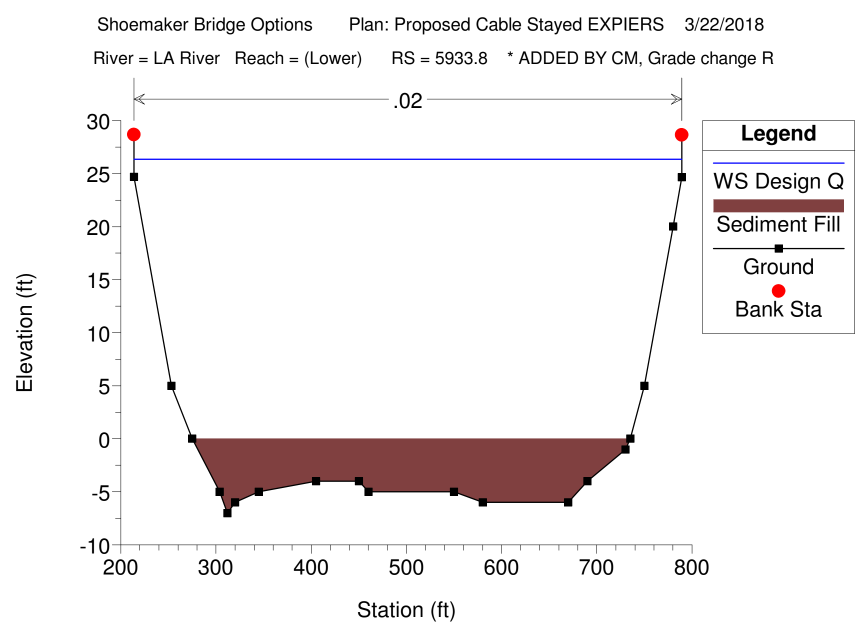
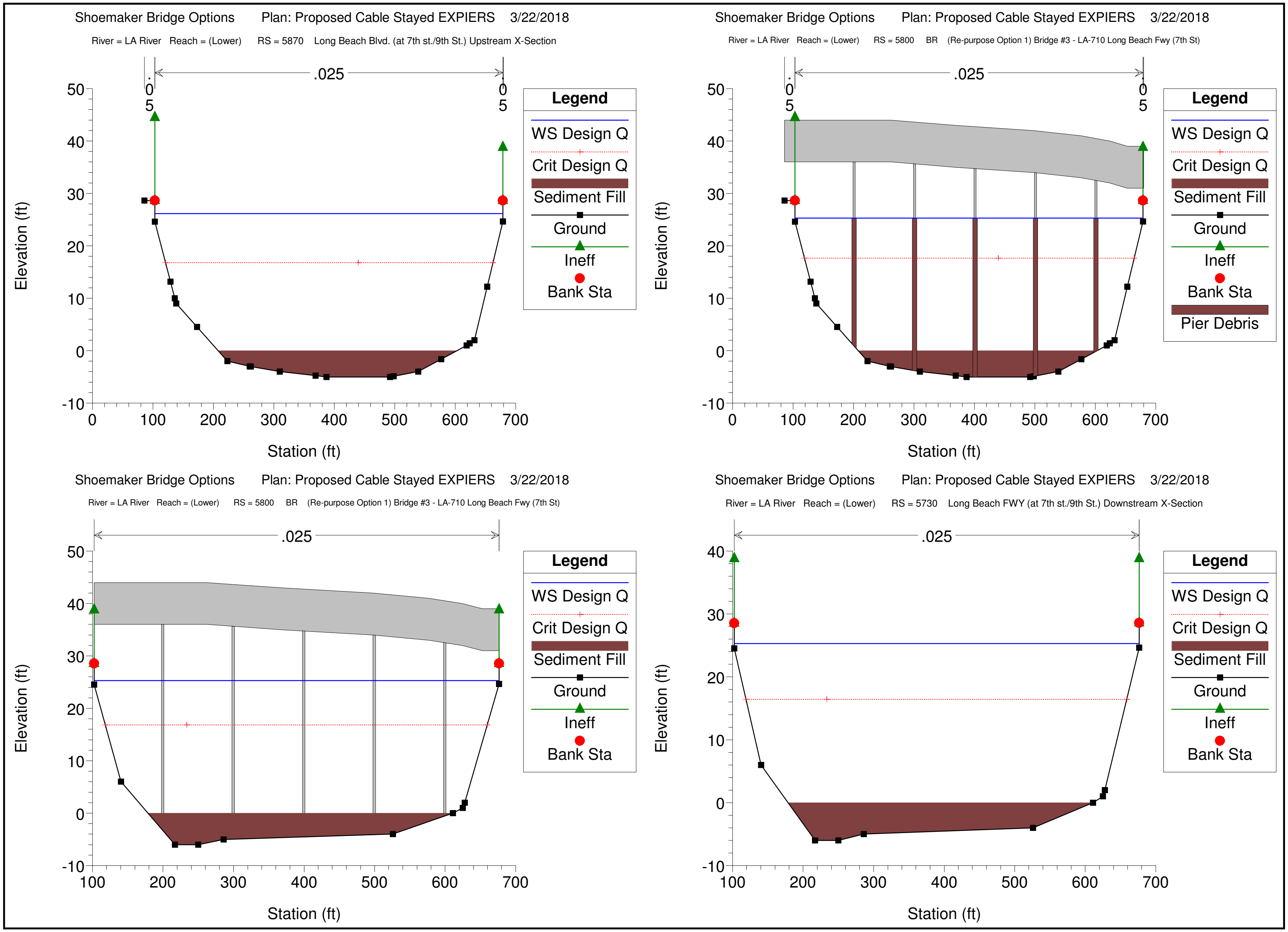
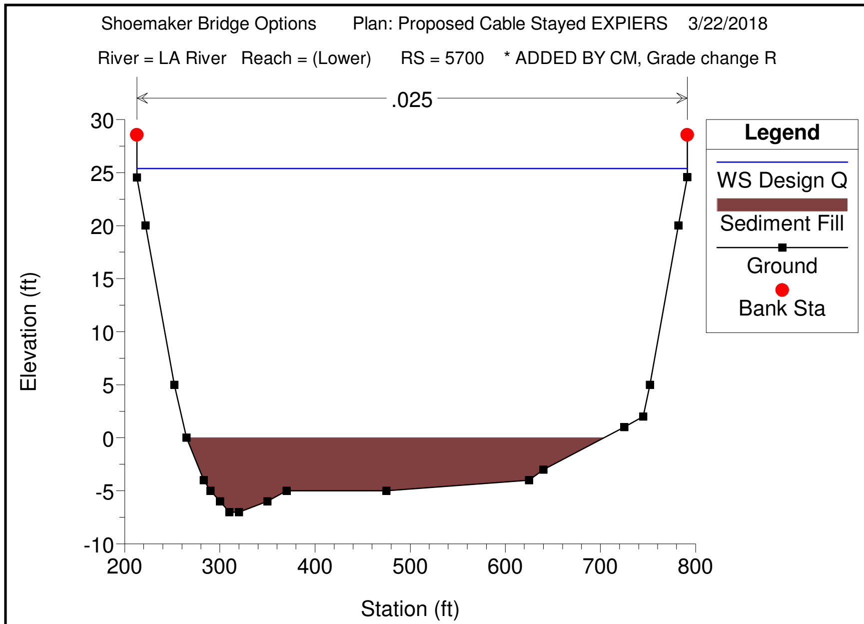

Shoemaker Bridge Options Plan: Proposed Cable Stayed EXPIERS 3/22/2018
River = LA River Reach = (Lower) RS = 6153.9 * ADDED BY CM, Grade change R
.02
Legend
WS Design Q
Sediment Fill
Ground
Bank Sta
Elevation (ft)
Station (ft)

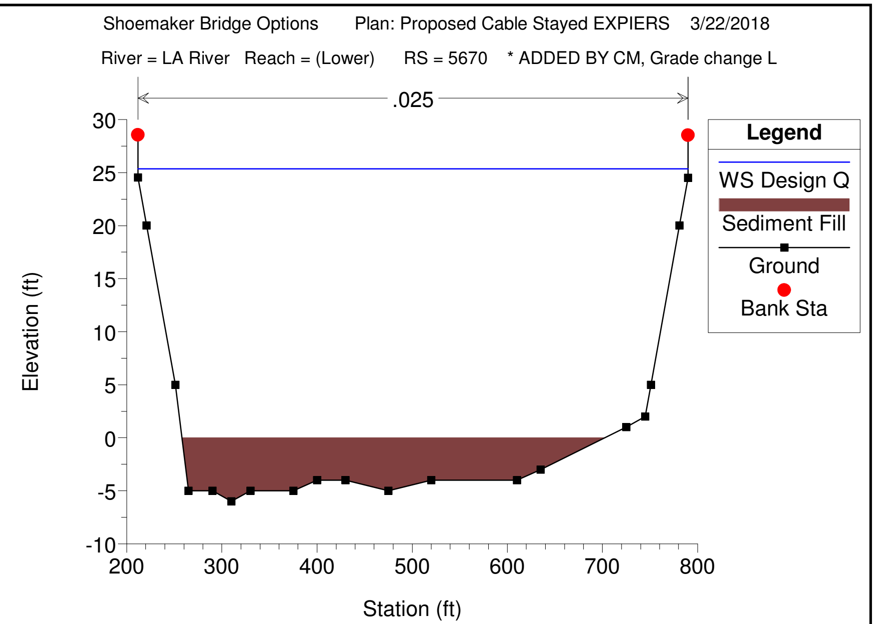

Shoemaker Bridge Options Plan: Proposed Cable Stayed EXPIERS 3/22/2018
River = LA River Reach = (Lower) RS = 6153.8 * ADDED BY CM, Grade change L, R
.02
Legend
WS Design Q
Sediment Fill
Ground
Bank Sta
Elevation (ft)
Station (ft)

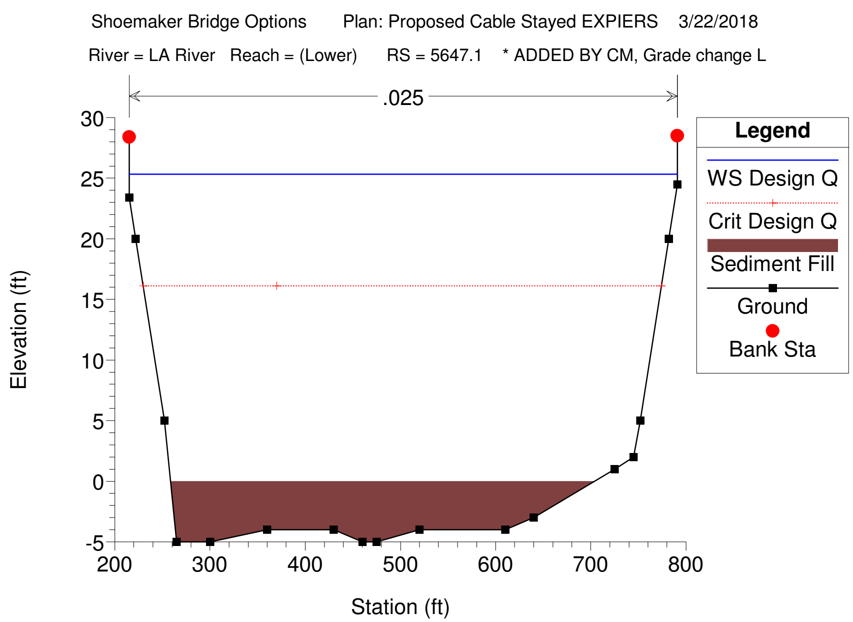

Shoemaker Bridge Options Plan: Proposed Cable Stayed EXPIERS 3/22/2018
River = LA River Reach = (Lower) RS = 6000
.02
Legend
WS Design Q
Sediment Fill
Ground
Bank Sta
Elevation (ft)
Station (ft)

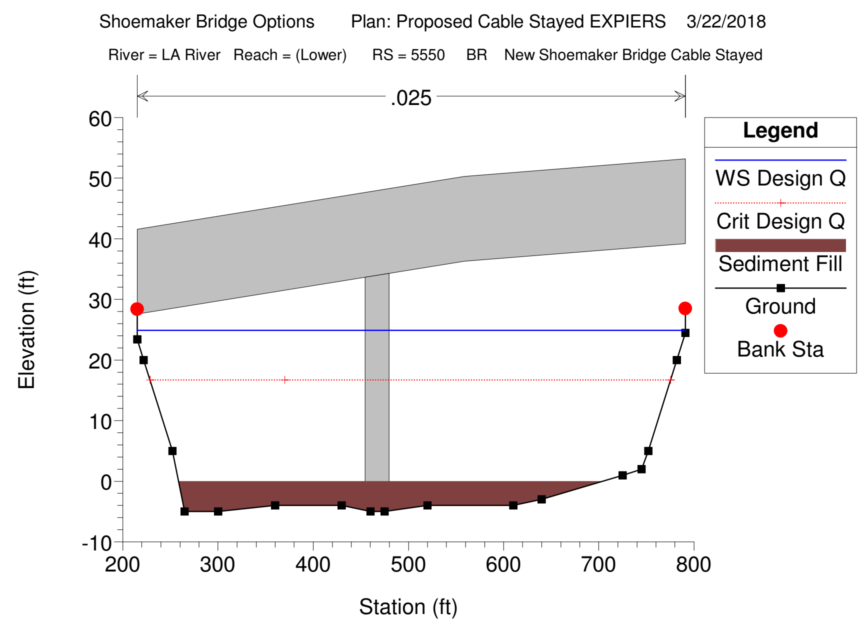

Shoemaker Bridge Options Plan: Proposed Cable Stayed EXPIERS 3/22/2018
River = LA River Reach = (Lower) RS = 5933.8 * ADDED BY CM, Grade change R
.02
Legend
WS Design Q
Sediment Fill
Ground
Bank Sta
Elevation (ft)
Station (ft)

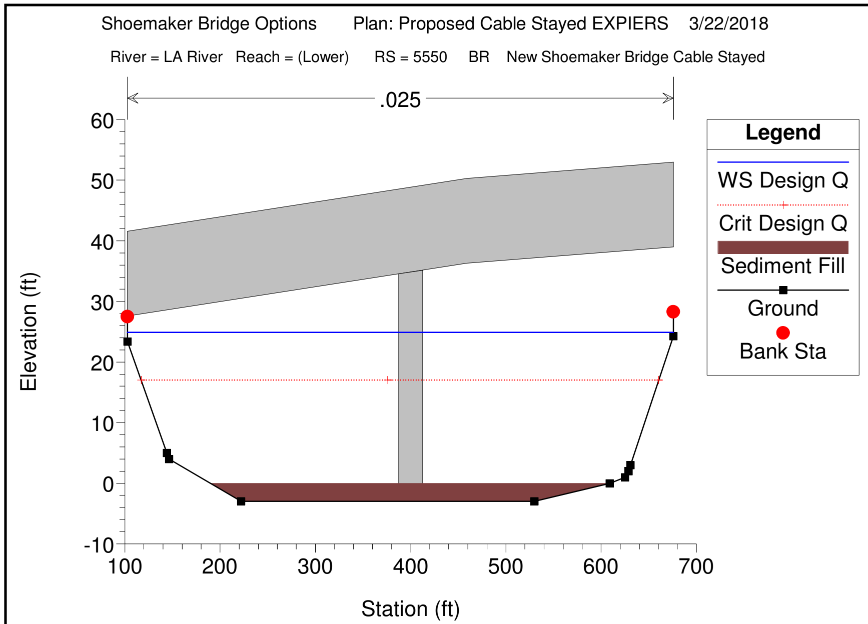

Shoemaker Bridge Options Plan: Proposed Cable Stayed EXPIERS 3/22/2018
River = LA River Reach = (Lower) RS = 5870 Long Beach Blvd. (at 7th st./9th St.) Upstream X-Section
.025
Legend
WS Design Q
Crit Design Q
Sediment Fill
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Shoemaker Bridge Options Plan: Proposed Cable Stayed EXPIERS 3/22/2018
River = LA River Reach = (Lower) RS = 5800 BR (Re-purpose Option 1) Bridge #3 - LA-710 Long Beach Fwy (7th St)
.025
Legend
WS Design Q
Crit Design Q
Sediment Fill
Ground
Ineff
Bank Sta
Pier Debris
Elevation (ft)
Station (ft)
Shoemaker Bridge Options Plan: Proposed Cable Stayed EXPIERS 3/22/2018
River = LA River Reach = (Lower) RS = 5800 BR (Re-purpose Option 1) Bridge #3 - LA-710 Long Beach Fwy (7th St)
.025
Legend
WS Design Q
Crit Design Q
Sediment Fill
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Shoemaker Bridge Options Plan: Proposed Cable Stayed EXPIERS 3/22/2018
River = LA River Reach = (Lower) RS = 5730 Long Beach FWY (at 7th st./9th St.) Downstream X-Section
.025
Legend
WS Design Q
Crit Design Q
Sediment Fill
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

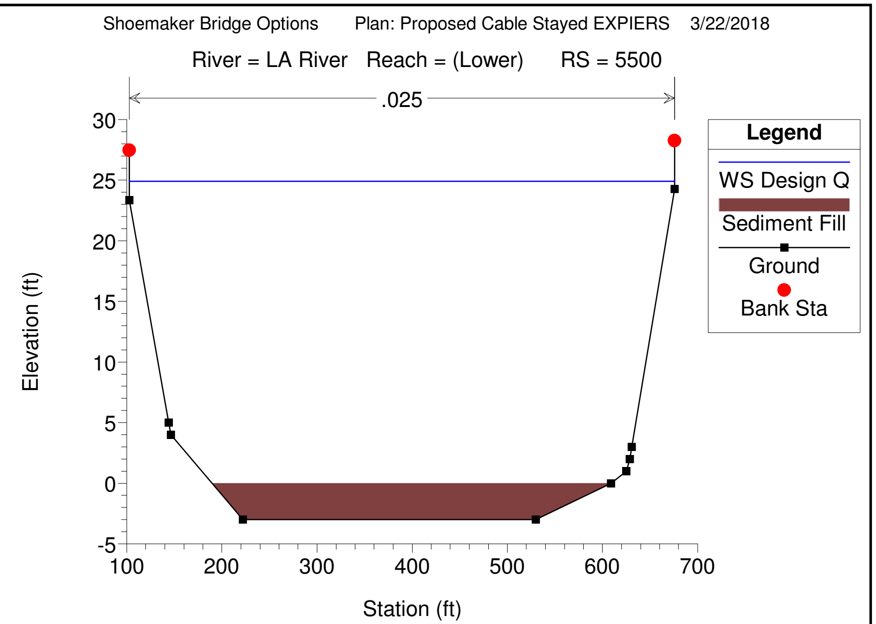

Shoemaker Bridge Options Plan: Proposed Cable Stayed EXPIERS 3/22/2018
River = LA River Reach = (Lower) RS = 5700 * ADDED BY CM, Grade change R
.025
Legend
WS Design Q
Sediment Fill
Ground
Bank Sta
Elevation (ft)
Station (ft)

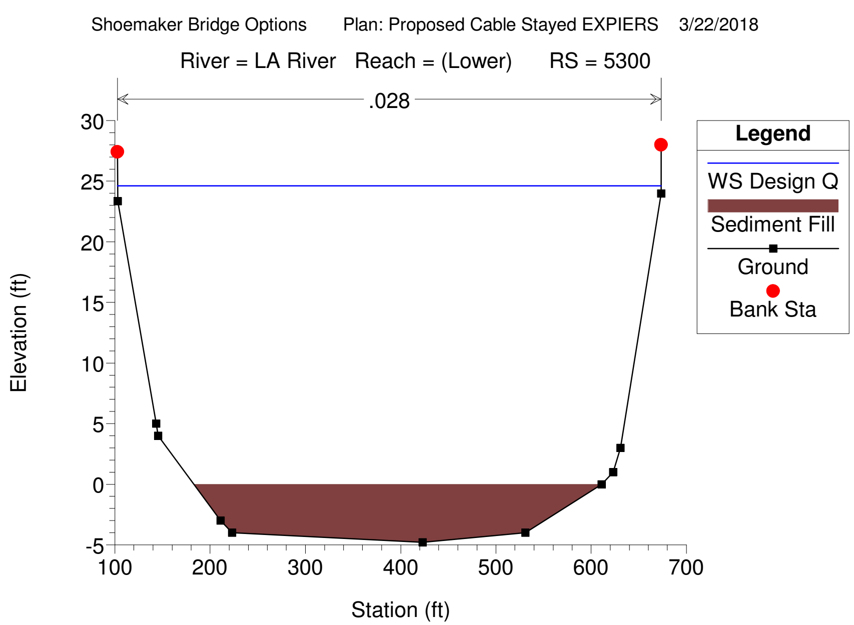

Shoemaker Bridge Options Plan: Proposed Cable Stayed EXPIERS 3/22/2018
River = LA River Reach = (Lower) RS = 5670 * ADDED BY CM, Grade change L
.025
Legend
WS Design Q
Sediment Fill
Ground
Bank Sta
Elevation (ft)
Station (ft)

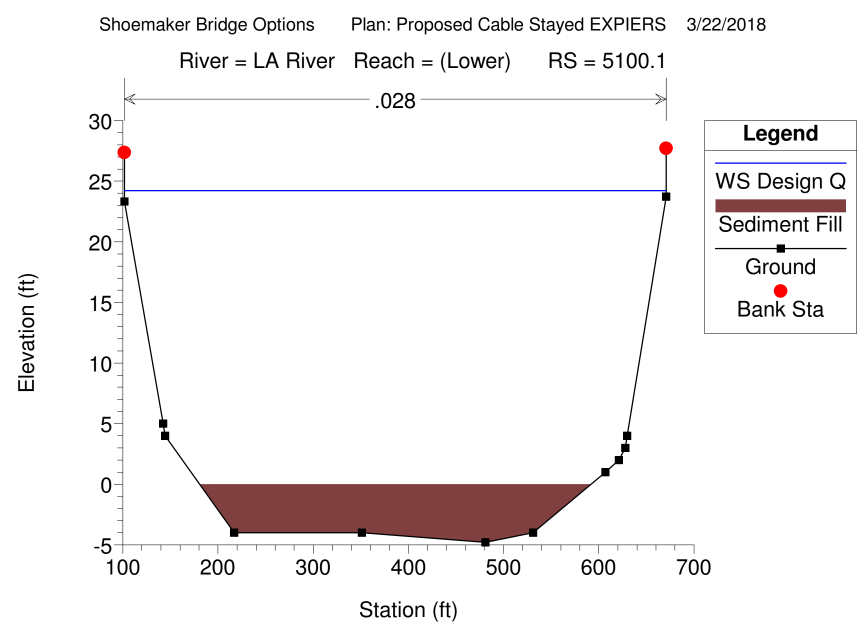

Shoemaker Bridge Options Plan: Proposed Cable Stayed EXPIERS 3/22/2018
River = LA River Reach = (Lower) RS = 5647.1 * ADDED BY CM, Grade change L
.025
Legend
WS Design Q
Crit Design Q
Sediment Fill
Ground
Bank Sta
Elevation (ft)
Station (ft)

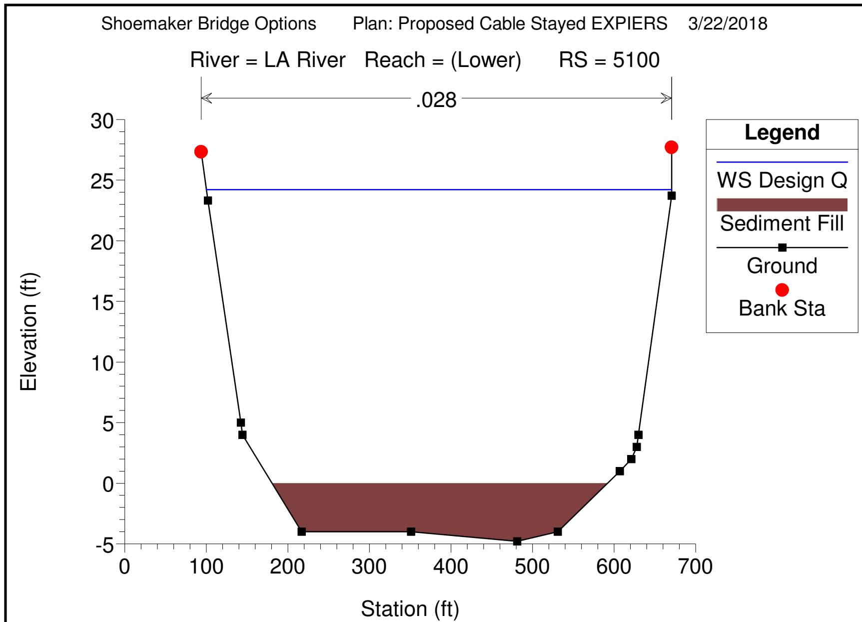

Shoemaker Bridge Options Plan: Proposed Cable Stayed EXPIERS 3/22/2018
River = LA River Reach = (Lower) RS = 5550 BR New Shoemaker Bridge Cable Stayed
.025
Legend
WS Design Q
Crit Design Q
Sediment Fill
Ground
Bank Sta
Elevation (ft)
Station (ft)

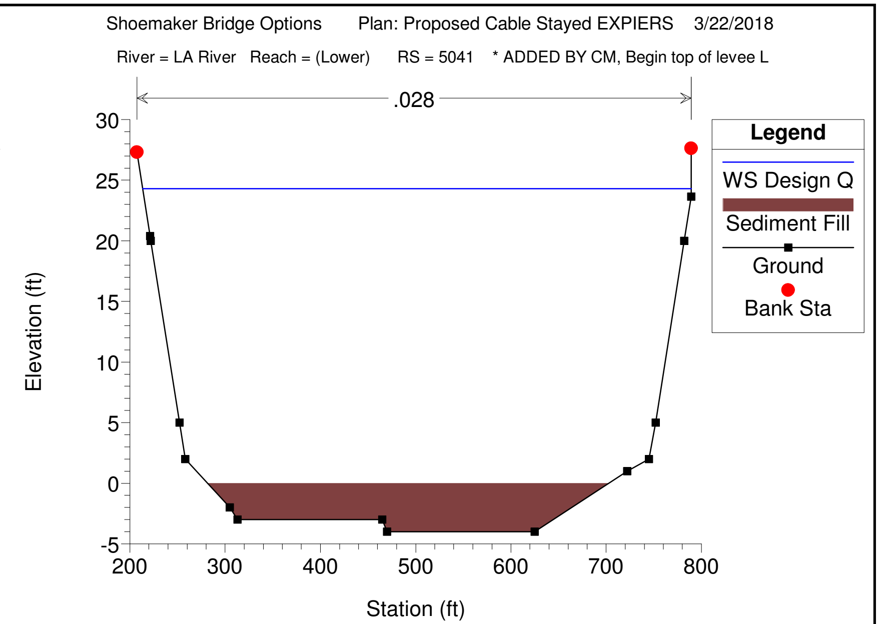

Shoemaker Bridge Options Plan: Proposed Cable Stayed EXPIERS 3/22/2018
River = LA River Reach = (Lower) RS = 5550 BR New Shoemaker Bridge Cable Stayed
.025
Elevation (ft)
Station (ft)
60
50
40
30
20
10
0
-10
100
200
300
400
500
600
700
Legend
WS Design Q
Crit Design Q
Sediment Fill
Ground
Bank Sta

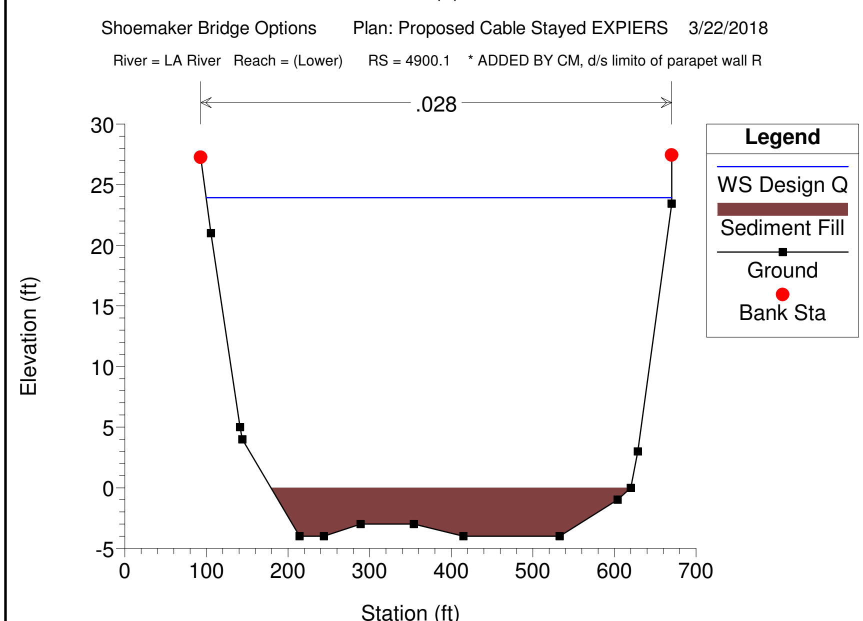

Shoemaker Bridge Options Plan: Proposed Cable Stayed EXPIERS 3/22/2018
River = LA River Reach = (Lower) RS = 5500
.025
Elevation (ft)
Station (ft)
30
25
20
15
10
5
0
-5
100
200
300
400
500
600
700
Legend
WS Design Q
Sediment Fill
Ground
Bank Sta

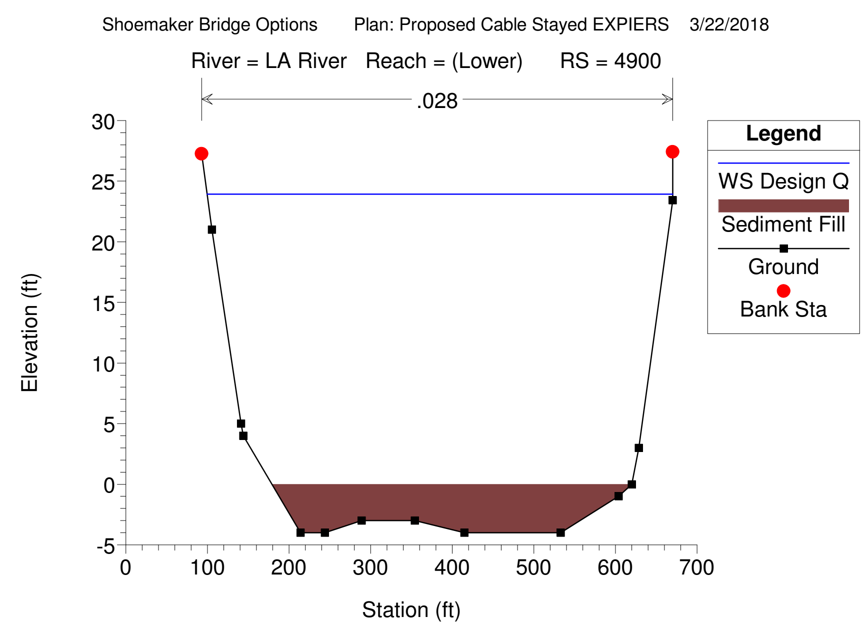

Shoemaker Bridge Options Plan: Proposed Cable Stayed EXPIERS 3/22/2018
River = LA River Reach = (Lower) RS = 5300
.028
Elevation (ft)
Station (ft)
30
25
20
15
10
5
0
-5
100
200
300
400
500
600
700
Legend
WS Design Q
Sediment Fill
Ground
Bank Sta

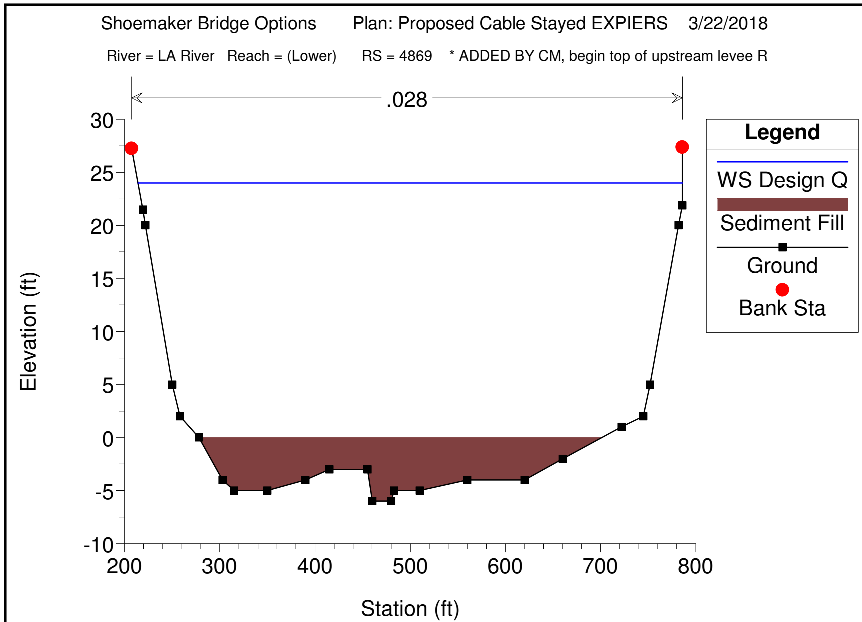

Shoemaker Bridge Options Plan: Proposed Cable Stayed EXPIERS 3/22/2018
River = LA River Reach = (Lower) RS = 5100.1
.028
Elevation (ft)
Station (ft)
30
25
20
15
10
5
0
-5
100
200
300
400
500
600
700
Legend
WS Design Q
Sediment Fill
Ground
Bank Sta

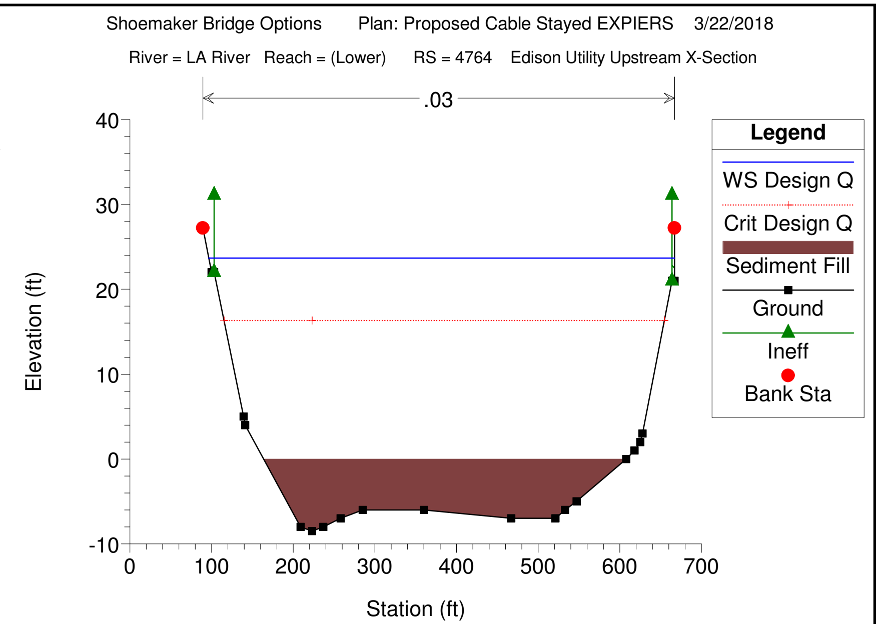

Shoemaker Bridge Options Plan: Proposed Cable Stayed EXPIERS 3/22/2018
River = LA River Reach = (Lower) RS = 5100
.028
Legend
WS Design Q
Sediment Fill
Ground
Bank Sta
Elevation (ft)
Station (ft)

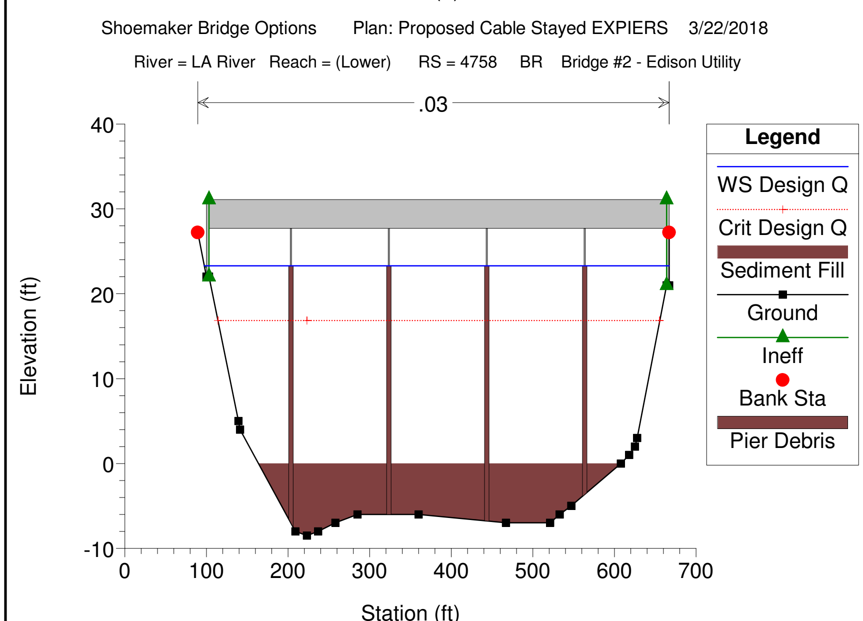

Shoemaker Bridge Options Plan: Proposed Cable Stayed EXPIERS 3/22/2018
River = LA River Reach = (Lower) RS = 5041 * ADDED BY CM, Begin top of levee L
.028
Legend
WS Design Q
Sediment Fill
Ground
Bank Sta
Elevation (ft)
Station (ft)

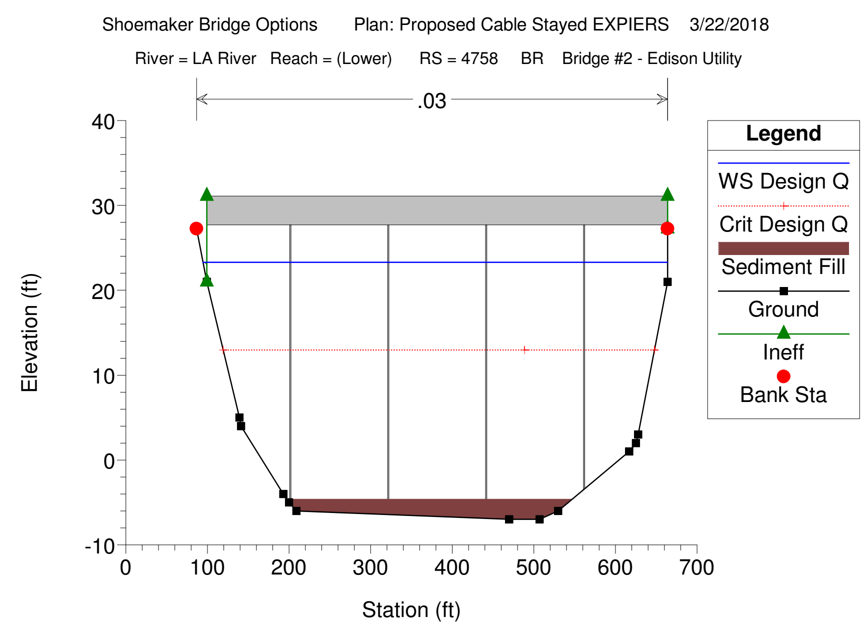

Shoemaker Bridge Options Plan: Proposed Cable Stayed EXPIERS 3/22/2018
River = LA River Reach = (Lower) RS = 4900.1 * ADDED BY CM, d/s limito of parapet wall R
.028
Legend
WS Design Q
Sediment Fill
Ground
Bank Sta
Elevation (ft)
Station (ft)

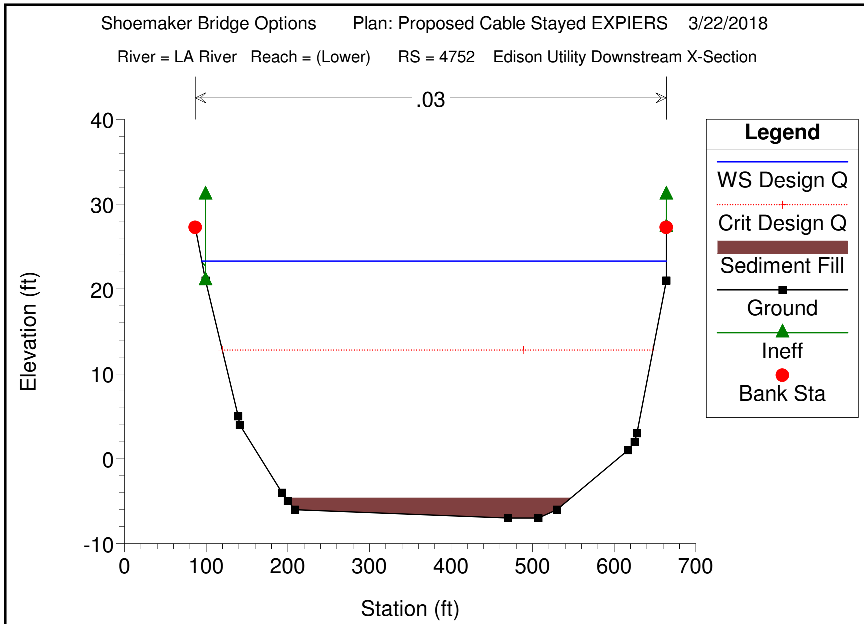

Shoemaker Bridge Options Plan: Proposed Cable Stayed EXPIERS 3/22/2018
River = LA River Reach = (Lower) RS = 4900
.028
Legend
WS Design Q
Sediment Fill
Ground
Bank Sta
Elevation (ft)
Station (ft)

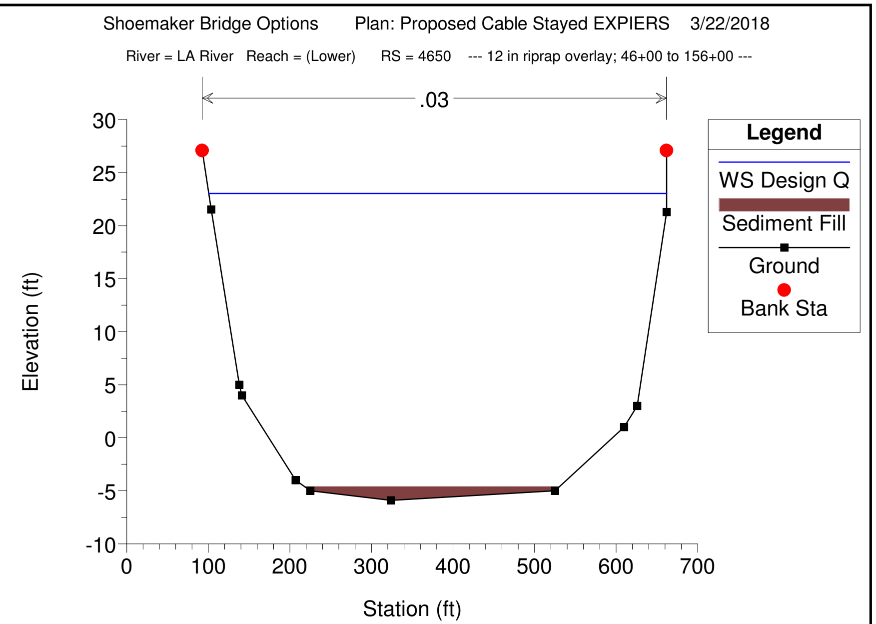

Shoemaker Bridge Options Plan: Proposed Cable Stayed EXPIERS 3/22/2018
River = LA River Reach = (Lower) RS = 4869 * ADDED BY CM, begin top of upstream levee R
.028
Legend
WS Design Q
Sediment Fill
Ground
Bank Sta
Elevation (ft)
Station (ft)
30
25
20
15
10
5
0
-5
-10
200
300
400
500
600
700
800

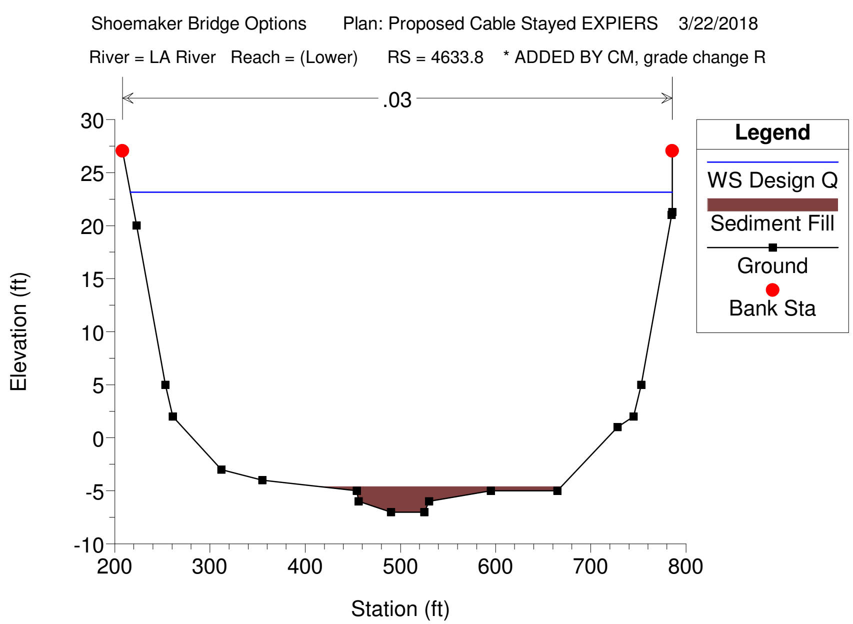

Shoemaker Bridge Options Plan: Proposed Cable Stayed EXPIERS 3/22/2018
River = LA River Reach = (Lower) RS = 4764 Edison Utility Upstream X-Section
.03
Legend
WS Design Q
Crit Design Q
Sediment Fill
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
40
30
20
10
0
-10
0
100
200
300
400
500
600
700

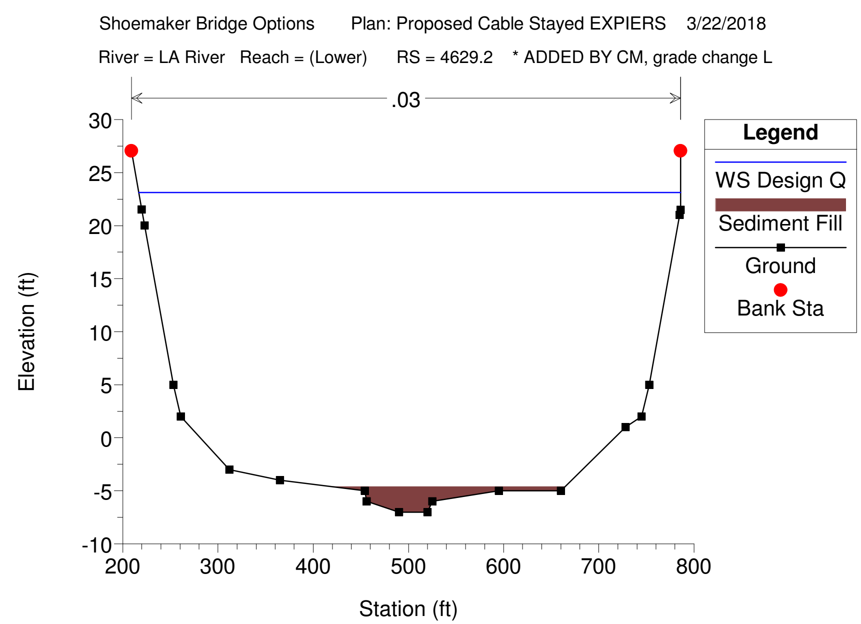

Shoemaker Bridge Options Plan: Proposed Cable Stayed EXPIERS 3/22/2018
River = LA River Reach = (Lower) RS = 4758 BR Bridge #2 - Edison Utility
.03
Legend
WS Design Q
Crit Design Q
Sediment Fill
Ground
Ineff
Bank Sta
Pier Debris
Elevation (ft)
Station (ft)
40
30
20
10
0
-10
0
100
200
300
400
500
600
700

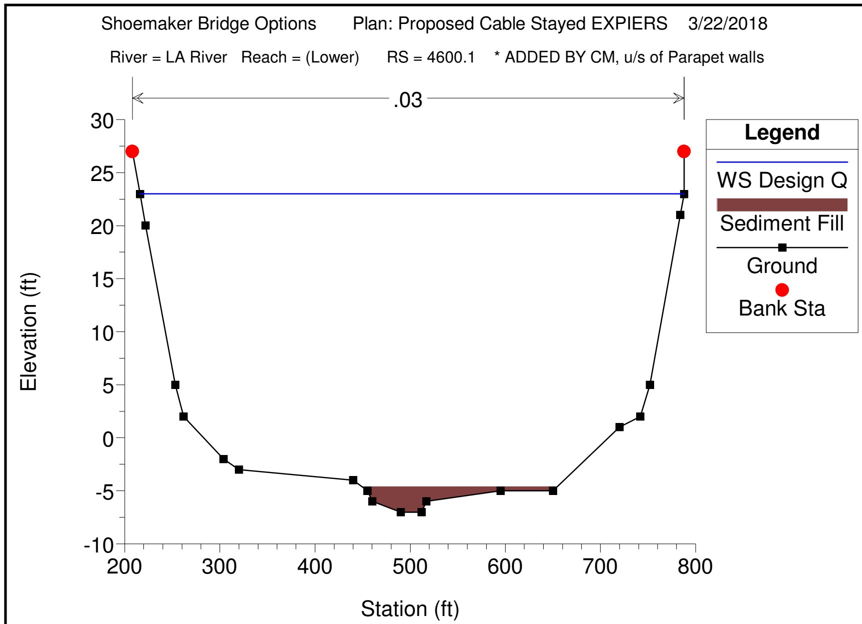

Shoemaker Bridge Options Plan: Proposed Cable Stayed EXPIERS 3/22/2018
River = LA River Reach = (Lower) RS = 4758 BR Bridge #2 - Edison Utility
.03
Legend
WS Design Q
Crit Design Q
Sediment Fill
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
40
30
20
10
0
-10
0
100
200
300
400
500
600
700

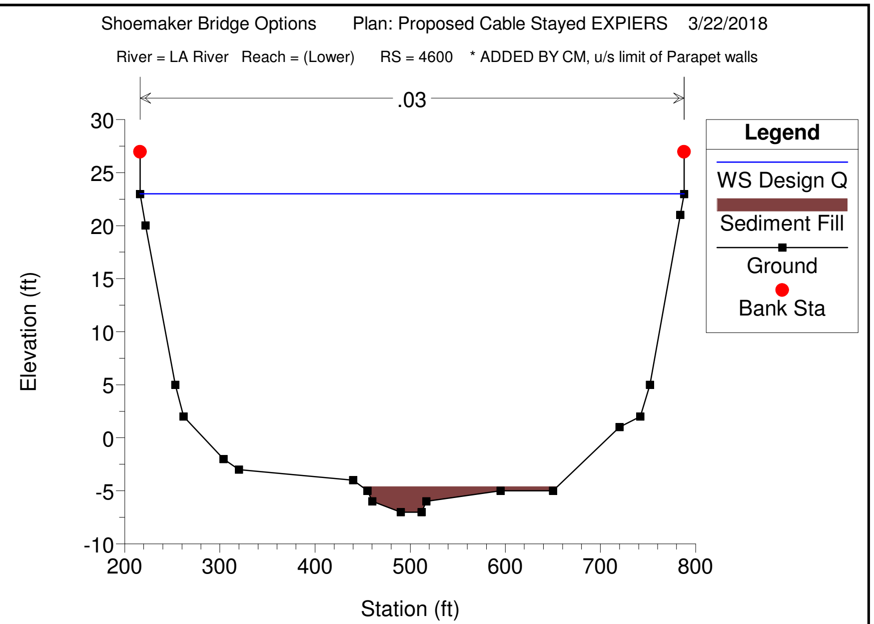

Shoemaker Bridge Options Plan: Proposed Cable Stayed EXPIERS 3/22/2018
River = LA River Reach = (Lower) RS = 4752 Edison Utility Downstream X-Section
.03
Legend
WS Design Q
Crit Design Q
Sediment Fill
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
40
30
20
10
0
-10
0
100
200
300
400
500
600
700

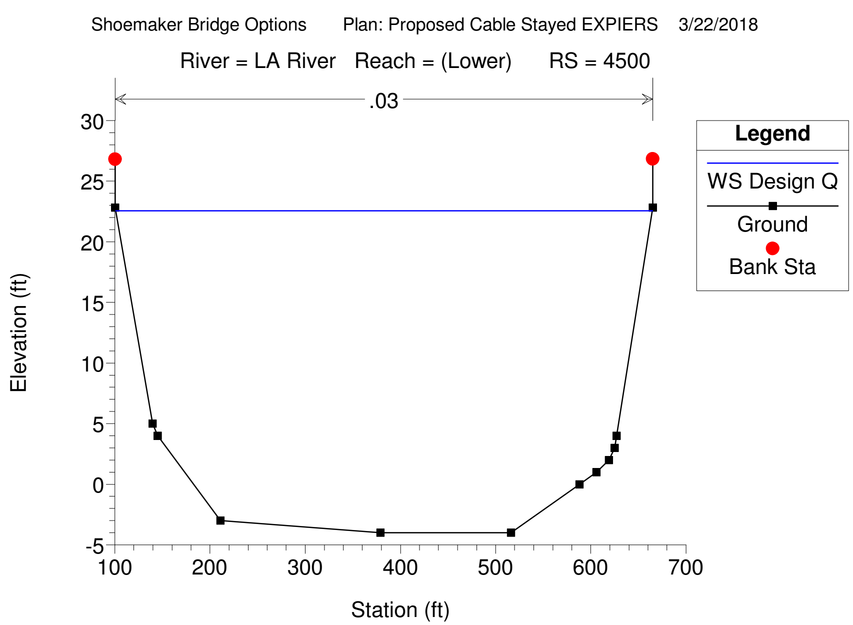

Shoemaker Bridge Options Plan: Proposed Cable Stayed EXPIERS 3/22/2018
River = LA River Reach = (Lower) RS = 4650 --- 12 in riprap overlay; 46+00 to 156+00 ---
.03
Legend
WS Design Q
Sediment Fill
Ground
Bank Sta
Elevation (ft)
Station (ft)
30
25
20
15
10
5
0
-5
-10
0
100
200
300
400
500
600
700

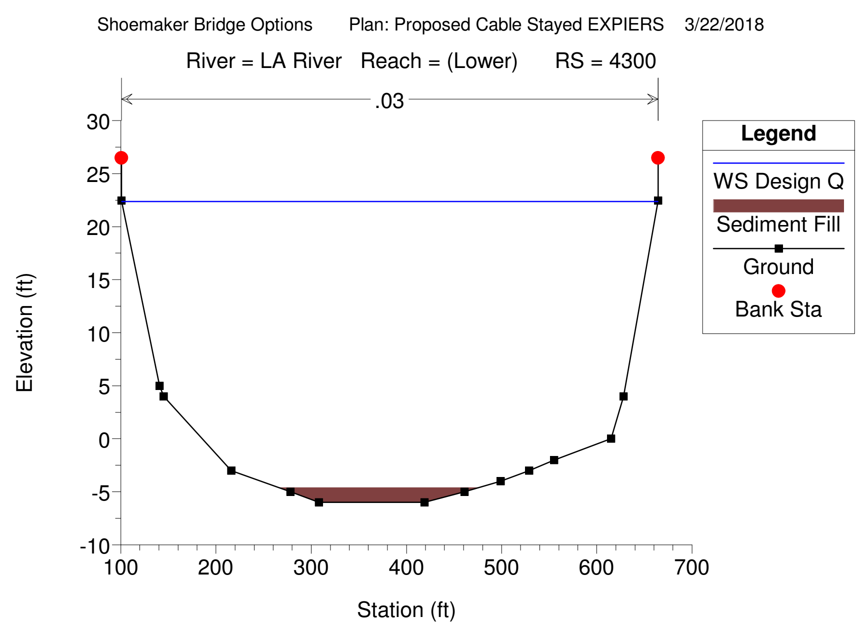

Shoemaker Bridge Options Plan: Proposed Cable Stayed EXPIERS 3/22/2018
River = LA River Reach = (Lower) RS = 4633.8 * ADDED BY CM, grade change R
.03
Legend
WS Design Q
Sediment Fill
Ground
Bank Sta
Elevation (ft)
Station (ft)
30
25
20
15
10
5
0
-5
-10
200
300
400
500
600
700
800

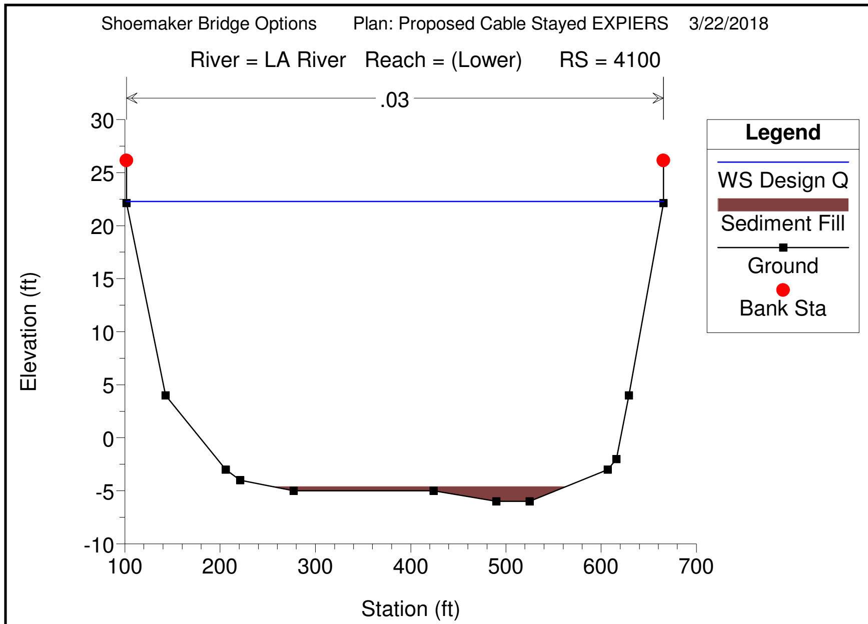

Shoemaker Bridge Options Plan: Proposed Cable Stayed EXPIERS 3/22/2018
River = LA River Reach = (Lower) RS = 4629.2 * ADDED BY CM, grade change L
.03
Legend
WS Design Q
Sediment Fill
Ground
Bank Sta
Elevation (ft)
Station (ft)
30
25
20
15
10
5
0
-5
-10
200
300
400
500
600
700
800


Shoemaker Bridge Options Plan: Proposed Cable Stayed EXPIERS 3/22/2018
River = LA River Reach = (Lower) RS = 4600.1 * ADDED BY CM, u/s of Parapet walls
.03
Legend
WS Design Q
Sediment Fill
Ground
Bank Sta
Elevation (ft)
Station (ft)

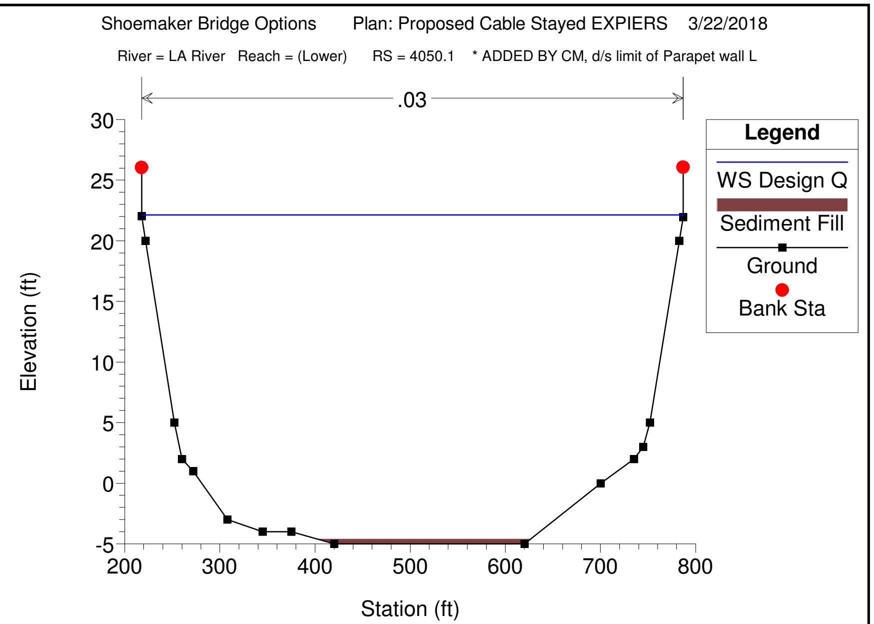

Shoemaker Bridge Options Plan: Proposed Cable Stayed EXPIERS 3/22/2018
River = LA River Reach = (Lower) RS = 4600 * ADDED BY CM, u/s limit of Parapet walls
.03
Legend
WS Design Q
Sediment Fill
Ground
Bank Sta
Elevation (ft)
Station (ft)


Shoemaker Bridge Options Plan: Proposed Cable Stayed EXPIERS 3/22/2018
River = LA River Reach = (Lower) RS = 4500
.03
Legend
WS Design Q
Ground
Bank Sta
Elevation (ft)
Station (ft)

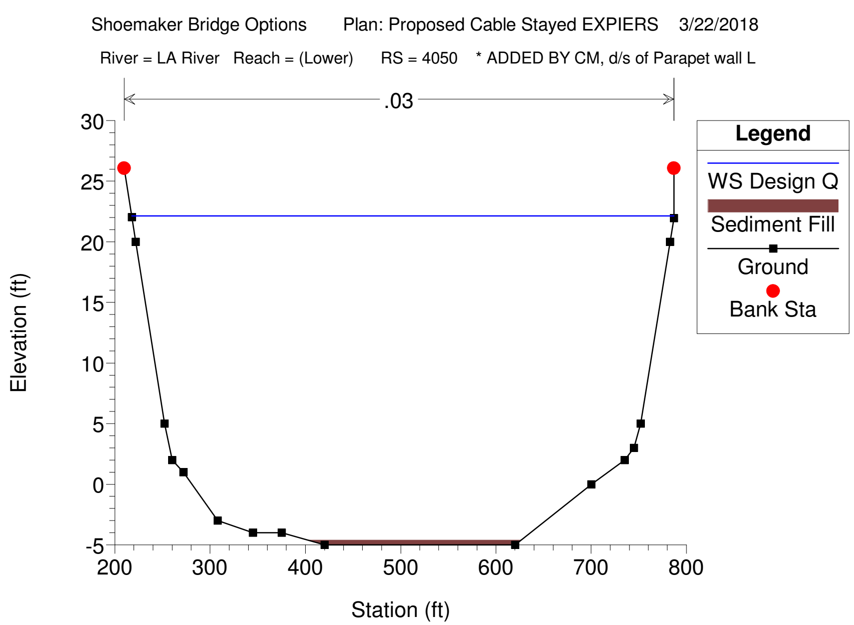

Shoemaker Bridge Options Plan: Proposed Cable Stayed EXPIERS 3/22/2018
River = LA River Reach = (Lower) RS = 4300
.03
Legend
WS Design Q
Sediment Fill
Ground
Bank Sta
Elevation (ft)
Station (ft)



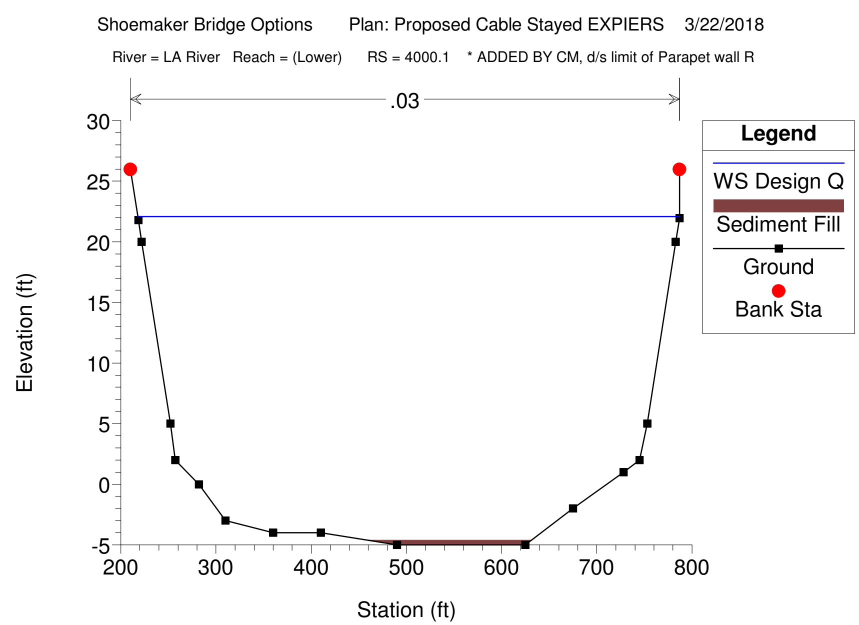
Shoemaker Bridge Options Plan: Proposed Cable Stayed EXPIERS 3/22/2018
River = LA River Reach = (Lower) RS = 4100
.03
Legend
WS Design Q
Sediment Fill
Ground
Bank Sta
Elevation (ft)
Station (ft)



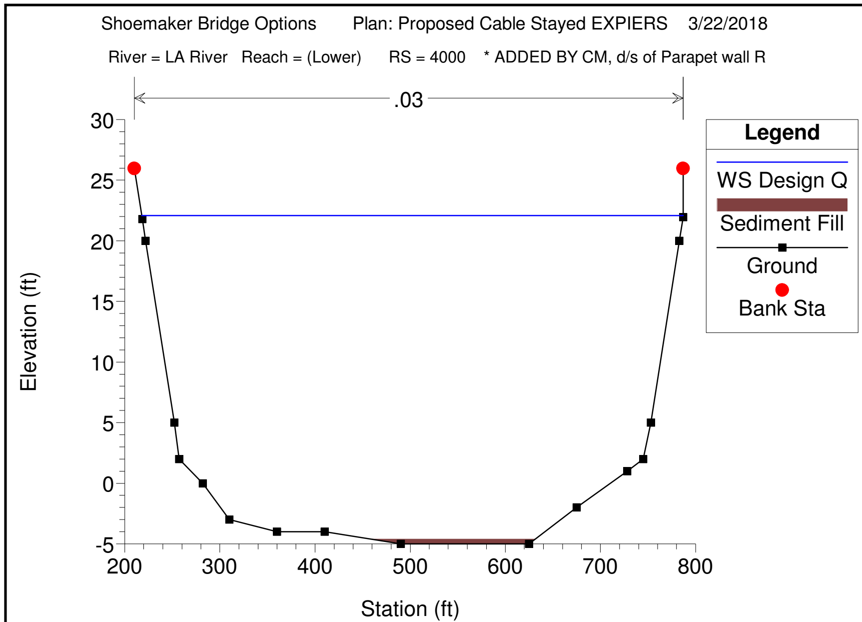
Shoemaker Bridge Options Plan: Proposed Cable Stayed EXPIERS 3/22/2018
River = LA River Reach = (Lower) RS = 4050.1 * ADDED BY CM, d/s limit of Parapet wall L
.03
Legend
WS Design Q
Sediment Fill
Ground
Bank Sta
Elevation (ft)
Station (ft)

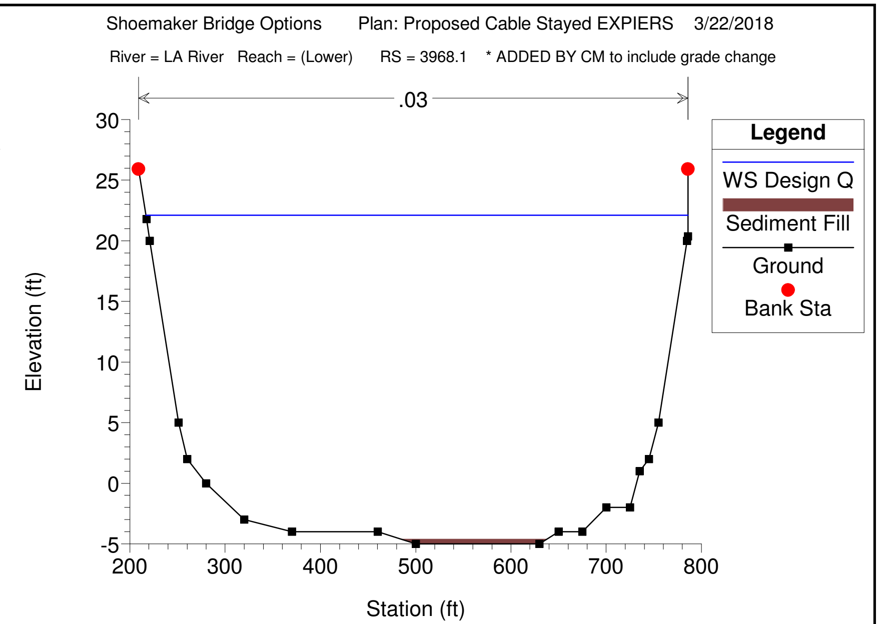


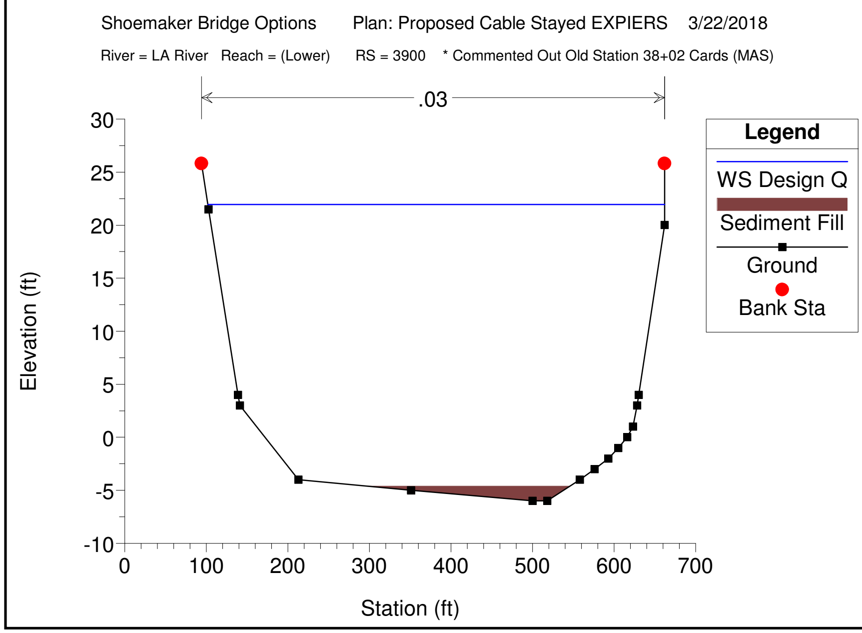
Shoemaker Bridge Options Plan: Proposed Cable Stayed EXPIERS 3/22/2018
River = LA River Reach = (Lower) RS = 4050 * ADDED BY CM, d/s of Parapet wall L
.03
Legend
WS Design Q
Sediment Fill
Ground
Bank Sta
Elevation (ft)
Station (ft)

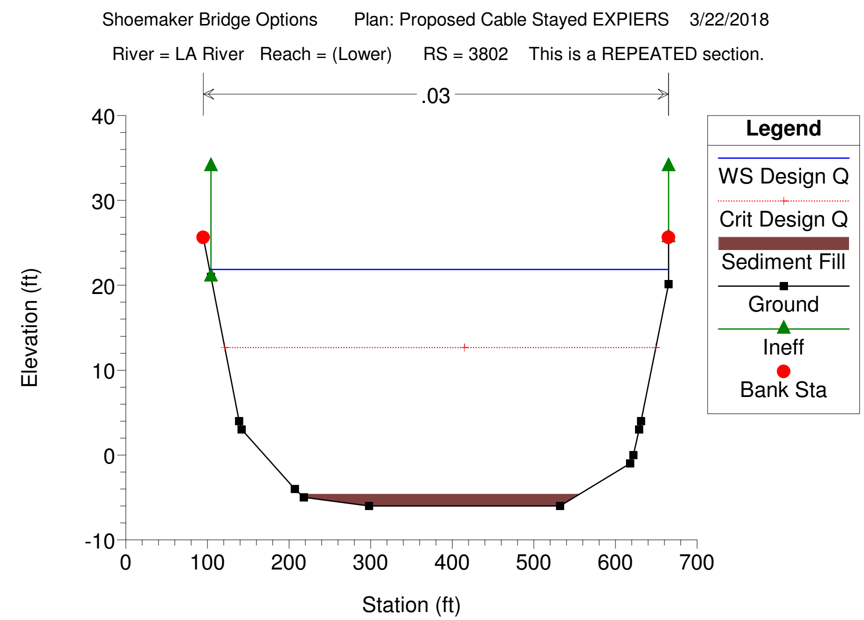


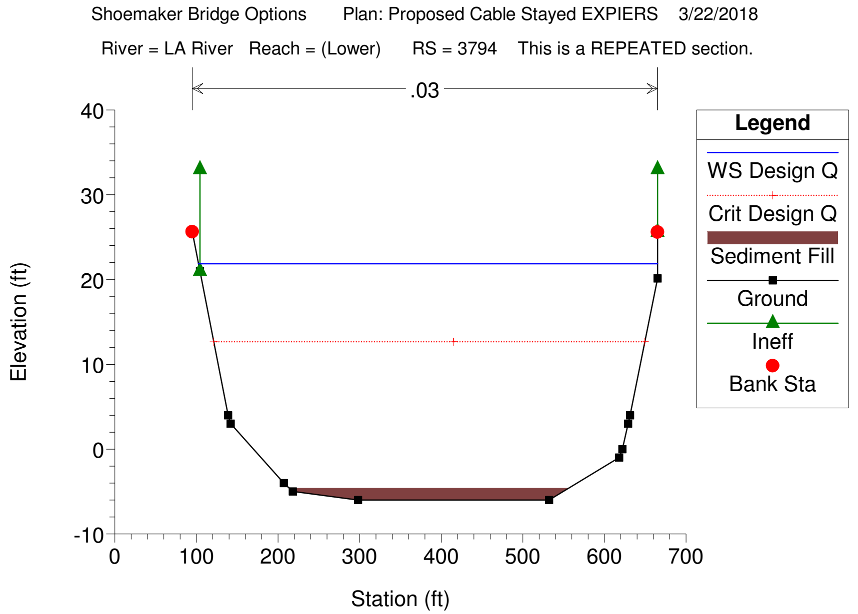
Shoemaker Bridge Options Plan: Proposed Cable Stayed EXPIERS 3/22/2018
River = LA River Reach = (Lower) RS = 4000.1 * ADDED BY CM, d/s limit of Parapet wall R
.03
Legend
WS Design Q
Sediment Fill
Ground
Bank Sta
Elevation (ft)
Station (ft)

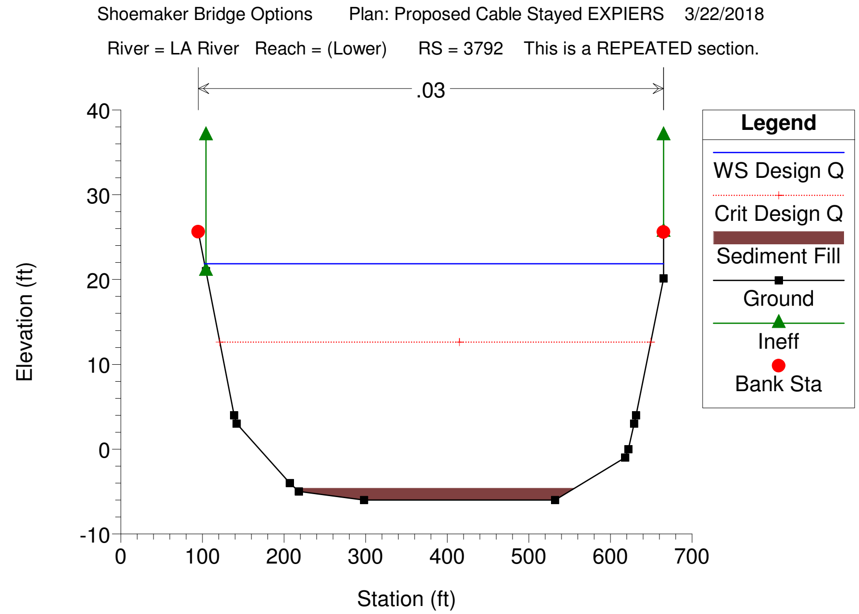

Shoemaker Bridge Options Plan: Proposed Cable Stayed EXPIERS 3/22/2018
River = LA River Reach = (Lower) RS = 4000 * ADDED BY CM, d/s of Parapet wall R
.03
Legend
WS Design Q
Sediment Fill
Ground
Bank Sta
Elevation (ft)
Station (ft)
30
25
20
15
10
5
0
-5
200
300
400
500
600
700
800

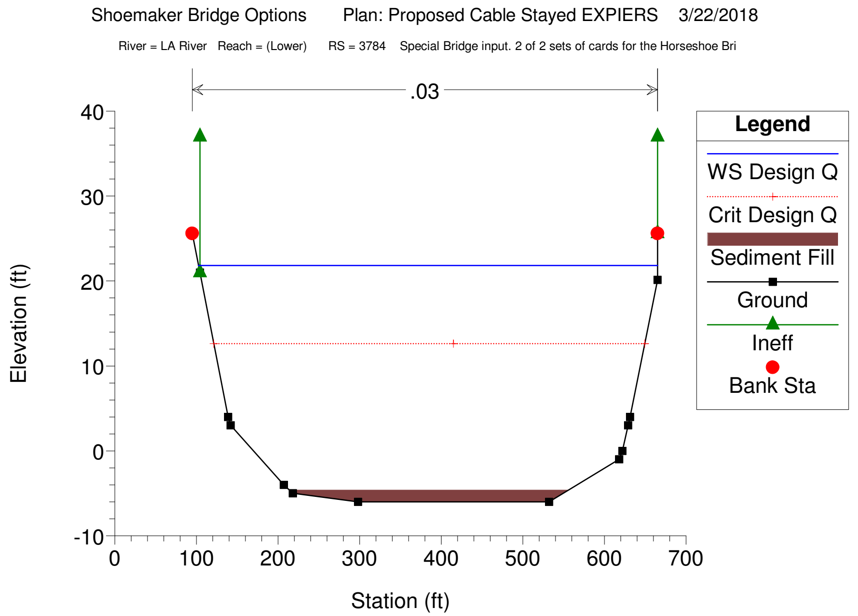

Shoemaker Bridge Options Plan: Proposed Cable Stayed EXPIERS 3/22/2018
River = LA River Reach = (Lower) RS = 3968.1 * ADDED BY CM to include grade change
.03
Legend
WS Design Q
Sediment Fill
Ground
Bank Sta
Elevation (ft)
Station (ft)
30
25
20
15
10
5
0
-5
200
300
400
500
600
700
800

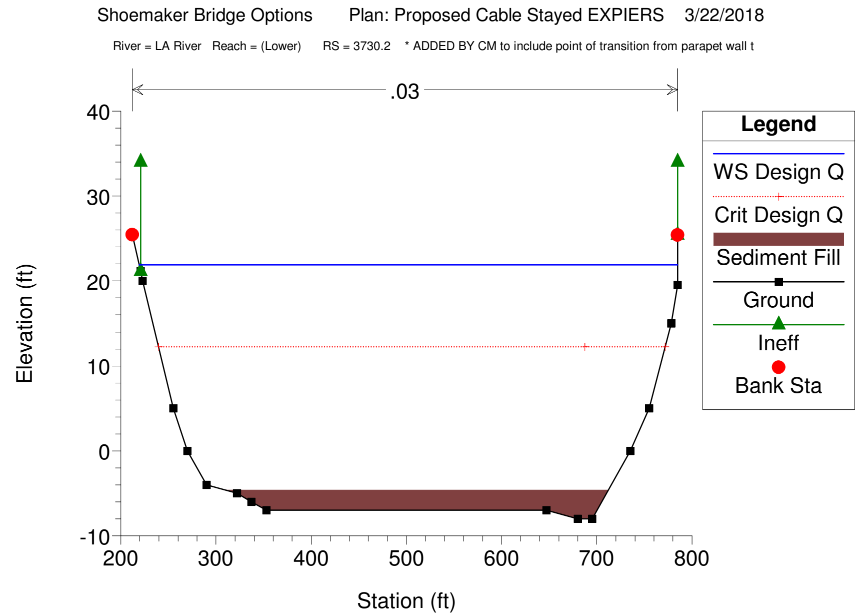

Shoemaker Bridge Options Plan: Proposed Cable Stayed EXPIERS 3/22/2018
River = LA River Reach = (Lower) RS = 3900 * Commented Out Old Station 38+02 Cards (MAS)
.03
Legend
WS Design Q
Sediment Fill
Ground
Bank Sta
Elevation (ft)
Station (ft)
30
25
20
15
10
5
0
-5
-10
0
100
200
300
400
500
600
700

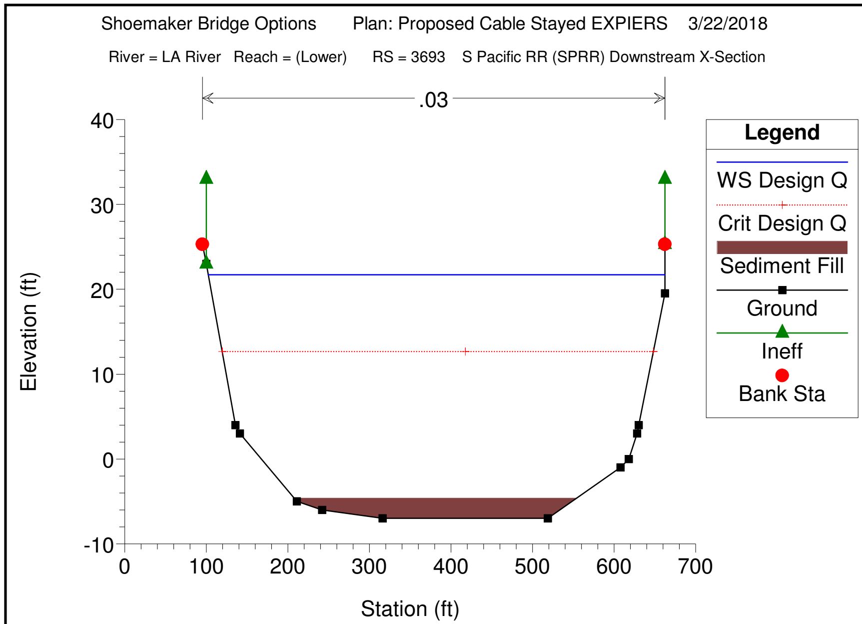

Shoemaker Bridge Options Plan: Proposed Cable Stayed EXPIERS 3/22/2018
River = LA River Reach = (Lower) RS = 3802 This is a REPEATED section.
.03
Legend
WS Design Q
Crit Design Q
Sediment Fill
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
40
30
20
10
0
-10
0
100
200
300
400
500
600
700

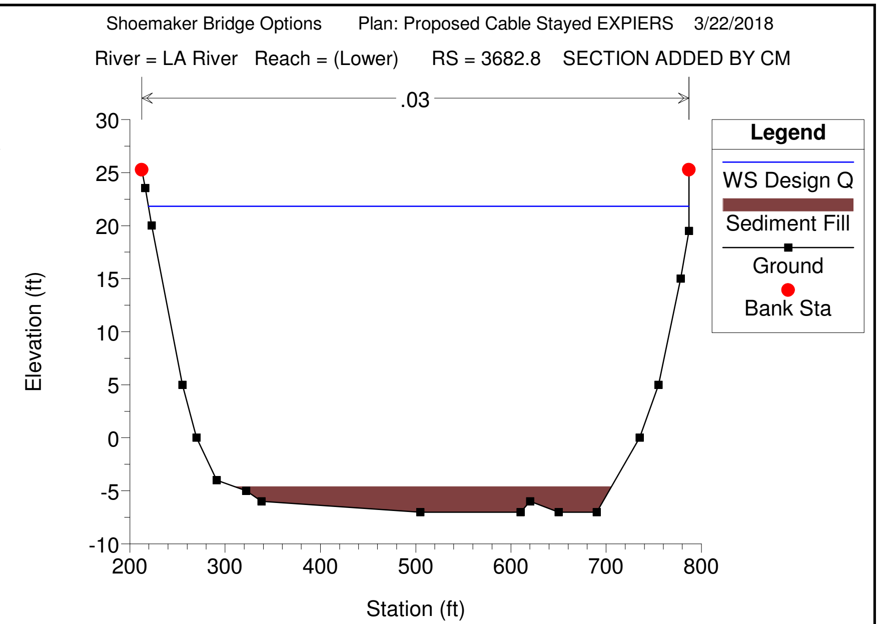

Shoemaker Bridge Options Plan: Proposed Cable Stayed EXPIERS 3/22/2018
River = LA River Reach = (Lower) RS = 3794 This is a REPEATED section.
.03
Elevation (ft)
Station (ft)
Legend
WS Design Q
Crit Design Q
Sediment Fill
Ground
Ineff
Bank Sta

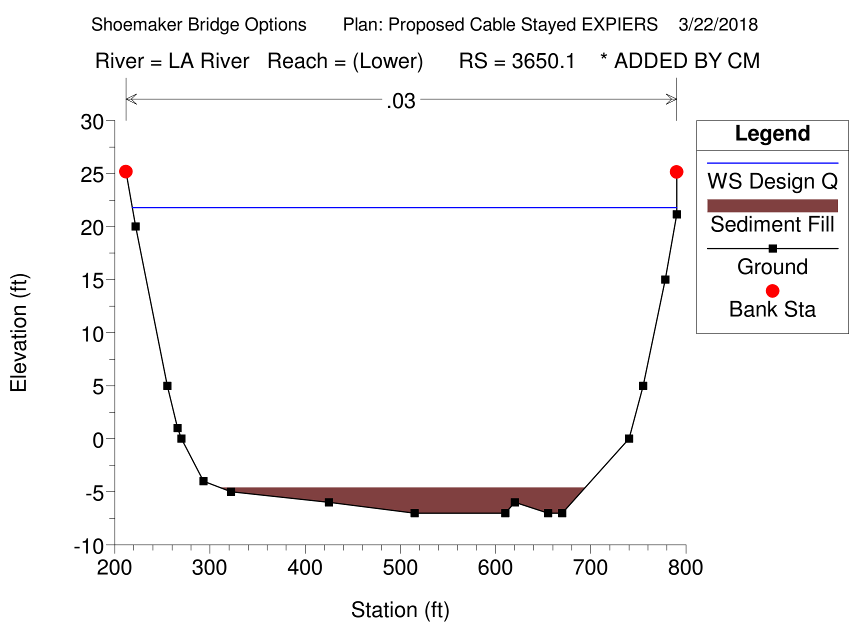

Shoemaker Bridge Options Plan: Proposed Cable Stayed EXPIERS 3/22/2018
River = LA River Reach = (Lower) RS = 3792 This is a REPEATED section.
.03
Elevation (ft)
Station (ft)
Legend
WS Design Q
Crit Design Q
Sediment Fill
Ground
Ineff
Bank Sta

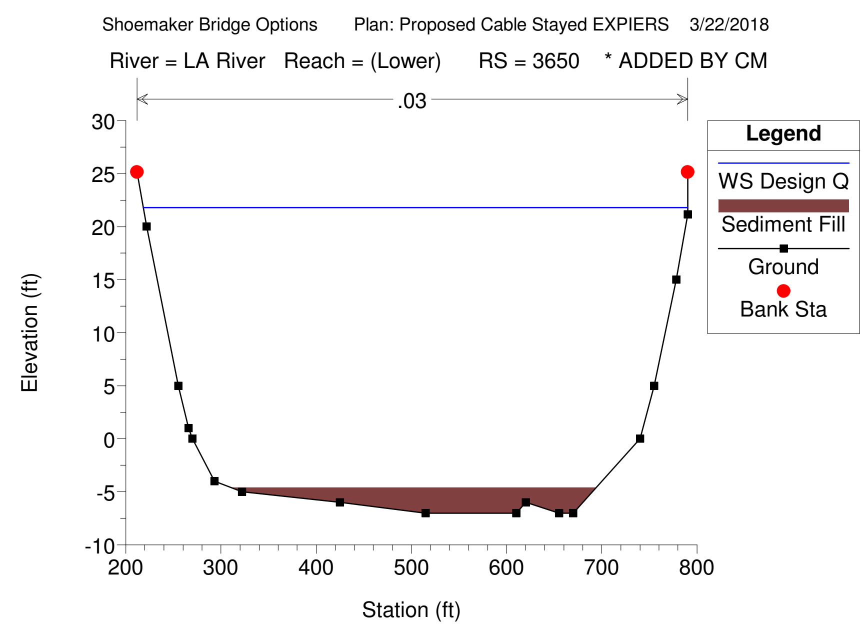

Shoemaker Bridge Options Plan: Proposed Cable Stayed EXPIERS 3/22/2018
River = LA River Reach = (Lower) RS = 3784 Special Bridge input. 2 of 2 sets of cards for the Horseshoe Bri
.03
Elevation (ft)
Station (ft)
Legend
WS Design Q
Crit Design Q
Sediment Fill
Ground
Ineff
Bank Sta

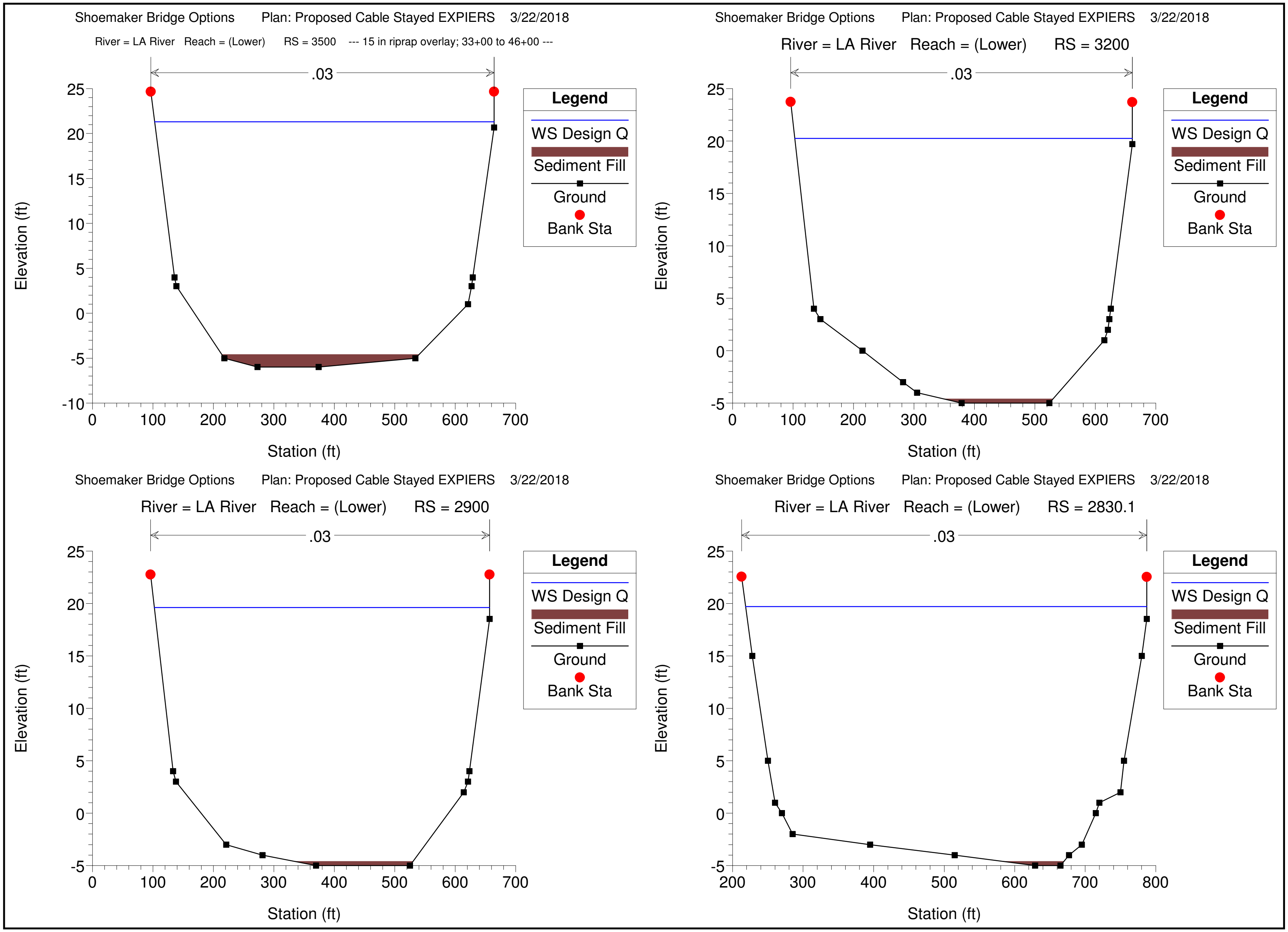

Shoemaker Bridge Options Plan: Proposed Cable Stayed EXPIERS 3/22/2018
River = LA River Reach = (Lower) RS = 3730.2 * ADDED BY CM to include point of transition from parapet wall t
.03
Elevation (ft)
Station (ft)
Legend
WS Design Q
Crit Design Q
Sediment Fill
Ground
Ineff
Bank Sta


Shoemaker Bridge Options Plan: Proposed Cable Stayed EXPIERS 3/22/2018
River = LA River Reach = (Lower) RS = 3693 S Pacific RR (SPRR) Downstream X-Section
.03
Legend
WS Design Q
Crit Design Q
Sediment Fill
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
40
30
20
10
0
-10
0
100
200
300
400
500
600
700

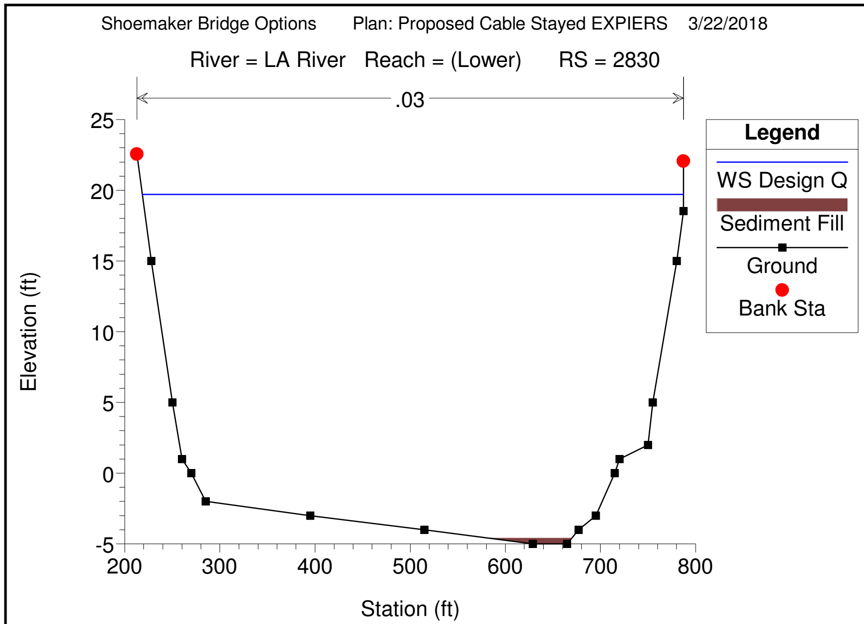

Shoemaker Bridge Options Plan: Proposed Cable Stayed EXPIERS 3/22/2018
River = LA River Reach = (Lower) RS = 3682.8 SECTION ADDED BY CM
.03
Legend
WS Design Q
Sediment Fill
Ground
Bank Sta
Elevation (ft)
Station (ft)
30
25
20
15
10
5
0
-5
-10
200
300
400
500
600
700
800

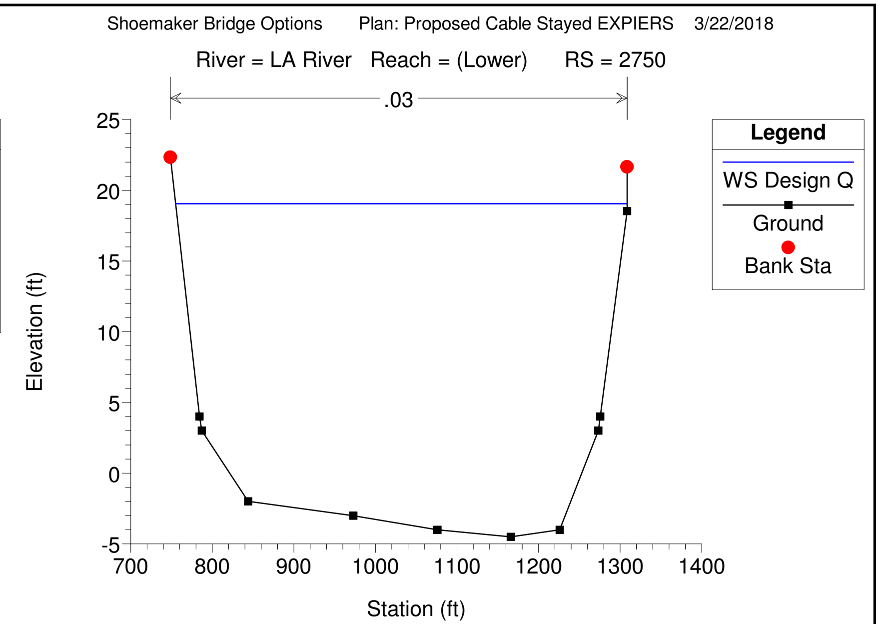

Shoemaker Bridge Options Plan: Proposed Cable Stayed EXPIERS 3/22/2018
River = LA River Reach = (Lower) RS = 3650.1 * ADDED BY CM
.03
Legend
WS Design Q
Sediment Fill
Ground
Bank Sta
Elevation (ft)
Station (ft)
30
25
20
15
10
5
0
-5
-10
200
300
400
500
600
700
800

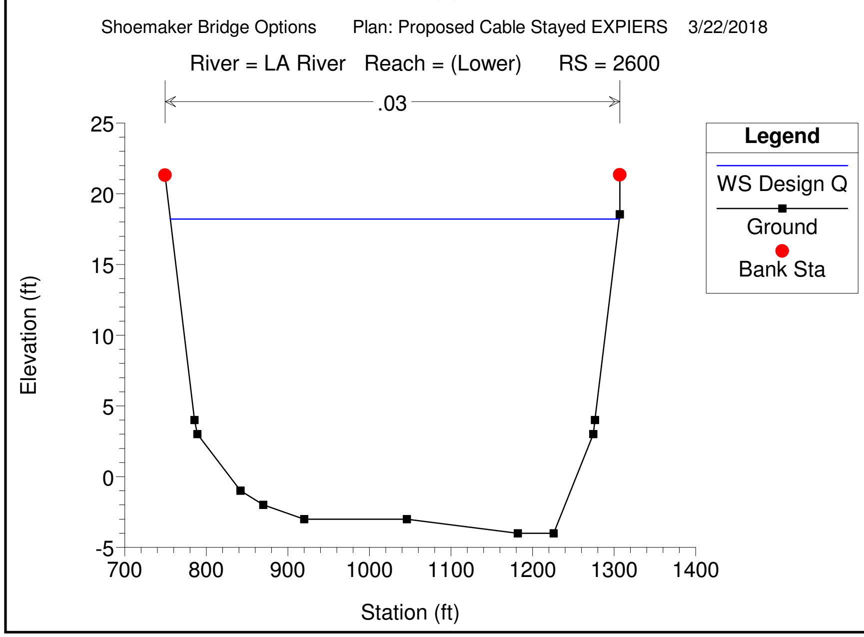

Shoemaker Bridge Options Plan: Proposed Cable Stayed EXPIERS 3/22/2018
River = LA River Reach = (Lower) RS = 3650 * ADDED BY CM
.03
Legend
WS Design Q
Sediment Fill
Ground
Bank Sta
Elevation (ft)
Station (ft)
30
25
20
15
10
5
0
-5
-10
200
300
400
500
600
700
800

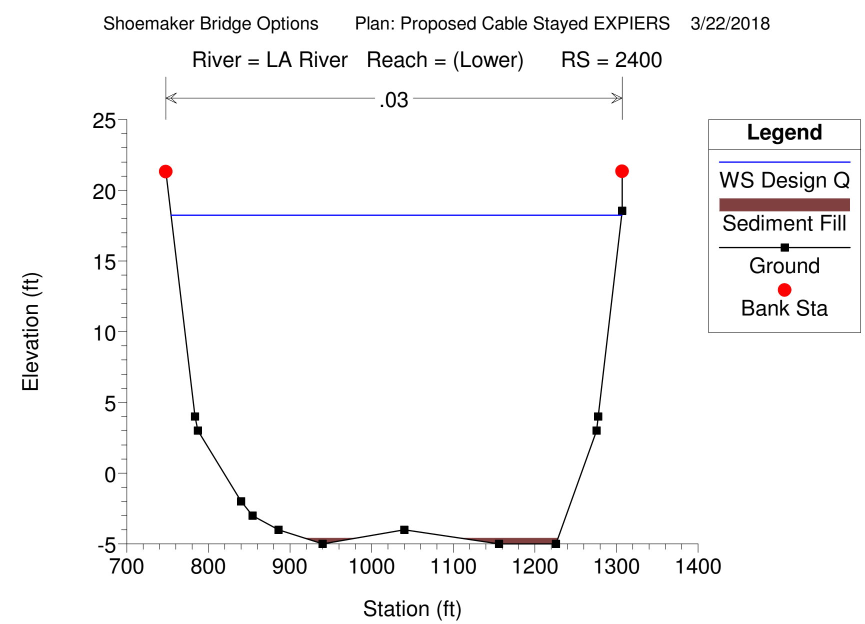


Shoemaker Bridge Options Plan: Proposed Cable Stayed EXPIERS 3/22/2018
River = LA River Reach = (Lower) RS = 3500 --- 15 in riprap overlay; 33+00 to 46+00 ---
.03
Legend
WS Design Q
Sediment Fill
Ground
Bank Sta
Elevation (ft)
Station (ft)
Shoemaker Bridge Options Plan: Proposed Cable Stayed EXPIERS 3/22/2018
River = LA River Reach = (Lower) RS = 3200
.03
Legend
WS Design Q
Sediment Fill
Ground
Bank Sta
Elevation (ft)
Station (ft)
Shoemaker Bridge Options Plan: Proposed Cable Stayed EXPIERS 3/22/2018
River = LA River Reach = (Lower) RS = 2900
.03
Legend
WS Design Q
Sediment Fill
Ground
Bank Sta
Elevation (ft)
Station (ft)
Shoemaker Bridge Options Plan: Proposed Cable Stayed EXPIERS 3/22/2018
River = LA River Reach = (Lower) RS = 2830.1
.03
Legend
WS Design Q
Sediment Fill
Ground
Bank Sta
Elevation (ft)
Station (ft)


Shoemaker Bridge Options Plan: Proposed Cable Stayed EXPIERS 3/22/2018
River = LA River Reach = (Lower) RS = 2830
.03
Legend
WS Design Q
Sediment Fill
Ground
Bank Sta
Elevation (ft)
Station (ft)
25
20
15
10
5
0
-5
200
300
400
500
600
700
800


Shoemaker Bridge Options Plan: Proposed Cable Stayed EXPIERS 3/22/2018
River = LA River Reach = (Lower) RS = 2750
.03
Legend
WS Design Q
Ground
Bank Sta
Elevation (ft)
Station (ft)
25
20
15
10
5
0
-5
700
800
900
1000
1100
1200
1300
1400


Shoemaker Bridge Options Plan: Proposed Cable Stayed EXPIERS 3/22/2018
River = LA River Reach = (Lower) RS = 2600
.03
Legend
WS Design Q
Ground
Bank Sta
Elevation (ft)
Station (ft)
25
20
15
10
5
0
-5
700
800
900
1000
1100
1200
1300
1400


Shoemaker Bridge Options Plan: Proposed Cable Stayed EXPIERS 3/22/2018
River = LA River Reach = (Lower) RS = 2400
.03
Legend
WS Design Q
Sediment Fill
Ground
Bank Sta
Elevation (ft)
Station (ft)
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20
15
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-5
700
800
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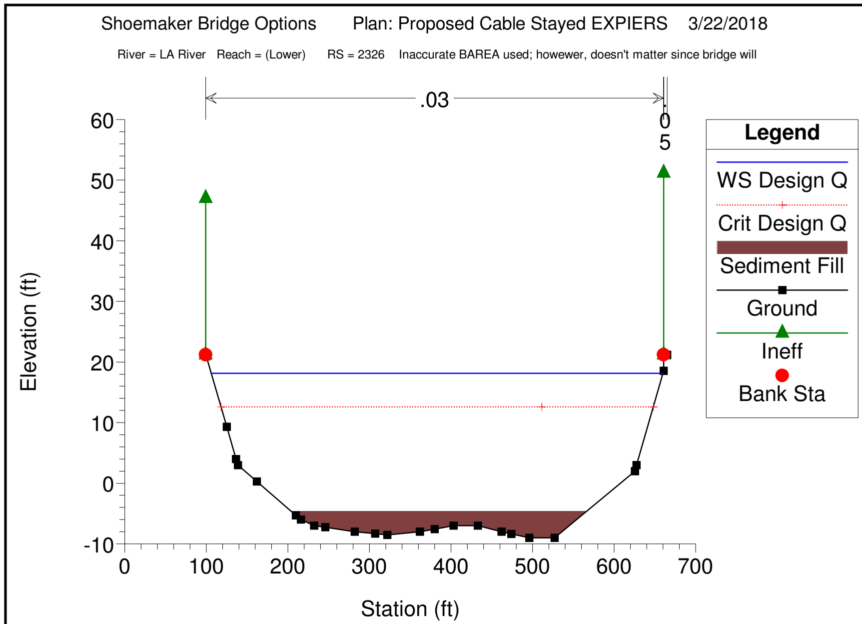
1100
1200
1300
1400


Shoemaker Bridge Options Plan: Proposed Cable Stayed EXPIERS 3/22/2018
River = LA River Reach = (Lower) RS = 2326 Inaccurate BAREA used; however, doesn't matter since bridge will
.03
0
5
Legend
WS Design Q
Crit Design Q
Sediment Fill
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
60
50
40
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20
10
0
-10
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100
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300
400
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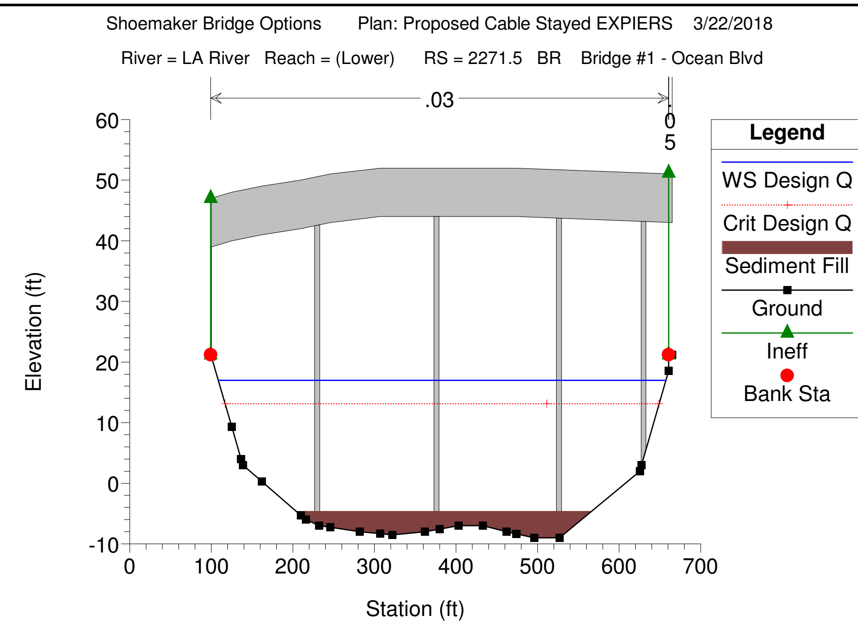
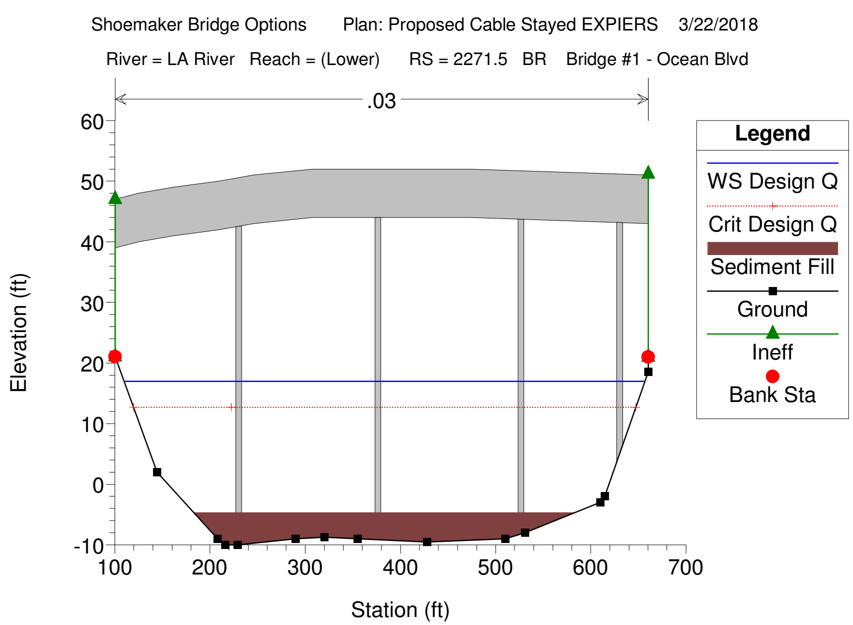
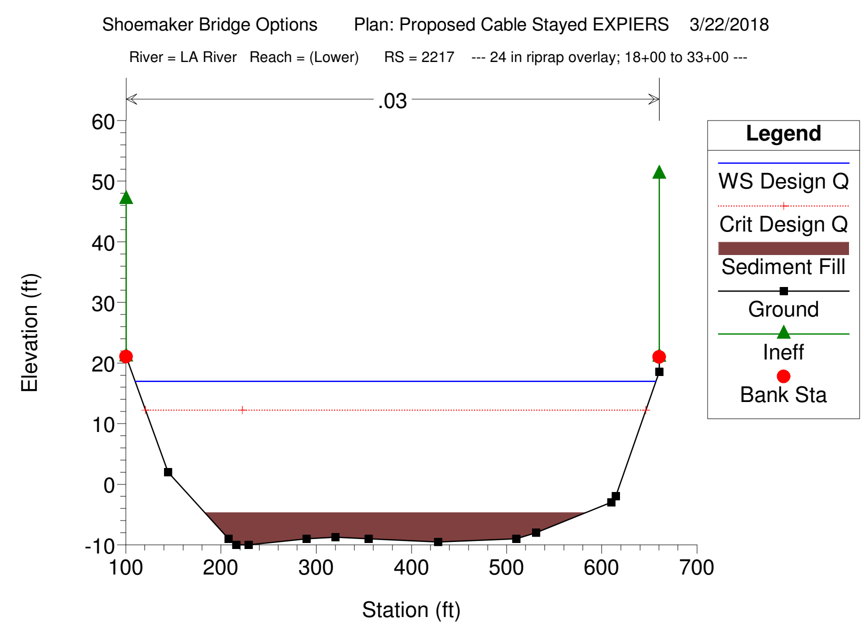
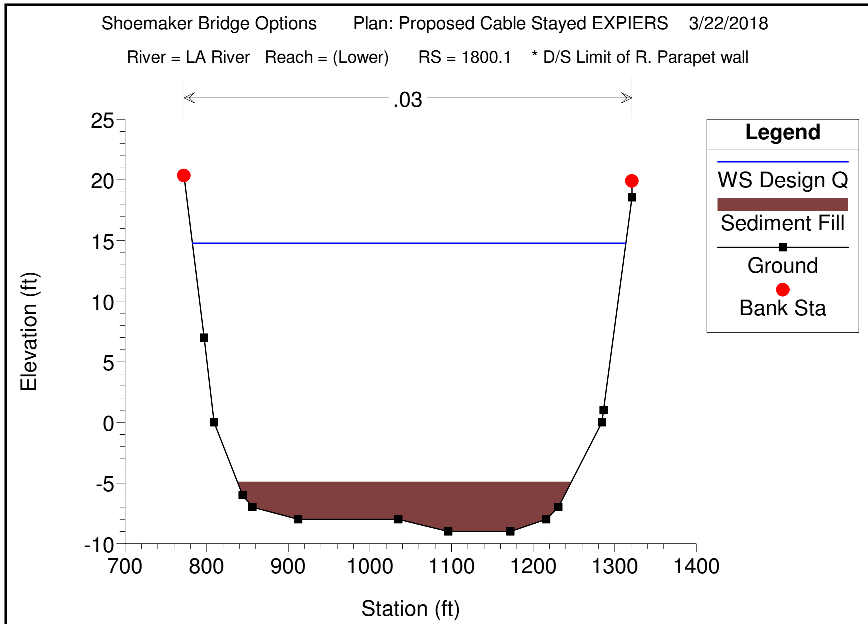
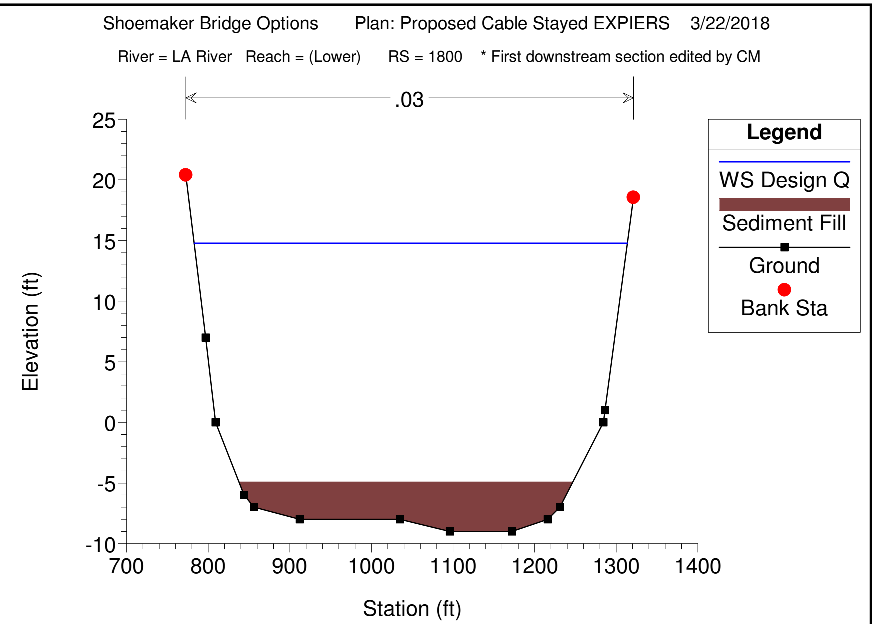
600
700

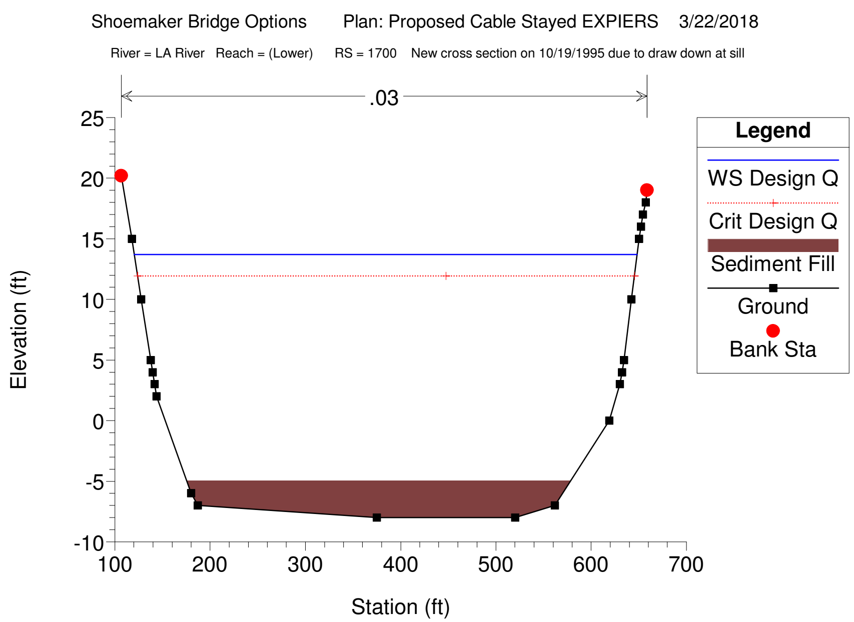

Shoemaker Bridge Options Plan: Proposed Cable Stayed EXPIERS 3/22/2018
River = LA River Reach = (Lower) RS = 2271.5 BR Bridge #1 - Ocean Blvd
.03
0
5
Legend
WS Design Q
Crit Design Q
Sediment Fill
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
60
50
40
30
20
10
0
-10
0
100
200
300
400
500
600
700

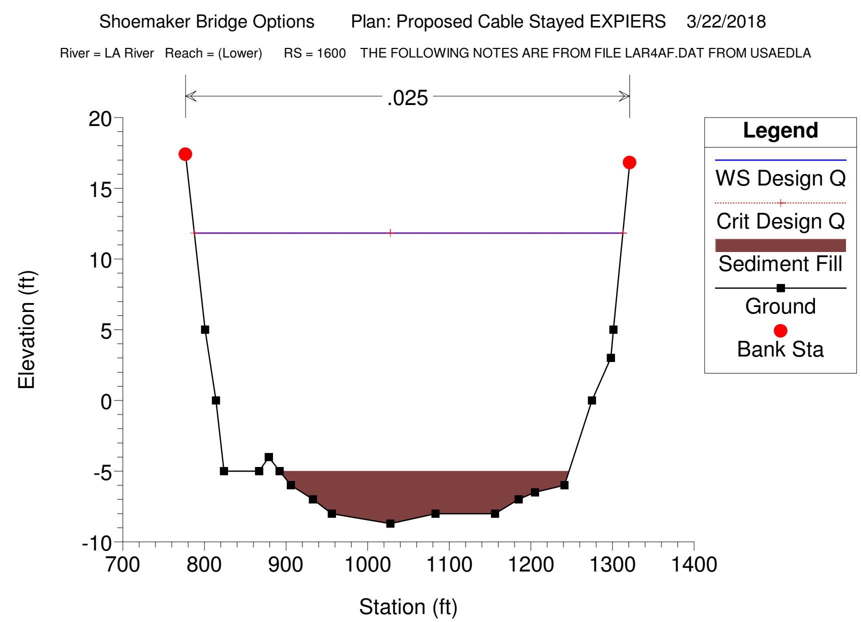

Shoemaker Bridge Options Plan: Proposed Cable Stayed EXPIERS 3/22/2018
River = LA River Reach = (Lower) RS = 2271.5 BR Bridge #1 - Ocean Blvd
.03
Legend
WS Design Q
Crit Design Q
Sediment Fill
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
60
50
40
30
20
10
0
-10
100
200
300
400
500
600
700


Shoemaker Bridge Options Plan: Proposed Cable Stayed EXPIERS 3/22/2018
River = LA River Reach = (Lower) RS = 2217 --- 24 in riprap overlay; 18+00 to 33+00 ---
.03
Legend
WS Design Q
Crit Design Q
Sediment Fill
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
60
50
40
30
20
10
0
-10
100
200
300
400
500
600
700


Shoemaker Bridge Options Plan: Proposed Cable Stayed EXPIERS 3/22/2018
River = LA River Reach = (Lower) RS = 1800.1 * D/S Limit of R. Parapet wall
.03
Legend
WS Design Q
Sediment Fill
Ground
Bank Sta
Elevation (ft)
Station (ft)


Shoemaker Bridge Options Plan: Proposed Cable Stayed EXPIERS 3/22/2018
River = LA River Reach = (Lower) RS = 1800 * First downstream section edited by CM
.03
Legend
WS Design Q
Sediment Fill
Ground
Bank Sta
Elevation (ft)
Station (ft)


Shoemaker Bridge Options Plan: Proposed Cable Stayed EXPIERS 3/22/2018
River = LA River Reach = (Lower) RS = 1700 New cross section on 10/19/1995 due to draw down at sill
.03
Legend
WS Design Q
Crit Design Q
Sediment Fill
Ground
Bank Sta
Elevation (ft)
Station (ft)


Shoemaker Bridge Options Plan: Proposed Cable Stayed EXPIERS 3/22/2018
River = LA River Reach = (Lower) RS = 1600 THE FOLLOWING NOTES ARE FROM FILE LAR4AF.DAT FROM USAEDLA
.025
Legend
WS Design Q
Crit Design Q
Sediment Fill
Ground
Bank Sta
Elevation (ft)
Station (ft)

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Appendix D. Location Hydraulic Study Form

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LOCATION HYDRAULIC STUDY FORM *

Dist. _7_ Co. _LA_ Rte. _710_ P.M. _6.0/6.4_
EA _27300_ Bridge No. 53C0932

Floodplain Description:
Existing Los Angeles River flood control channel downstream of Compton Creek to drain storm runoff from the upper watershed to the ocean.

1. Description of Proposal (include any physical barriers i.e. concrete barriers, soundwalls, etc. and design elements to minimize floodplain impacts)
Replace existing Shoemaker Bridge with the new bridge that will place 25 feet wide central pier in the river, 220 feet downstream of the existing bridge.

2. ADT: Current______ Projected__________

3. Hydraulic Data: Q_{100}= _174,000_ CFS (per conservative USACE estimate)
WSE_{100}= _24.67_ The flood of record, if greater than Q_{100}:
Q= _N/A_ CFS WSE= _N/A_
Overtopping flood Q= _251,000_ CFS WSE= _42.68_ (flood barely overtopping

bridge deck based on hydraulic model evaluation)

Are NFIP maps and studies available? YES _x_ NO_________

4. Is the highway location alternative within a regulatory floodway ?
YES _x_ NO_________

5. Attach map with flood limits outlined showing all buildings or other improvements within the base floodplain. (no buildings in floodplain)

Potential Q_{100} backwater damages:

A. Residences? NO _x_ YES________
B. Other Bldgs? NO _x_ YES________
C. Crops? NO _x_ YES________
D. Natural and beneficial
Floodplain values? NO _x_ YES_______

6. Type of Traffic:

A. Emergency supply or evacuation route? NO_________ YES _x_
B. Emergency vehicle access? NO_________ YES _x_
C. Practicable detour available? NO _x_ YES________
D. School bus or mail route? NO_________ YES _x_

7. Estimated duration of traffic interruption for 100-year event hours: _none_

8. Estimated value of Q_{100} flood damages (if any) – minimum risk level.

A. Roadway $ _0_
B Property $ _0_
Total $ _0_

9. Assessment of Level of Risk Low___x______
Moderate_____
High_________

For High Risk projects, during design phase, additional Design Study Risk Analysis
May be necessary to determine design alternative.

Signature – Dist. Hydraulic Engineer _______Dragoslav Stefanovic__Date___6/20/18_______
(Item numbers 3,4,5,7,9)

Is there any longitudinal encroachment, significant encroachment, or any support of incompatible
Floodplain development? NO____x______YES_________

If yes, provide evaluation and discussion of practicability of alternatives in accordance with 23 CFR 650.113

Information developed to comply with the Federal requirement for the Location Hydraulic Study shall be retained in the project files.

Signature – Dist. Project Engineer______________________________Date_________
(Item numbers 1,2,6,8)

* Same as Figure 804.7A Technical Information for Location Hydraulic Study located in Chapter 804 of the Caltrans *Highway Design Manual*

Figure 804.7B

Floodplain Evaluation Report Summary

Dist. 7 Co. LA Rte. 710 P.M 6.0/6.4
Project No. EA 27300 Bridge No. 53C0932
Limit
On Route 710 between 0.4 mile south of Route 710/1 Interchange and 0.1 mile north of Pico Avenue and on-ramp overhead; and on Shoreline Drive between 0.3 mile north of Long Beach Freeway Bridge over Los Angeles River (Shoemaker Bridge) and 0.1 mile south of Golden Shore Street overcrossing.

Floodplain Description
Per FEMA Flood Insurance Rate Map (FIRM) for Los Angeles County (Map Numbers 06037C1964F, 06037C1962F, and 06037C1965F), the portions of the project area that include the bridge and the Los Angeles River, are in Zone A or Zone AH, which are defined as areas within the 100-year floodplain. However, the proposed bridge replacement will have a minimal impact on the 133-year design flood water surface of less than 2 inches and that impact does not increase the base floodplain extents since the entire flow is contained within the flood control channel between the levee parapet walls.

		Yes	No
1.	Is the proposed action a longitudinal encroachment of the base floodplain?		x
2.	Are the risks associated with the implementation of the proposed action significant?		x
3.	Will the proposed action support probable incompatible floodplain development?		x
4.	Are there any significant impacts on natural and beneficial floodplain values?		x
5.	Routine construction procedures are required to minimize impacts on the floodplain. Are there any special mitigation measures necessary to minimize impacts or restore and preserve natural and beneficial floodplain values? If yes, explain.		x
6.	Does the proposed action constitute a significant floodplain encroachment as defined in 23 CFR, Section 650.105(q).		x
7.	Are Location Hydraulic Studies that document the above answers on file? If not explain.	x	

PREPARED BY:

Signature - Dist. Hydraulic Engineer Date

Signature - Dist. Environmental Branch Chief Date

Signature - Dist. Project Engineer Date

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