San Francisco Bay Conservation and Development Commission
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TO: All Engineering Criteria Review Board Members

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SUBJECT: **Union Pacific Railroad Martinez Bridge Replacement Project 100-percent-design Criteria Review Meeting, Permit Application M2016.008.00**
(For Board consideration on March 21, 2017)

Project Summary

Project Name. Union Pacific Railroad Bridge Replacement, Milepost 20.92, Martinez Subdivision

Applicant. Union Pacific Railroad (UPRR)

Project Representatives. Damian Wallner/UPRR

Presenters: Branden Strahm, P.E., CFM/Olsson Associates; Jason Buenker, Senior Engineer/Shannon & Wilson, Inc., Adam McCune, P.E./HDR Inc..

Project Description. UPRR has submitted an application for a BCDC permit to authorize the replacement of a two-span, 30-foot long by 65-foot wide double track timber stringer trestle bridge in Hercules in Contra Costa County. The bridge spans Refugio Creek adjacent to San Pablo Bay. The bridge supports freight and passenger rail service along East San Pablo Bay connecting East Bay cities in the south to Sacramento, San Joaquin Valley, and north and east states.

The criteria represent a 100-percent design (Enclosure 2.b.). The existing bridge will be replaced with a proposed three-span, 60-foot long by 31-foot wide prestressed concrete slab bridge. The project would be done in two stages with temporary shoring to work on one mainline track at a time. Temporary track curfews would be used to control rail traffic and allow for construction access to drive piles through deck openings. There are utility lines including two petroleum pipelines and a fiber optic line and a three-culvert crossing along the southeast (Refugio Creek) side of the tracks**.** The bridge west side is adjacent to the San Pablo bay.

The superstructure will consist of handrails parallel to the bridge centerline, steel rails on timber ties over a minimum 8 inch-layer of ballast over a deck plate and a 20-inch concrete slab beam underlain by a ¾-inch elastomeric bearing pad.

The substructure will consist of 24 bent and abutment piles, six 100-foot-long H-piles inside 2.5-foot diameter pile encasements for each of the two center bents, and six H-piles for each abutment. The end piles to the north and south will be tapered. The abutment piles will be placed behind the existing timber backwalls. Existing timber piles will be broken off 3 to 5 feet below ground. Each span will be supported by 16.3-foot long by 3-foot wide and 1.25-foot tall pile caps. Concrete wingwalls on the sides of the abutments will be 7.75 feet wide and 5 feet tall attached to the concrete pile caps. Two and half-foot drilled shafts would be used to place 9 soldier H-piles to support a pile retaining wall on the west side.

Precast concrete will contain a corrosion inhibiting additive. All steel embedded in the precast concrete substructure pieces will be stainless steel. Piles and pile connection to pile caps will be coated in coal tar epoxy to provide corrosion protection. The creek channel will be excavated and widened by 174 square feet in order to meet the UPRR's hydraulic criteria for 50- and 100-year runoff events. Riprap would be placed adjacent to the abutments and beneath the bridge to stabilize the slope and protect it from erosion. A 10-foot-wide by 75-foot-long apron of riprap will be placed in the channel bottom adjacent to the western end soldier pile wall and a 20-foot-wide by 70-foot-long embankment of riprap will be placed along the eastern bank. The riprap will be 3 feet deep and keyed into the subsurface.

Previous ECRB Review. A bridge replacement project near this location, associated with the City of Hercules Intermodal Transit Center project, was first reviewed by the ECRB on May 19, 2010 (Enclosure 1). However, UPRR was not the project proponent at that time and the scope and design of that project is not the same as the current bridge structure proposed by UPRR; the location of the previous version was 130 feet north and on the same alignment; the post-mileage of the former was "UPRR Bridge 20.91;" the current post-mileage is "UPRR Bridge 20.92." Because the City of Hercules is not able to fund the Intermodal Transit Center project, and because of the deteriorating condition of the existing structure, UPRR must replace its existing structure at this location. This does not, however, preclude the bridge project associated with the Intermodal Transit Center in the future.

As originally proposed, the 2010 project included three bridges, including a new UPRR bridge, and one railroad terminal. Unlike this project, that project proposed to realign and straighten the creek channel by removing the 90 degree bent (dog-leg) on the east side of the UPRR bridge, shifting the creek alignment to the north and widening it to create a more hydraulically efficient crossing. Such bridge version would span 62 feet (versus the 30-foot long by 65 foot wide existing bridge.) Further, the floodplains were to be expanded to reduce water velocities. The bridge was to be raised over existing to provide more freeboard. There were discussions of performing ground improvement to assuage concerns of lateral spreading, most specifically on the abutments as well as embankments towards the Bay. It was required that downdrag loads should be considered in the design. The 2010 proposed bridge would raise the bridge tracks by 2.2 feet resulting in about a foot of freeboard.

At the time, the ECRB did not have a Coastal/Hydraulic Engineering member; therefore, the board raised nominal questions about flooding and hydraulic loading concerns.

Hydrology/Hydraulic. According to the Hydrology/Hydraulic report (Enclosure 2.c.), there are three culverts on the upstream side of the existing bridge that will remain. The hydraulic/hydrology evaluation computed the 100-year floodwater surface elevation (WSE_{100}) or base flood elevation (BFE) at the upstream face of the post-project bridge to be 10.78 feet.[1] The bridge low chord (L/C) elevation will be 8.96 feet.

The design water velocity (bridge velocity) for the 100-year run-off event will be 7.33 feet/second; therefore, Class II rock riprap for design water velocities of 12-14 feet/second has been recommended for an estimated 21.3 feet of scour conditions. The recommendations include H-piles to be driven to refusal, if possible, or to a minimum of 112 ton capacity. The estimated pile depths will be 120 feet.

Sea Level Rise. The base of rail (B/R) elevation of the proposed bridge will be the same as the existing at approximately 12 feet. Current Federal Emergency Management Agency's (FEMA) BFE for the site is 12.0 feet. Therefore, the B/R elevation is the same as the BFE. The expected life of the bridge will be approximately 50 to 75 years. The estimated elevation of sea level rise and BFE at the downstream boundary conditions (Bay side) for year 2070 will be 14.3 feet (2.3 feet above B/R) and for year 2100 will be 16.6 feet (4.6 feet above B/R). For the upstream boundary conditions (creek side), the estimated SLR plus BFE elevation will be 10.8 feet for year 2070 (1.2 feet below B/R but 1.84 feet above the L/C) and 11.6 feet (0.4 feet below B/R but 2.64 feet above the L/C.)

Geotechnical, Physical Conditions and Seismic Design Criteria. According to the geotechnical design report (Enclosure 2.d.), soil site conditions include corrosive and expansive soils (highly plastic). The report also indicates that soils in the Boring B-1 profile will liquefy in the upper 28 feet during a 2475-year return period earthquake. Seismic design recommendations were provided in the geotechnical report to mitigate the effects of liquefaction. Ground water was observed about 7 feet below ground surface. The proposed bridge will be founded on HP 14x78 driven steel piles with concrete encasements at the top of the piles.

The geotechnical report provides seismic design recommendations based on design criteria found in the 2013 California Building Code (CBC) and the American Railway Engineering and Maintenance Association (AREMA) Manual. Because of copyright restrictions, UPRR did not provide copies of the AREMA standards as part of the design submittal. However, UPRR has since provided BCDC a copy of the relevant AREMA manual chapters and copies of specific section references to be included in the ECRB review packet (Enclosures 8 and 9) as supplemental references. Attachment 7 of the "basis of design" references almost exclusively the AREMA design criteria whereas the 2013 CBC criteria are implied in the geotechnical report.

[1] All vertical elevations are in NAVD88 datum.

In response to this, the applicant notes that, “the discrepancy exists because the geotechnical report was prepared early in the project design phase, before design criteria and agency review/permitting requirements were available for the project. The project later solely adopted AREMA design criteria; therefore, only AREMA design recommendations provided in the geotechnical report apply to the project. “

Further, the project proponents explain, “note that the highest design-level earthquake required by the CBC matches the life safety design-level earthquake required in the AREMA Manual, which is the 2475-year return period earthquake. Therefore, liquefaction and generalized ground motion recommendations provided in the geotechnical report for the CBC remain applicable to the project. Additional seismic design recommendations using AREMA design criteria were provided in the Shannon & Wilson letter dated March 2, 2017 (Enclosure 3).”

Law and Policy Considerations. The *McAteer-Petris Act* allows the Commission to approve fill[2] only when public benefits from fill clearly exceed public detriment from the loss of the water areas and should be limited to water-oriented uses (Section 66605). Transportation infrastructure is considered a water-oriented use.

Further, fill shall meet certain specific criteria, including that the fill be constructed "in accordance with sound safety standards which will afford reasonable protection to persons and property against the hazards of unstable geologic or soil conditions or of flood or storm waters" (Section 66605(e)).

The project that includes the bridge and embankments and structure is within BCDC’s jurisdiction, which includes the Bay (coastline and Refugio Creek) as the primary jurisdiction and the 100-foot shoreline band, as the secondary jurisdiction. The threshold between the two jurisdictions is the shoreline, defined as the Mean High Water (MHW) line. Therefore, all areas of the project bayward of the MHW are subject to the Bay and all upland areas from the shoreline up to 100 feet are in the shoreline band.

Because the project is within both BCDC’s jurisdiction, some of the *San Francisco Bay Plan policies on the Safety of Fills* in the Bay and *Shoreline Protection* in the Bay and 100-foot Shoreline Band apply.

Applicable Policies on the Safety of Fills

1. **Policy No. 1** states, in part, that “the Commission has appointed and empowered the ECRB to “establish and revise safety criteria for Bay fills and structures thereon.”
2. **Policy No. 2** states, in part, that “[e]ven if the Bay Plan indicates that a fill may be permissible, no fill or building should be constructed if hazards cannot be overcome adequately for the intended use in accordance with the criteria prescribed by the ECRB.”

[2]Fill is defined in the McAteer-Petris Act as "earth or any other substance or material, including pilings or structures placed on pilings, and structures floating at some or all times and moored for extended periods, such as houseboats and floating docks" (Section 66632(a)) .

3. **Policy No. 4** states, in part, that "[a]dequate measures should be provided to prevent damage from sea level rise and storm activity that may occur on fill or near the shoreline over the expected life of a project. The Commission may approve fill that is needed to provide flood protection for existing projects and uses. New projects on fill or near the shoreline should either be:

   [a] set back from the edge of the shore so that the project will not be subject to dynamic wave energy,

   [b] be built so the bottom floor level of structures will be above a 100-year flood elevation that takes future sea level rise into account for the expected life of the project,

   [c] be specifically designed to tolerate periodic flooding, or

   [d] employ other effective means of addressing the impacts of future SLR and storm activity."

Applicable Policies on the Shoreline Protection

1. **Policy No. 1** states, in part, that, "[n]ew shoreline protection projects and the maintenance or reconstruction of existing projects and uses should be authorized if:

   (a) the project is necessary to provide flood or erosion protection for (i) existing development, use or infrastructure, or (ii) proposed development, use or infrastructure that is consistent with other Bay Plan policies;

   (b) the type of the protective structure is appropriate for the project site, the uses to be protected, and the erosion and flooding conditions at the site;

   (c) the project is properly engineered to provide erosion control and flood protection for the expected life of the project based on a 100-year flood event that takes future sea level rise into account;…

   …and (e) the protection is integrated with current or planned adjacent shoreline protection measures. Professionals knowledgeable of the Commission's concerns, such as civil engineers experienced in coastal processes, should participate in the design."

2. **Policy No. 2** states, in part, that, "[r]iprap revetments, the most common shoreline protective structure, should be constructed of properly sized and placed material that meet sound engineering criteria for durability, density, and porosity. Armor materials used in the revetment should be placed according to accepted engineering practice,… Riprap revetments constructed out of other debris materials should not be authorized."

3. **Policy No. 3** states, in part, that, "[a]uthorized protective projects should be regularly maintained according to a long-term maintenance program to assure that the shoreline will be protected from tidal erosion and flooding and that the effects of the shoreline protection project on natural resources during the life of the project will be the minimum necessary…" and…

4. **Policy No. 4** states, that, "[w]henever feasible and appropriate, shoreline protection projects should include provisions for nonstructural methods such as marsh vegetation and integrate shoreline protection and Bay ecosystem enhancement, using adaptive management. Along shorelines that support marsh vegetation, or where marsh establishment has a reasonable chance of success, the Commission should require that the design of authorized protection projects include provisions for establishing marsh and transitional upland vegetation as part of the protective structure, wherever feasible."

Request for the ECRB's Technical Advice. The UPRR railroad and associated bridges are considered critical infrastructure for the Bay region due to its economic and public safety significance. The bridge serves as a rail corridor for freight and passenger rail service along the East Bay shoreline. Therefore, BCDC seeks the expertise advice of the Board regarding the adequacy of the project's proposed overall safety standards as described in the materials. BCDC's safety questions are not limited to the staff's comments and do not preclude any others by the ECRB.

1. **Seismic, Structural and Geotechnical Criteria.** AREMA criteria are explicitly indicated as the basis of design of the project under Attachment 7; although the geotechnical report based its recommendations on both the 2013 CBC and the AREMA manual, it is not clear how the AREMA criteria influence the design. Consequently, the staff requests your comments on the following.

    a. Is the information sufficient to ensure the long-term safety of the project?

    b. Are the structural design criteria adequate in addressing seismic and hydraulic loads including lateral and uplift movement for the life of the structure?

    c. Is the ground motions response assessment appropriate for the project?

    On Friday, March 3, 2017 UPRR met with BCDC to discuss this summary and agreed to provide AREMA criteria information as referenced in the project. Such items are to be distributed to the ECRB as part of its review package. In addition, the applicant provided responses to staff comments (Enclosure 3) regarding seismic hazards including shear wave velocity, ground response to seismic loadings and estimated response spectra for the ECRB review.

2. **Sea Level Rise and Flooding.** The hydrology/hydraulic study indicates that in order to reduce water flow velocities and water surface elevation, the channel will be expanded by 174 square feet (334 vs. 160 square feet of existing). As a result, the proposed bridge would be 31 feet longer than the existing and riprap would be placed next to the abutments for scour and flood protection.

Further, the report shows that the top of the bridge could be inundated by today's FEMA BFE or 100-year flood events so that the rails elevations will match the BFE at 12.0 feet. By years 2070 and 2100, which are the anticipated life of the bridge, the BFE plus sea level rise elevation projections at the site could potentially be 14.3 and 16.6 feet, respectively, on the coastal (San Pablo Bay) side and 13.7 feet on the upstream (Refugio Creek) side for both years overtopping the bridge.

Therefore, BCDC would like your comments on the following potential concerns regarding the stability and overall safety of the bridge.

a. Stability of superstructure from lateral load. Lateral loads from water against the side of the bridge.

b. Stability of superstructure from buoyancy.

c. Stability of piers and abutments from lateral loads.

d. Stability of piers and abutments due to scour.

e. Strength and behavior of girders due to lateral loads.

f. Resiliency of bridge concrete and steel components including welds, anchor bolts and rebar reinforcement to deterioration from salt water.

On Friday, March 3, 2017 meeting with BCDC, the applicant provided responses addressing the bridge stability concerns in relation to hydraulic forces and agreed to provide the specifics of the analysis for distribution with this summary. See Enclosure 10.

Enclosed Material

1. ECRB minutes of May 19, 2010 for a nearby separate project.
2. February 8, 2017 CH2M letter and attachments
   a. Attachment 1, Figure 1-Project Area Map.
   b. Attachment 2, Design Drawings, "Union Pacific Railroad/3 Span 20" PCS x 60' (2 tracks)/Replacing 2 span TST-BD x 31'," dated October 27, 2015.
   c. Attachment 3-Final Report Hydrological & Hydraulic Evaluation/Union Pacific Railroad Company, Omaha, Nebraska, February 2017 by Olsson Associates.

   Appendix A: Figures
   i. Topographic Location Map
   ii. Project Work Map
   iii. Existing Bridge-Upstream Face Profile
   iv. Proposed Bridge-Upstream Face Profile
   v. Area Location Map

Appendix B: Bridge Survey Photolog

Appendix C: FEMA FIRM

Appendix D: HEC RAS Output Tables

d. Attachment 4-Geotechnical Report by Shannon&Wilson, Inc./Geotechnical and Environmental Consultants, dated August 14, 2014 by Jason Buenker, P.E. and R. Travis Deane, P.E., G.E.

3. "Response to Geotechnical Review Comments by the San Francisco Bay Conservation and Development Commission, Milepost 20.89 Bridge Replacement, Martinez Subdivision, Union Pacific Railroad, Hercules, California," by R. Travis Deane, PE, GE of Shannon & Wilson, Inc. and dated March 2, 2017.
4. "Allowable Axial Capacity 20-inch Driven Pipe Pile Foundation/Generalized Subsurface Conditions/Figure 6," by Shannon & Wilson, Inc., dated August 2015. (Also available in Enclosure 2.d.)
5. Spreadsheet on BCDC Comment response submitted on March 3, 2017.
6. Condensed Profile
7. UPRR Bridge Standards, Concrete Beam Bridges. 14" to 20" x 7'0" Slab Beam. Various Lengths, Framing and Reinforcement.
8. **To be furnished later.** American Railways Engineering and Maintenance-of-Way Association (AREMA). 2015. Chapter 8 - Concrete Structures & Foundations. Pages 8-I to 8-viii and 8-2-8 to 8-2-20.
9. **To be furnished later.** American Railways Engineering and Maintenance-of-Way Association (AREMA). 2015. Chapter 15 - Steel Structures. Pages 15-1 to 15-v and 15-1-23 to 15-1-46.
10. "Martinez Bridge 20.89/Secondary Force Design," by BJW of HDR and dated March 6, 2017.