TECHNICAL MEMORANDUM

Broadway Bridge Feasibility Study Conceptual Alignment Alternatives

PREPARED FOR:	City of West Sacramento, in cooperation with the City of Sacramento
PREPARED BY	CH2M

Bridge Alignments

As a result of agency and stakeholder coordination, four bridge alignments have been considered in the feasibility study. The alignment alternatives represent the range of variations to address the land use, economic, property access, regulatory constraints, and opportunities on both sides of the river. The range of alignment alternatives was focused within this range. This is due to the logical connection point at Broadway on the east side of the river, the minimum distance required from the Pioneer fixed bridge to the north, and the need to maintain a minimum skew across the river for marine vessel navigation through the Broadway Bridge movable span. Alignments A, B, and C were provided to the USCG and waterway users as part of a field visit in April 2015 to determine the appropriate navigation channel. Subsequent to the USCG waterway user outreach for alignments A, B and C, the City of West Sacramento requested the project team analyze a fourth alignment (Alignment D). Figure 1 provides an overview of the four bridge alignments and affected properties.

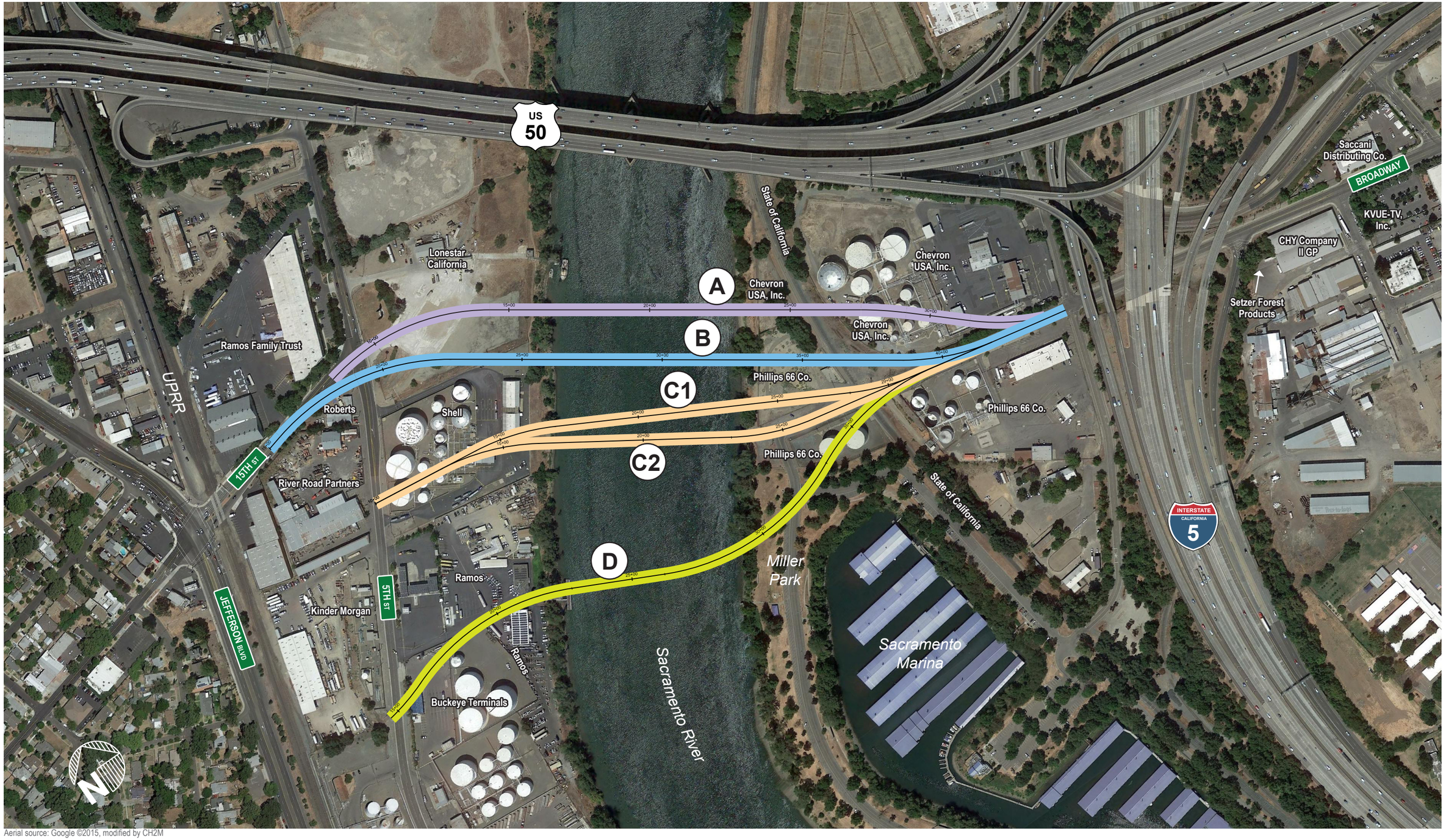
On the east side of the river, all alignments share a common connection to Broadway. However, the specific connection points and impacts vary by alignment. One of the City of Sacramento's overarching objectives is to maintain existing access to the Sacramento Marina and Miller Park, regardless of alignment. All alignments on the east side will either directly or indirectly impact Phillips 66 properties located on both the north and south sides of Broadway. Details of each alignment are described below.

Alignment A

On the West side of the river, Alignment A connects directly to Jefferson Boulevard via 15th Street. The primary constraints, or factors, for this alignment are to avoid the Shell tank farm and to maintain the existing 15th Street alignment at the 5th Street intersection. To accomplish this, on the east side alignment A must start angling away from Broadway several hundred feet east of the railroad tracks. This serves to maintain adequate skew across the river. However, by doing so, it creates a significant skew at the railroad tracks and impacts the existing Chevron facilities on both sides of the tracks.

Alignment B

This alignment also connects directly to Jefferson Boulevard via 15th Street, but the 5th/15th Street intersection is reconfigured, which is consistent with the City of West Sacramento's circulation plans for Pioneer Bluff. Alignment B also avoids direct impacts to the Shell tank farm. By realigning 15th Street, the alignment is able to avoid impacting the Chevron facilities on the east side of the river. The skew across the railroad tracks is similar to that of Alignment A.



Aerial source: Google ©2015, modified by CH2M

0 250 500

Approximate Scale In Feet

Figure 1. Bridge Alignment Alternatives

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Alignment C1/C2

Alignment C connects directly to 5th Street several hundred feet south of the 15th Street intersection. At approximately 2,000 feet long, this alignment is the shortest and most direct. The specific connection point at 5th Street will be required to meet the City of West Sacramento's intersection spacing standards. By doing so, alignment C impacts the Shell tank farm. The alignment has two variations (C1 and C2). C2 aimed to optimize the bridge skew across the river and to minimize impacts to Phillips 66 facilities. An active Kinder Morgan petroleum line runs in the vicinity of Broadway and under the Sacramento River, which conflicts with alignment C2. Alignment C1 avoids the Kinder Morgan line, but also impacts Phillips 66 and creates a greater skew across both the river and railroad tracks.

Alignment D

Based on preliminary input and analysis, alignment D aims to balance the transportation benefits and impacts resulting from a new cross-river connection with the right of way constraints, and the real estate potential, for Pioneer Bluff, Stone Lock, and Southport.

At the time of writing this technical memorandum, only informal coordination has been initiated with the USCG regarding alignment D. Based on the USCG preliminary feedback, the movable navigation span for alignment D would need to be wider than the 170 feet proposed for alignments A, B, and C to enable tug and barge traffic to negotiate the river bend immediately downstream. To confirm the navigation channel required, the cities will need to submit a formal request to the USCG. This request will also subsequently be submitted to the waterway users for a 30-day comment and response period.

The project team has prepared preliminary cost estimates for alignment D to inform stakeholders and decision-makers of the potential cost implications of the longer overall alignment and wider movable span. A cost comparison table is included in the executive summary, and detailed assumptions are included in the Cost Estimate Technical Memorandum.

Alignment D impacts property owned by Ramos and Buckeye Terminals on the west side. On the east side, the alignment directly impacts Phillips 66 tanks south of Broadway and encroaches into Miller Park, requiring a significant configuration of the existing access to both the park and marina.

Local Connections

East Side

The connections to Broadway are critical considerations to integrate the bridge traffic into the street network, while also balancing impacts to adjacent neighborhoods with the potential to realize planned economic development and revitalization of area businesses. The year 2040 traffic forecasts show approximately 5,300 daily vehicles utilizing Broadway without a new river crossing. To coordinate with visioning efforts underway for the Broadway corridor, and based on concerns voiced by the Broadway and Upper Land Park stakeholders, the team analyzed three options to balance future traffic volumes and distribution onto Broadway and the surrounding local road network. Each scenario has unique traffic implications, which are summarized below. All scenarios assume a future streetcar connection will be maintained through the intersection(s) and continue east along Broadway. More detailed traffic information is included in the Traffic Analysis Technical Memorandum.

Option A – Broadway Direct Connection

This option assumes traffic using the new river crossing will access Broadway via a direct connection, No significant changes to existing roadways or intersections are assumed, with the exception of the widening and operational improvements needed to support anticipated travel demand. Depending on the bridge width constructed (i.e., two versus four lanes), daily traffic volumes on Broadway will increase from the 5,300 forecasted in 2040 with no project, to between 8,500 and 11,500 with the Broadway Bridge in place. As shown in Figure 11 in the traffic technical memo, daily traffic volumes will decrease east along Broadway with this option, as they disperse to local and regional streets from connection points between Front Street and Freeport Boulevard. In the Broadway Connection alternative, the four-lane roadway cross section scenario would require improvements to extend from the Broadway Bridge to 3rd Street.

Option B – X Street Connection

Option B would direct traffic onto X Street just east of the I-5 northbound off-ramp intersection. This option would require closure of the I-5 southbound X Street off-ramp. Daily volumes on Broadway in 2040 would increase to between 7,400 and 9,900. Closure of the X Street off-ramp and potential improvements needed to the I-5 northbound off-ramp would require approval from Caltrans. Figure 2 demonstrates one potential scenario with a direct connection to X Street, requiring closure of the X Street off-ramp. These scenarios will require a more detailed operational analysis in the next phase of work to identify the full range of impacts and benefits.

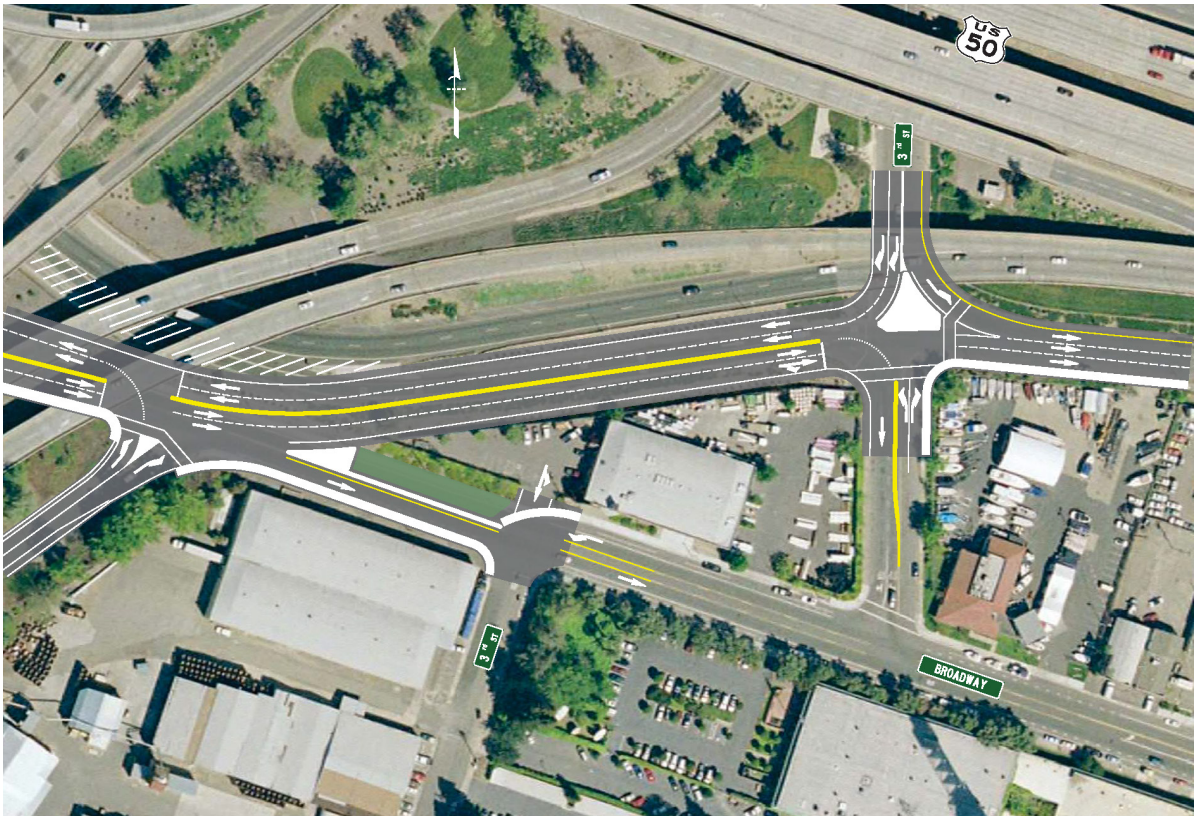


Figure 2. X Street Connection

Option C – Broadway/3rd Street Intersection Modification

An option was developed that modifies the Broadway/3rd Street intersection by providing a direct connection to 3rd Street, combined with a tee intersection at Broadway. This option facilities the movement of the majority of traffic wishing to access downtown Sacramento and the freeway network while still providing access to Broadway as a local connection. Intersection spacing between Broadway and X Street is an issue with this option, and will need to be explored further in the next phase.

It should be noted that forecasted traffic volumes on Broadway assume the City of Sacramento's Riverfront reconnection project is in place. This project includes improved connections from Front Street to downtown Sacramento. Phase 1 of the reconnection project is currently under construction.

West Side

In West Sacramento, most of the travel demand for the new crossing will be to and from the Southport area. Between the new crossing and Southport, travelers will use either 5th Street or Jefferson Boulevard. How the crossing connects to both will affect which corridor travelers choose.

15th Street Connection

Both alignments A and B direct traffic to Jefferson Boulevard via 15th Street. Jefferson Boulevard is the established corridor, but directing the bridge traffic there will significantly increase the volume of cars crossing the Union Pacific Railroad (UPRR) tracks at the 15th Street grade crossing, which will be a key concern for the railroad and the CPUC. The City, as part of a countywide working group, is conducting a cost/benefit analysis to relocate existing rail lines out of the cities of Davis, Woodland, and West Sacramento. Land use and planning criteria for both the Bridge District and Pioneer Bluff assume the rail will be relocated between 2025 and 2030.

Alignments A and B also have impacts to existing entitlements developed for the Bridge District and Pioneer Bluff. Namely, the existing alignment of Riverfront Street, its connection at the 5th/15th Street intersection, and supporting entitlements, would be impacted by these two alignments. Consent of the affected parties to amend existing development agreements would be required. The City has discussed this options with the affected parties, who are amenable and have voiced specific preference for the 15th Street alignment. Figures 3 and 4 show two conceptual connection scenarios for alignments B and

Figure 3. Alignment B, 15th Street Connection Concept

C. Specific intersection geometrics, limits and lane configurations will be confirmed as part of the traffic analysis in the next phase of work.

5th Street Connection

Directing traffic to 5th Street eliminates the need to cross the UPRR, but will direct a majority of the traffic bound for Southport, which is in conflict with current Pioneer Bluff transition efforts. As shown in Figure 2, the 5th Street current plan is for lower volume and multimodal (similar to Riverfront Street).

Alignment D was presented by City of West Sacramento to maximize the development potential assumed in the Pioneer Bluff re-use master plan, and in conjunction with area's circulation planning, to be compatible with the City's street hierarchy assumptions. Additional mitigation may be required to fully realize the benefits and impacts of this alignment, and should be analyzed in the next phase.

Traffic volumes resulting from the 5th Street connection may not be compatible with the City's vision for 5th Street.

Figure 4. Alignment C, 5th Street Connection Concept

Alignment D was presented by City of West Sacramento to maximize the development potential assumed in the Pioneer Bluff re-use master plan, and in conjunction with area's circulation planning, to be compatible with the City's street hierarchy assumptions. Additional mitigation may be required to fully realize the benefits and impacts of this alignment, and should be analyzed in the next phase.

Vertical Profile

The vertical alignment for this bridge is influenced by several factors. These include hydraulic criteria, roadway geometric criteria, and constructability. All of these items were closely evaluated as part of this study. Figure 5, graphically identifies all of the key design elements discussed below.

Hydraulic Driven Criteria - Minimum Soffit Elevation in Closed Position

The primary design element that is driven by hydraulics is the minimum soffit elevation in the closed position. The criteria of the 200-year flood event plus 3 feet of freeboard was chosen to set this criteria. This results in a minimum soffit elevation of 40.4-feet (NAVD88) in the closed position. The 200-year flood event elevation of 36.4-feet (NAVD88) was used. This elevation was provided by WRECO. The three feet of freeboard provides clearance for floating debris that could be in the water way during a flood event. Additionally, a 2% normal crown was assumed for the roadway typical section. If the maximum bridge width is selected, this cross slope would result in approximately 1 foot of elevation difference between roadway centerline and edge of bridge. These three components were added together to form the criteria for minimum soffit elevation in the closed position at centerline. The equation below summarizes these components:

200-year WSE (NAVD88) + freeboard + account for cross slope: 36.4' + 3' + 1' ***= 40.4' (NAVD88)***

As part of a check, this elevation was compared to the soffit elevation of three adjacent bridges. Soffit elevations for the Tower Bridge, the I Street Bridge, and the Pioneer Bridge were acquired with a mobile scanner and provided by R.E.Y. Engineers, Inc. Below is a brief summary of the soffit elevations of these bridges relative to the proposed Broadway Bridge. All elevations below are based on NAVD88.

- Tower Bridge, Soffit Elevation: 37.4-feet
- I Street Bridge, Soffit Elevation: 36.9-feet
- Pioneer Bridge, Soffit Elevation: 93.0-feet (non-movable bridge)
- Proposed Broadway Bridge, Soffit Elevation: 40.4-feet

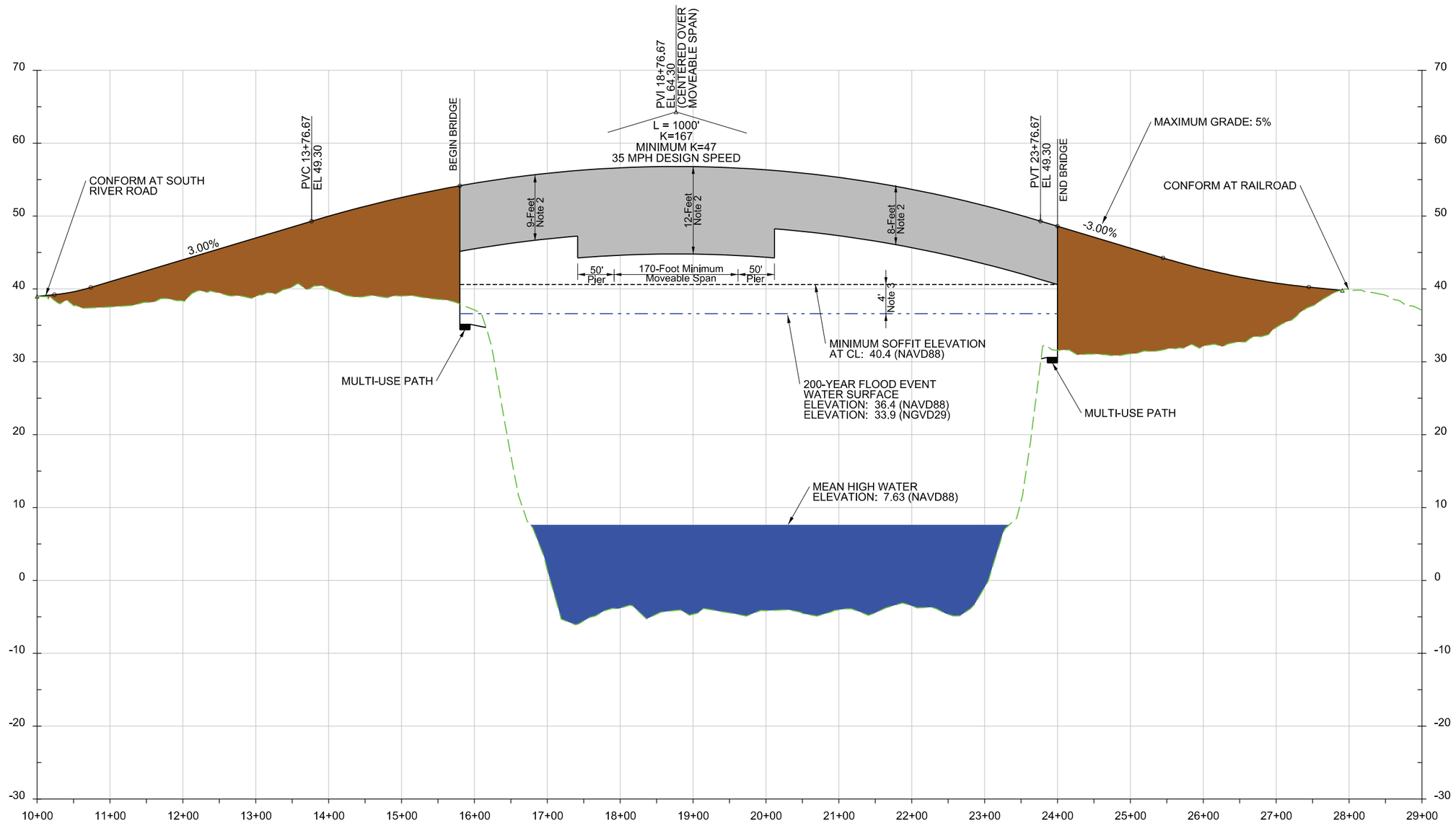
Based on this comparison it was confirmed that the criteria of 40.4-feet (NAVD88) would not create a new "minimum clearance" point along the river corridor.

Roadway Geometric Criteria

The critical factors behind roadway vertical alignment from a geometric standpoint are design speed, compliance with ADA requirements, and vertical conform points.

A design speed of 35 mph was selected. This was based on the existing posted speed on Broadway of 30 mph, combined with the fact that, between 5th Street on the west side, and 3rd Street on the east side, approximately 7 intersections or at-grade crossings (i.e., movable bridge, excursion rail) and multiple property access points will be traversed by autos, transit vehicles, and non-motorized users. The maximum K value associated with a 35 mph crest curve is 47. This corresponds to a stopping sight distance of 250 feet based on Caltrans Highway Design Manual. The maximum grade established for the vertical alignment was 5%. This allows for the sidewalks to meet ADA requirements for the maximum longitudinal grade. Evaluation of preliminary alignments revealed that the vertical alignment criteria can be comfortably met with a grade of 2%-4%.

The vertical conformation to existing ground on both sides of the river was the other critical design element. The vertical conform to the east is tightly constrained by the existing railroad tracks. This project does not intend to vertically relocate the existing railroad tracks, so a key design element is to conform vertically at the railroad crossing. On the west side of the river, the vertical alignment would ideally conform prior to the intersection with 5th Street, but vertically re-aligning 5th Street is feasible if deemed necessary to make the vertical conforms work on the west side of the River. The location of this conform will be influenced by which horizontal alignment is selected.



NOTES:
1. VERTICAL EXAGGERATION: 10X
2. STRUCTURE DEPTH USED FOR SETTING PROFILE GRADE BASED ON PRELIMINARY DESIGN. ACTUAL DEPTH TO BE REFINED DURING FINAL DESIGN.
3. DISTANCE REPRESENTS 3-FEET OF FREEBOARD PLUS 1-FOOT TO ACCOUNT FOR THE DIFFERENCE IN ELEVATION BETEWEEN CL OF BRIDGE AND EDGE OF BRIDGE AS A RESULT OF A 2% NORMAL CROWN.

Figure 5. Key Design Elements

Bridge Design/Constructability

The primary constructability consideration relative to the vertical alignment is the location the crest curve relative to the movable portion of the bridge. The PVI associated with the crest curve going over the bridge needs to be centered over the movable span. Additionally, symmetry of the crest curve was evaluated relative to the movable portion of the bridge. During the course of this feasibility study three vertical alignment concepts were developed.

The first was a symmetrical single crest vertical curve. This vertical alignment employed the same entrance and exit grades.

The second was an asymmetrical single crest vertical curve centered over the movable span. This vertical alignment employed different entrance and exit grades.

The third was a series of three crest vertical curves. These consisted of a crest curve at the beginning and end of the bridge, in addition to a near flat crest curve centered over the movable span. This created the appearance of a flat bridge. After evaluating these three concepts, it was determined that the first concept, the symmetrical single crest, was the preferred concept due to its simplicity and symmetry when compared to the others.

Bridge Cross Section

The selection of the crossing width has long-term implications as widening a movable span may be infeasible or very expensive in the future. Traffic modeling efforts suggest the future travel demand may require up to a 4-lane crossing of the river. However, depending on how the intersections are configured at 5th Street and Broadway, it is possible that a 2-lane crossing may be a viable solution. The 2-lane crossing may be more compatible with the Neighborhood Friendly definition and more acceptable to stakeholders. If a 2-lane crossing is pursued, a key consideration in the ability and cost to widen the movable span to 4 lanes if needed in the future. For example, a swing bridge cannot be widened given its rotating span.

Multiple comments received at the West Sacramento Transportation, Mobility and Infrastructure (TMI) Commission Workshop held on July 6, 2015 and the community open house held on July 23, urged the agencies to construct a crossing that serves all modes (i.e., bicycle, pedestrian, and transit) (Figure 6). Therefore, common elements of all bridge alternatives include provisions for future streetcar and bike/ped connectivity.

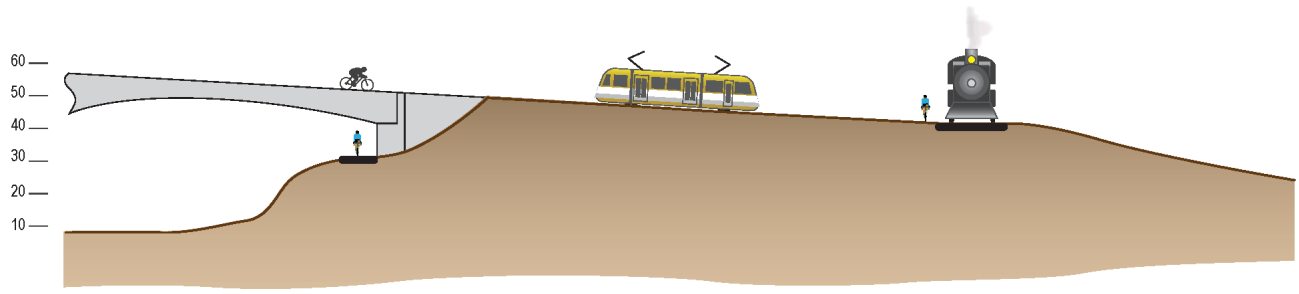
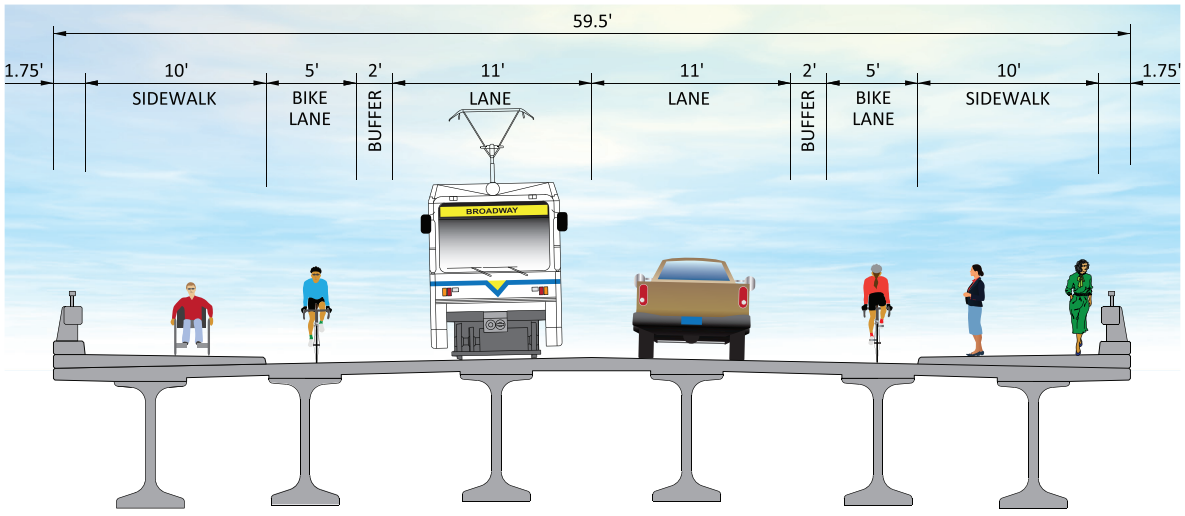


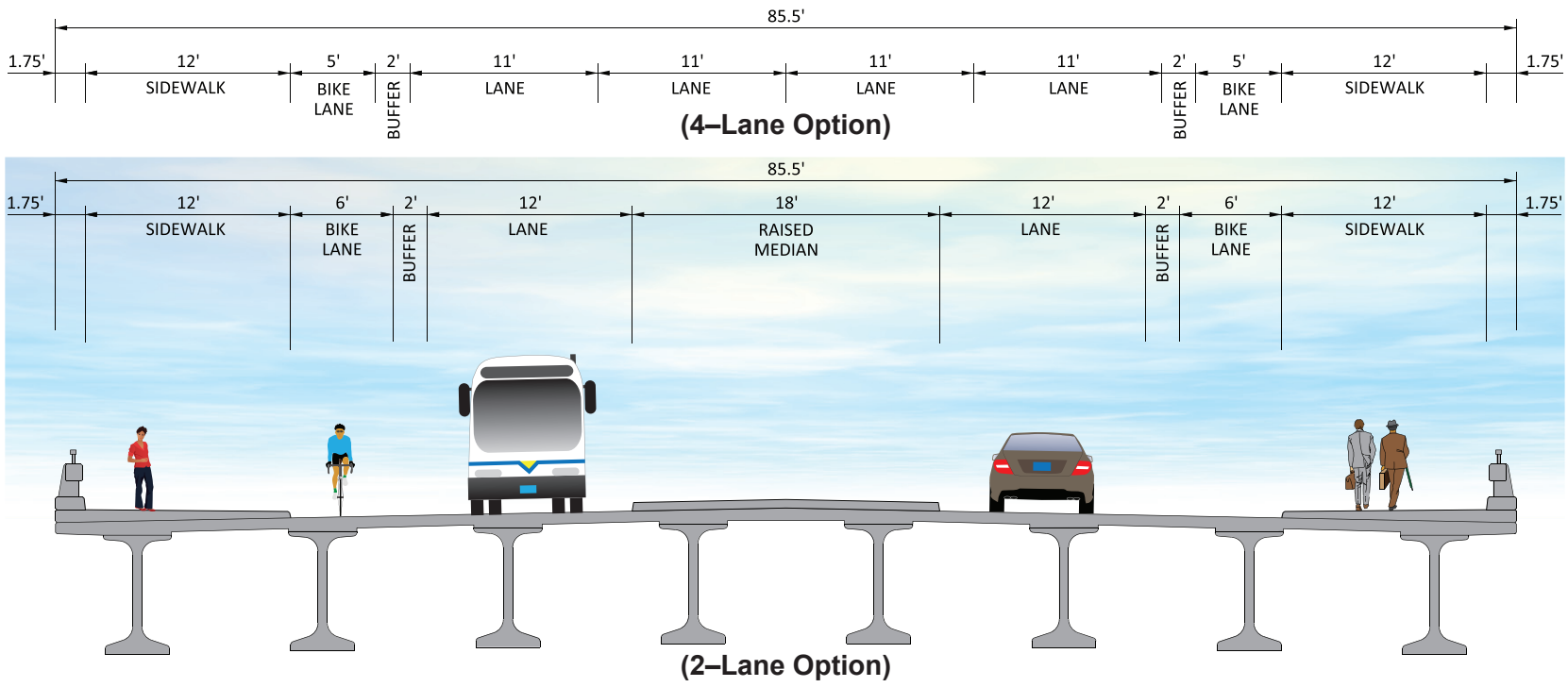
Figure 6. Multimodal Concept for the Broadway Bridge East Span

To thoroughly inform stakeholders and decision-makers, the Study includes four alternative bridge configurations that would be carried forward to the environmental analysis phase. These conceptual alternatives represent both 2-lane and 4-lane bridges. Figure 7 illustrates those cross sections including a 2-lane bridge design, an adaptable 2-to 4-lane bridge configuration, and a typical 4-lane bridge design with an optional 2-vehicle plus 2 transit-only lane configuration, for use by future streetcar, potential Bus Rapid Transit (BRT), and/or local bus transit. Analysis of alternative bridge configurations that include both 2 and 4 lane bridge sections with transit-only lane options are consistent with the 2011 Sacramento River Crossings Study and TMI Commission recommendations.

Standard 2–Lane



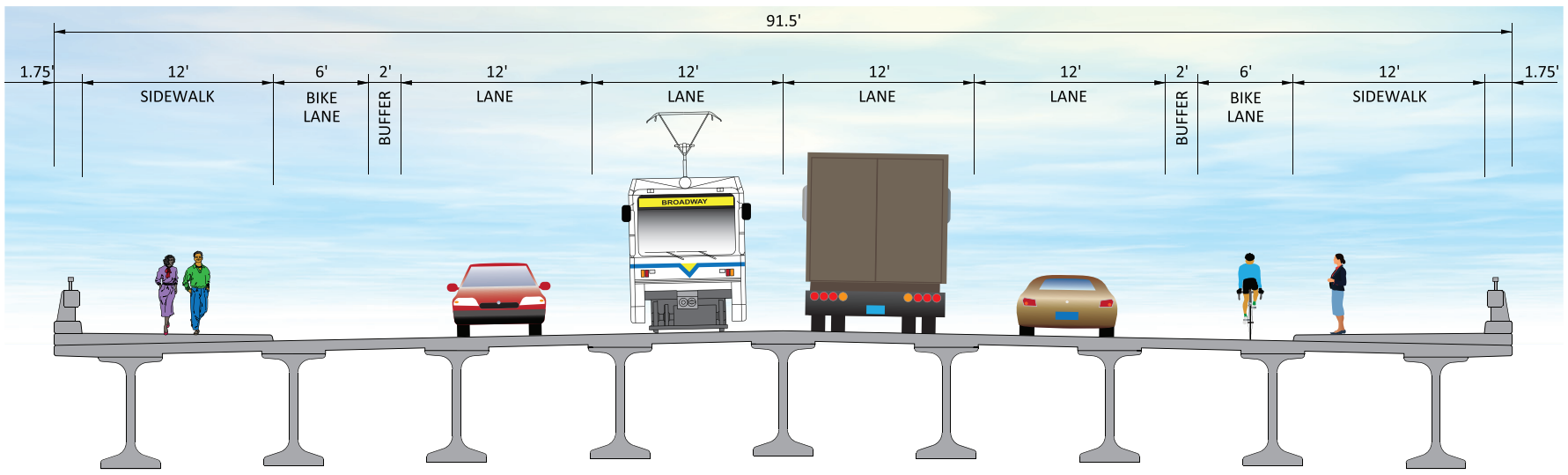
2– to 4–Lane Conversion



(4–Lane Option)

(2–Lane Option)

Standard 4–Lane



Dedicated Transit 4–Lane

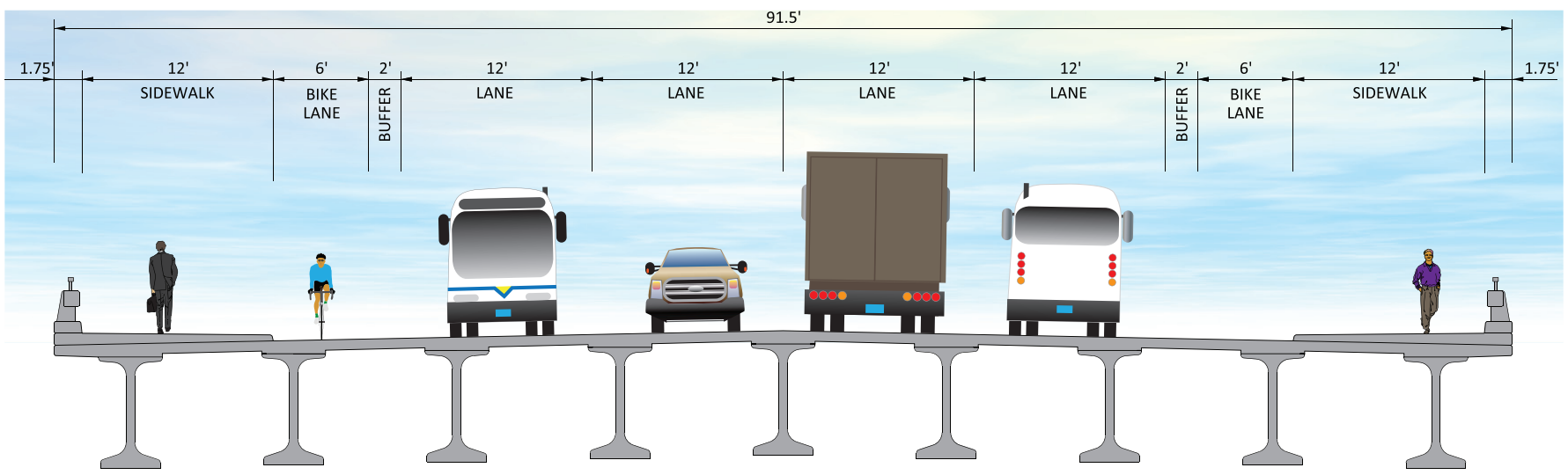


Figure 7. Alternative Bridge Configurations

The City Council of West Sacramento reviewed and concurred with the cross section concepts at their regularly scheduled meetings on October 22 and November 18. As of the writing of the document, the Sacramento City Council has not taken formal action on the bridge alternatives.

Two-Lane Bridge Section

This is the minimal cost alternative, and assumes minimum widths required to meet current standards while addressing multimodal needs. The cross section includes 10’ sidewalks, 5’ bike lanes with a 2’ buffer from the 11’ mixed flow lanes which will be shared by autos, trucks, and transit vehicles. With this cross section of 60’, all three of the movable bridge types presented are feasible.

Adaptable Two- to Four-Lane Bridge Section

This cross section provides flexibility by constructing the bridge width needed to efficiently serve 2 lanes of mixed flow vehicles and non-motorized users in the near term, while not precluding the ability to accommodate 4 travel lanes in the future. Common features of both options include 12’ sidewalks to support Caltrans bridge inspections, and 2’ buffers between bicyclists and vehicles. In the 2-lane scenario, 12’ travel lanes and 6’ bike lanes are assumed, along with an 18’ center median. In the 4-lane scenario, the raised median is removed, travel lanes are reduced to 11’, and bike lanes are reduced to 5’. With this cross section of 86’, all three movable bridge types are feasible, with the exception of the swing bridge for Alignment D.

Four-Lane Bridge Section (includes dedicated transit lane option)

In this option, full standard vehicle, bike, and sidewalk widths are assumed at initial construction. The cross section would accommodate 4 future mixed flow lanes or 2 dedicated transit lanes. With a total width over 90’, this cross section reduces the feasible movable bridge types. For alignment D, the combination of 4-lane width and additional navigation clearance required at this location, the vertical lift may be the only feasible movable type.

The Executive Summary and Bridge Alternatives Technical Memorandum include a comparative matrix that summarizes these issues.