5. Summary and Structure Selection

5.1 Project Description

Fourth Street is a major east west route through Pueblo connecting I-25, downtown, and western residential neighborhoods. The new 4th St. Bridge will replace an existing crossing and carry State Highway 96A (SH96A) across a small city street, the Union Pacific (UPRR) and Burlington Northern Santa Fe (BNSF) railroad yard (Pueblo Yard), a floodwall, and the Arkansas River. Project construction limits are between Midtown Circle Drive and W. Corona Avenue on 4th St. west of downtown and I-25.

The Pueblo Yard is a major railroad system component with approximately 30 closely spaced tracks at the bridge location, including one BNSF and two UPRR mainlines. The yard is currently running at or above capacity. The Arkansas River in this area is relatively narrow and shallow with flow controlled by the Pueblo Reservoir. The floodwall was constructed in the early 1920's when the river was re-channelized after the Pueblo flood of 1921. The City of Pueblo and U.S. Army Corps Of Engineers are teaming on the Legacy Project, which will re-establish the riverine environment and improve recreation in and around the river in this area. River channel changes, improvements to wildlife and fish habitats, and recreational boating and kayaking are part of the project goals.

Goals of the 4th St. Bridge Project include improving safety to motorists, pedestrians, and bicyclists on the bridge, increasing capacity, providing a higher functioning level of service, improving railroad clearances, and increasing load carrying capacity. Community and agency involvement in decision making related to project elements such as bridge, roadway, aesthetics, and urban design is key to the successful project. The bridge and roadway cross-section will be improved to accommodate current and future traffic demands on the 4th St. corridor. The new cross-section is shown in Figure 5.1 below:

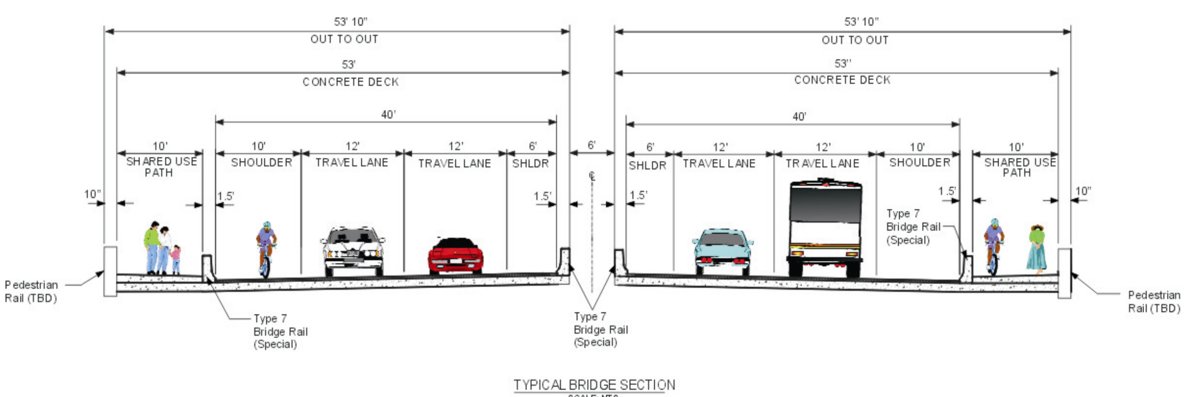

Figure 5.1 Proposed Bridge Cross Section

5.2 Existing Conditions

The existing 4th St. Bridge, structure number K-18-Z, was constructed in 1958 and is approximately 1068 feet long and 68 feet wide. The existing bridge was most recently rated by CDOT in March 2002 and given a Sufficiency Rating of 24 out of a possible 100 (SIA, 2002). The sufficiency rating is a function of the structural adequacy, safety, serviceability, functional obsolescence, and public use of the bridge. The bridge has been classified as "Structurally Deficient" (SD), and the overall structural condition described as "meets the minimum tolerable limits to be left in place as is." The SD rating is based on substantial substructure pier deterioration, which is described as "poor with advanced section loss, deterioration, spalling, and/or scour." The superstructure and deck conditions are rated as "satisfactory with some minor deterioration of the structural elements." The rating report describes horizontal under-clearance as "basically intolerable requiring high priority of replacement." This is due to the close proximity of railroad tracks to existing bridge piers, which are much less than required by AREMA, AASHTO, and the railroads.

Horizontal clearance between the face of piers and the centerline of adjacent railroad tracks is a critical project issue as it relates to the safety of the public and railroad personnel. In the past, existing yard and bridge pier configuration has resulted in bridge strikes from derailed freight cars. Railroad standards require 18'-0" minimum horizontal clearance between the face of a pier and the centerline of an adjacent track when pier crash walls are provided. Without pier crash walls, this increases to 25'-0". The minimum existing clearance in the yard is 8'-3" at Pier 5 along the floodwall toe of slope.

The bridge deck and the girders in spans 3 through 5 have 65% and 75% of the capacity of the original HS20 design loading at inventory level. This equates to 52% and 60% of current vehicle design load requirements. New bridge structures, designed to current standards, normally rate at or above 125% of HS20 at inventory level (HS25 or HL93).

Roadway and bridge geometry at the east and west ends are substandard by current design standards. The downgrade of the bridge combined with tight curvature at each end has been blamed for unsafe driving conditions especially during inclement weather. The reverse curve on the west approach is undesirable and also a concern for motorists. The bridge deck cross section consists of narrow 11-foot lanes, 2-foot maximum shoulders, and substandard 4 foot combined use sidewalks.

5.3 Bridge Options

The Structure Concept Report (FIGG, 2001) identified three layout alternates with five associated structure types for further engineering study during the preliminary design phase. These bridge alternates were chosen for further study after evaluation of many options over a comprehensive list of project criteria. The bridge alternates studied and presented in this report are listed below:

Bridge Alternate	**Structure Type**
Match Existing with Modified River Spans	Spliced Post-tensioned Bulb T Girders Spliced Post-tensioned U Girders
Moderate Span 2	Steel Plate Girders Steel Box Girders
Long Span 3	Cast-in-Place Concrete Box Girders Built from Above w/ Form Travelers

All of these options follow the recommended alignment for the new bridge and roadway to the north of and parallel to the existing structure. The bridge and approach profile has been designed to current standards and accommodates all railroad and roadway vertical clearance requirements. Preliminary engineering and cost analysis have been completed for each of these alternates and results presented in this report.

All of the bridge options studied are conventional and can be constructed by a wide range of contractors. Bridge layouts with five (5) spans, six (6) spans, and eight (8) spans were considered. Precast concrete bulb-T and U girders were studied for the short span bridge option. Spliced post-tensioned girders would be necessary for these options where practical span lengths are exceeded (greater than 150-feet). For the moderate span option, steel plate girders and box girders were studied, and for the long span option, the structure type considered was a cast-in-place concrete box girder built from above with form travelers. The cast-in-place box girders would be built in balanced cantilever from the piers, while the end spans would be cast on falsework since adequate space beneath the bridge is available in these areas.

5.4 Bridge Type Evaluation

Each structure option and type was evaluated against the project goals, critical issues, and constraints of the site. The recommended bridge structure is that solution which provides the best overall value to the project in terms of a diverse set of evaluation criteria. The evaluation criteria are based on the structural and functional requirements of the bridge facility and include the following:

- Impact to the Arkansas River Floodwall
- Impact to the UPRR and BNSF Railroad Yards
- Arkansas River Impacts
- Bridge Aesthetics
- Bridge Cost
- Constructibility
- Durability / Maintainability

Evaluation of each bridge option for each of the criterion listed above is discussed in detail in Section 4, and results summarized in Table 5.1, below. Each option has been given a rating of between one (lowest) and five (highest) to represent how well each criterion is satisfied for a given bridge option. An overall rating is then calculated for each option based on a weighted average that considers the importance of each criterion in the overall project. The option receiving the highest overall rating is the recommended structure for the new 4th St. Bridge.

5.5 Structure Selection

Long Span Layout 3 received the highest possible score of five (5) for all criteria except impacts to the Arkansas River Floodwall, for which it received a score of four (4). All options studied, however, received a four (4) for this criterion since all options have a pier located at the toe of floodwall on the railroad yard side. Long Span Layout 3 also received the highest score of any options for all of the remaining criteria, and the highest computed overall score of 4.95 / 5.00.

Long Span Layout 3 provides the least amount of impact to the floodwall by locating Pier 3 as near the toe of slope as possible and far enough away from UPRR Yard Track 21 to facilitate construction. Two drilled shafts will be used under each pier to minimize the foundation footprint and minimize disruption to the wall. Impacts to the UPRR and BNSF railroad yard have been minimized with this option through careful pier location selection and increased span length. Both the UPRR and BNSF facilities are completely spanned and substructure elements optimized such that all required railroad clearance requirements are satisfied without the need for costly yard modifications. No other option accomplishes this goal.

Impacts to the Arkansas River and planned improvements in the surrounding area have been carefully considered and minimized by selection of a pier location between the river channel and existing trail where construction activities can occur in relatively dry conditions. Bridge aesthetics and urban design are important considerations given the redevelopment occurring in Pueblo and the community's strong desire to build a "signature bridge" that is a "Gateway to Pueblo." Structure type is the first step in achieving aesthetic goals, and the dual single-cell cast-in-place concrete box girders specified for the Long Span Layout 3 option have proven superior aesthetics.

Bridge cost is important to the project as funding and economic considerations play a major role in project decisions. Since the new bridge structure crosses a major railroad yard, there are potentially a great deal of costs that the project could incur from yard modification requirements and construction activities. Bridge cost analysis for each option considered all of these factors and results indicate that Long Span Layout 3 is the least expensive solution since it minimizes all railroad related costs.

Method of construction can greatly affect railroad operations. Long Span Layout 3 utilizes cast-in-place construction from above in the railroad yard region. Therefore, crane movements in the yard and on existing tracks for the erection of large girders is not required. Substructure operations are minimized since this option requires the fewest piers, and once pier tables are complete, superstructure erection is completely from above such that all railroad operations can continue uninterrupted. The Contractor's time in the yard is minimized and thus project expenses reduced.

The concrete box girder for Long Span Layout 3 is the most durable and maintainable structure type. The entire bridge cross section is constructed as an integral concrete pour and post-tensioning in both the longitudinal and transverse directions ensures the most durable bridge deck with the lowest possible permeability and highest strength. Lack of intermediate expansion joints, integral connection with the substructure, and no need for a mildly reinforced deck placed as a secondary pour, also contribute to the most durable structure type. The most durable structure requires the least amount of maintenance and extends the life of the bridge.

Long Span Layout 3 provides the best value for the project and is therefore the recommended structure for the new 4th St. Bridge in Pueblo. Preliminary Design plans (FIR) have been completed for this structure and are included in Appendix A. Bridge design criteria are included in Appendix B, and graphical representations of the bridge plan, elevation, and typical section are shown in Figures 5.1 and 5.2 at the end of this section.

5.6 Maintenance of Traffic

The split alignment for the Long Span Layout 3 options allows for the most feasible and economic maintenance of traffic scheme for the bridge and approach roadways. The westbound bridge will be completely constructed north of the existing such that all four lanes of traffic on 4th St. can continue without interruption. The majority of the eastbound bridge can also be built without affecting existing traffic. Once complete, all four lanes of traffic will be shifted onto the new westbound structure and completely off of the existing bridge. This will allow access to the existing bridge for removal of the eastern spans and subsequent completion of the new eastbound structure and project.

Temporary placement of four lanes of traffic on the westbound bridge requires utilizing future sidewalk space for vehicle lanes. The sidewalks are secondary pours so this can easily be accommodated though construction staging of the walks and inside barriers.

5.7 Bridge Inspection Considerations

The new bridge must allow for easy access and inspection, especially considering difficulties associated with gaining right to entry in the railroad yard. The importance of this access is evidenced in previous CDOT rating reports for the existing bridge, which contain inspector's comments noting that some items could not be inspected due to the railroad facilities.

The dual single-cell concrete box girders specified for Long Span Layout 3 provide the best possible inspection and maintenance access of any bridge option studied. This option will require the least possible maintenance due to the concrete post-tensioned structure type chosen, and the lack of expansion joints as discussed above. To facilitate inspection of the bridge, access holes will be located in the bottom slabs near each abutment for entry into the box girders. Man-ways though the concrete diaphragms at each pier and abutment allow for full inspection of the concrete and post-tensioning system from end to end from inside the bridge. Exterior bridge inspection of the asphalt wearing coarse, barriers, sidewalks, and exterior concrete surfaces can be accomplished from the bridge deck using “snooper” trucks parked on the structure. The split alignment results in an opening between structures such that this inspection can occur from either side of the bridge. If subsequent substructure inspection is required for the four columns at piers 3 and 4, yard roads can be utilized due to the proximity of these piers near or on these roads.

5.8 Removal of the Existing Bridge

Removal of the existing bridge must also be completed minimizing railroad and river impacts. Due to non-composite superstructure construction, cutting and lifting from above could remove deck sections. Girder removal could also be from above provided that stress changes are maintained within allowable levels during the change in structural state that would result. Substructure removal would most likely be from the railroad yard, however, time to accomplish this removal is expected to be short and have limited impact on railroad operations. The exact means and methods of removal will be at the contractor’s discretion.

5.9 Project Walls

The selected alignment and profile were used to complete a wall study for the project. Potential wall locations include the north side of the alignment at the west end of the bridge, and the east end approach fill, on both the north and south sides. On the west end, the existing bluff will be cut where the north half of the alignment continues west of the west abutment. On the east end, fill will be required for the alignment as it connects with the existing roadway east the east abutment.

Right-of-way implications, possible wall types, and a cost comparison were presented to CDOT for consideration. Comparison Costs are shown in Table 5.2, below. Considering cost, maintenance, right-of-way implications, and other factors, CDOT Region 2 has concluded that right-of-way acquisition is preferable over retaining wall construction. Therefore, walls will not be constructed and space necessary for cut and fill slopes will be obtained through the right-of-way acquisition process.

Table 5.1 Structure Selection Matrix

Structure Selection Matrix

Rating Scale
1 - Lowest
5 - Highest

			Evaluation Criteria & Weighting Factor							
			Impact to Floodwall	Impact to UP & BNSF Railroads	Impact to Arkansas River	Bridge Aesthetics	Bridge Cost	Constructibility	Durability/ Maintainability	Overall Rating
Bridge Option		Structure Type	5%	15%	5%	5%	50%	10%	10%	100%
1	Match Existing RR Spans w/ Mod. River Spans	Precast Spliced Bulb-T	4	2	3	3	4.62	3	4	3.81
2		Precast Spliced U Girder	4	2	3	4	4.40	3	4	3.75
3	Moderate Span 2	Steel Plate Girder	4	3	4	3	4.42	4	3	3.91
4		Steel Box Girder	4	3	4	4	4.01	4	3	3.76
5	Long Span 3	C.I.P. Box w/Travelers	4	5	5	5	5.00	5	5	4.95

Table 5.2 Wall vs. ROW Costs

Location	**Estimated Retaining Wall Cost**	**Estimated ROW Cost**
West End Bluff (Cut) (J.C. Davis)	$125,000	$200,000 (Full)
East End – North Side (Fill) (Midtown Center)	$190,000	$60,000 (Partial)
East End – South Side (Fill) (Pueblo Imports)	$135,000	$350,000 (Full)

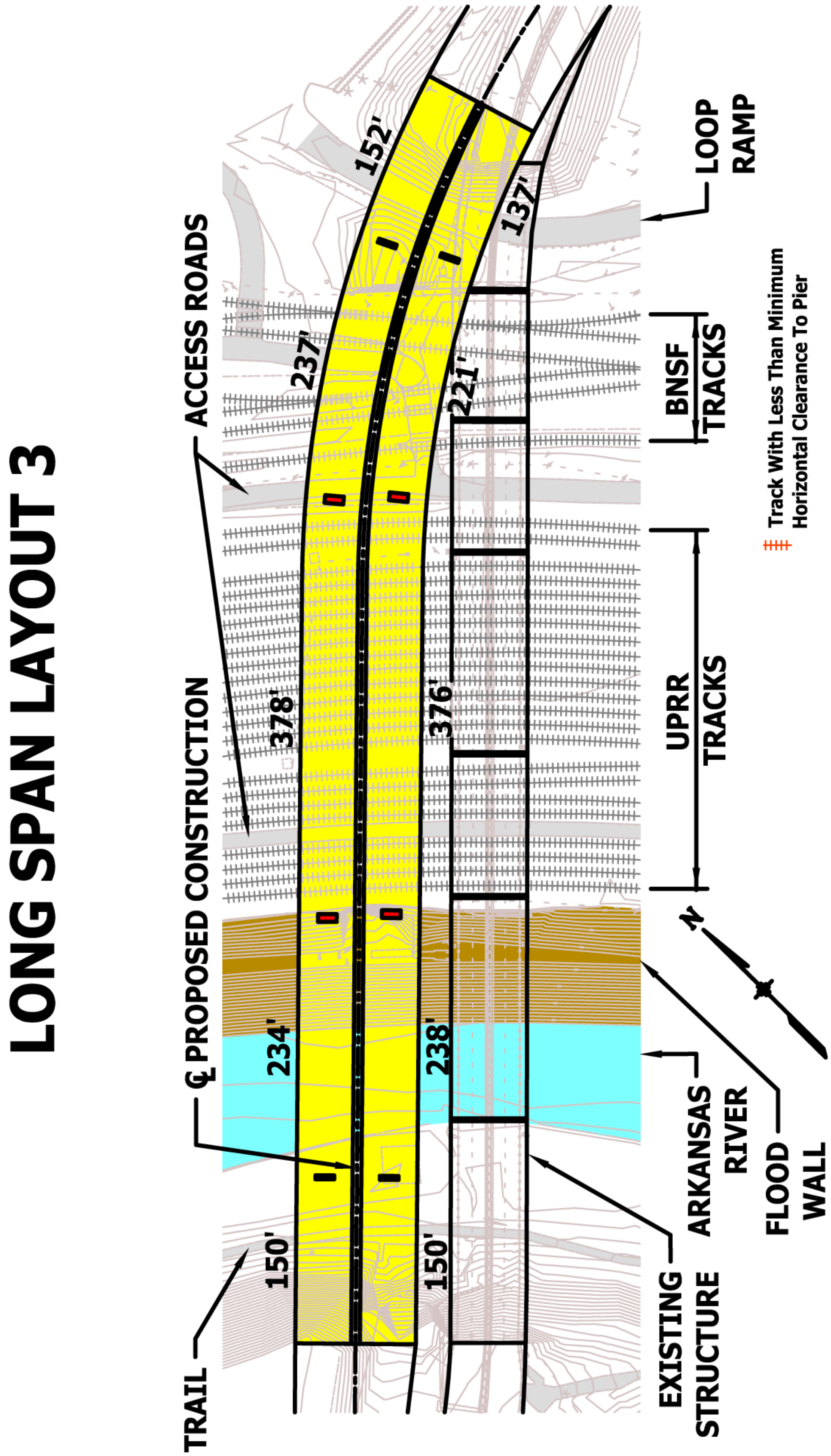

Figure 5.2 Long Span Layout 3 - Plan

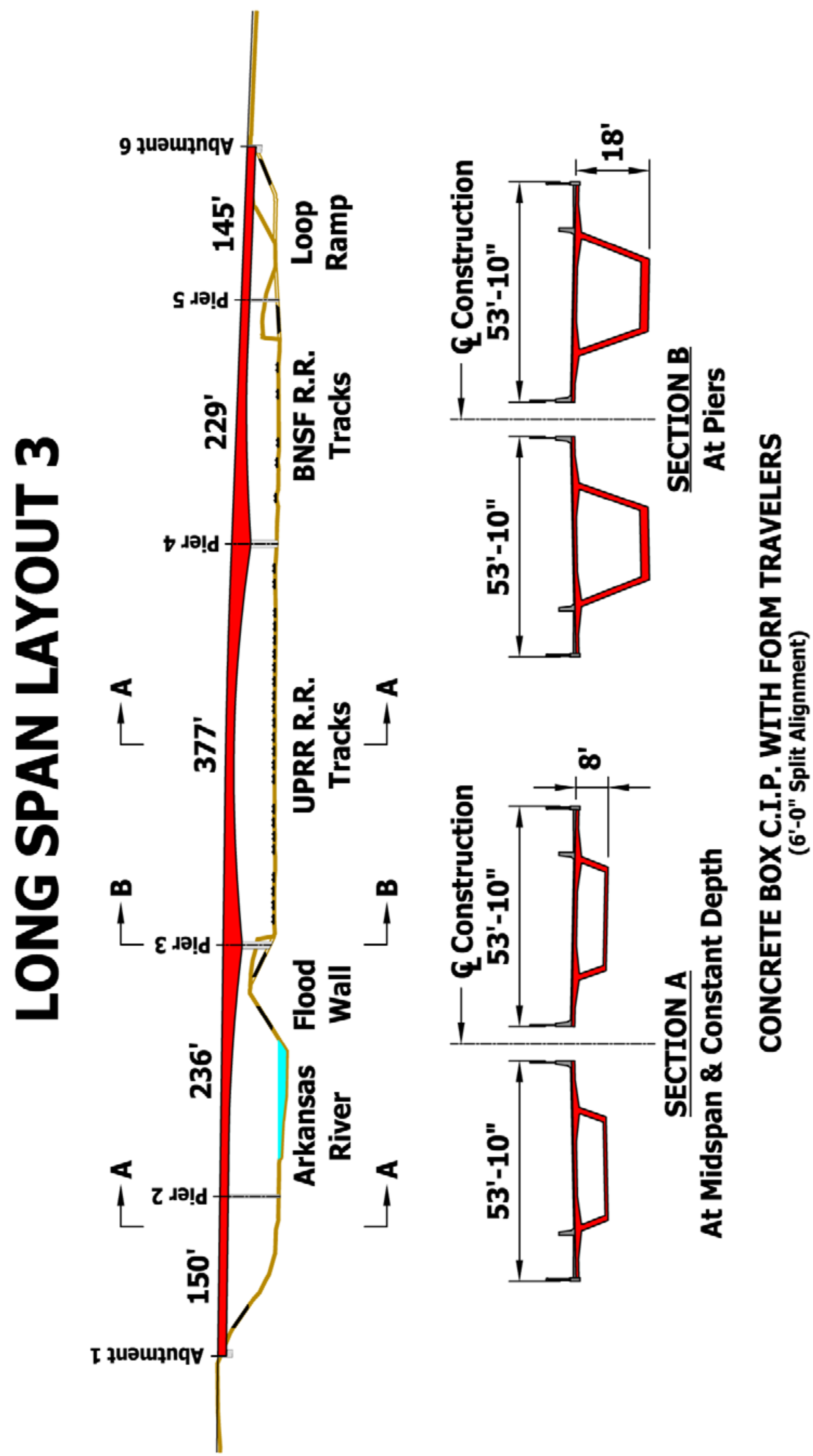

Figure 5.3 Long Span Layout 3 - Elevation