Long Bridge Project

Environmental Impact Statement (EIS)

Long Bridge Structures Study Report

March 8, 2019

District Department of Transportation

U.S. Department of Transportation
Federal Railroad Administration

Long Bridge Project EIS
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1.0 Executive Summary

The Federal Railroad Administration (FRA), jointly with the District Department of Transportation (DDOT), is preparing an Environmental Impact Statement (EIS) in accordance with the National Environmental Policy Act (NEPA) for the Long Bridge Project (Project). The Project consists of achieving four-track capacity over the Potomac River and related railroad infrastructure improvements located between the RO Interlocking near Long Bridge Park in Arlington, Virginia, and the L'Enfant (LE) Interlocking near 10th Street SW in the District of Columbia (collectively, the Long Bridge Corridor).

As part of the Project, a new two-track railroad bridge is proposed across the Potomac River, upstream from the existing Long Bridge. The existing two-track bridge is owned, operated, and maintained by CSX Transportation (CSXT). The existing bridge will either remain in use or be replaced on approximately its existing alignment to provide four-track capacity between the two bridges. The bridges will continue to serve CSXT freight trains, as well as commuter and intercity passenger service for Virginia Railway Express (VRE) and Amtrak. Norfolk Southern (NS) has operational rights on the Long Bridge Corridor but currently does not operate freight traffic at this location.

The purpose of this report is to evaluate conceptual design options and provide justification for the proposed new railroad bridge type in support of the EIS. Selection of the recommended bridge type considers factors such as vertical and horizontal clearances; structure geometry; bridge component fabrication, erection, and delivery; constructability; redundancy; accessibility for future maintenance and inspection; and aesthetics. This report does not serve as a Type, Size & Location (TS&L) Report, but is intended to narrow the number of bridge type options for the evaluation of impacts in the EIS and will be used as a foundation for developing a TS&L Report in future project phases.

This report provides background information on the existing bridge configuration, as well as evaluation of the proposed bridge location and configuration for the proposed structure types. The scope of this report is only intended for the bridge crossing the Potomac River and does not evaluate the other bridge structures affected by the overall Project. This report is developed based upon the criteria set forth by the *Long Bridge Project Basis of Design: Technical Criteria for Concept and Preliminary Engineering*.

Two primary structure types are evaluated as part of this study. These include a steel deck girder bridge and a steel through girder bridge. Each of these structure types offer various advantages and disadvantages for the proposed span arrangements, and evaluation of each structure type is provided.

2.0 Background and Existing Conditions

2.1. Bridge History[1]

The existing Long Bridge was initially constructed in 1903 by the Baltimore and Potomac Railroad (which was controlled by the Pennsylvania Railroad) and opened in 1904. The bridge ownership changed several times before CSXT acquired ownership in 1999. The bridge comprised eleven through truss approach spans and a double-span through truss swing span over the channel[2]. Of the eleven approach spans, ten of them were originally in service at the Pennsylvania Railroad's Lower Trenton Bridge across the Delaware River in Trenton, New Jersey. These truss spans were dismantled in New Jersey, moved to the Long Bridge site, and reconstructed on the new bridge piers. It is likely that the Long Bridge span arrangements were dictated by the spans that were available at the time for reuse. Only the swing-span and the northernmost[3] span were constructed new for the Long Bridge in 1903.

In approximately 1942, the through truss approach spans were replaced with through girder spans. For the modified span arrangement, new piers were built typically halfway between each of the original piers, and the span lengths were cut in half. This allowed the bridge to carry heavier loads than the original bridge, as demanded by war efforts during World War II. The new piers were built wider than the original ones to support catenary structures for railroad electrification. The electrification has since been deactivated and the steel catenary structures have been removed. The movable span has not opened since 1969, and it is currently unable to open due to the removal of the operator house in the 1970s[4].

2.2. Existing Bridge Configuration

The existing bridge carries two tracks across the Potomac River, serving CSXT freight trains, as well as passenger trains for VRE and Amtrak. The bridge is composed of twenty-two approach spans with a double-span swing span over the channel. The total length of the bridge is 2,529 feet between abutments.

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[1] More detailed history of the bridge is available through various sources and has been described in previous documents associated with the Long Bridge Project. For this report, only relevant historical information is described.

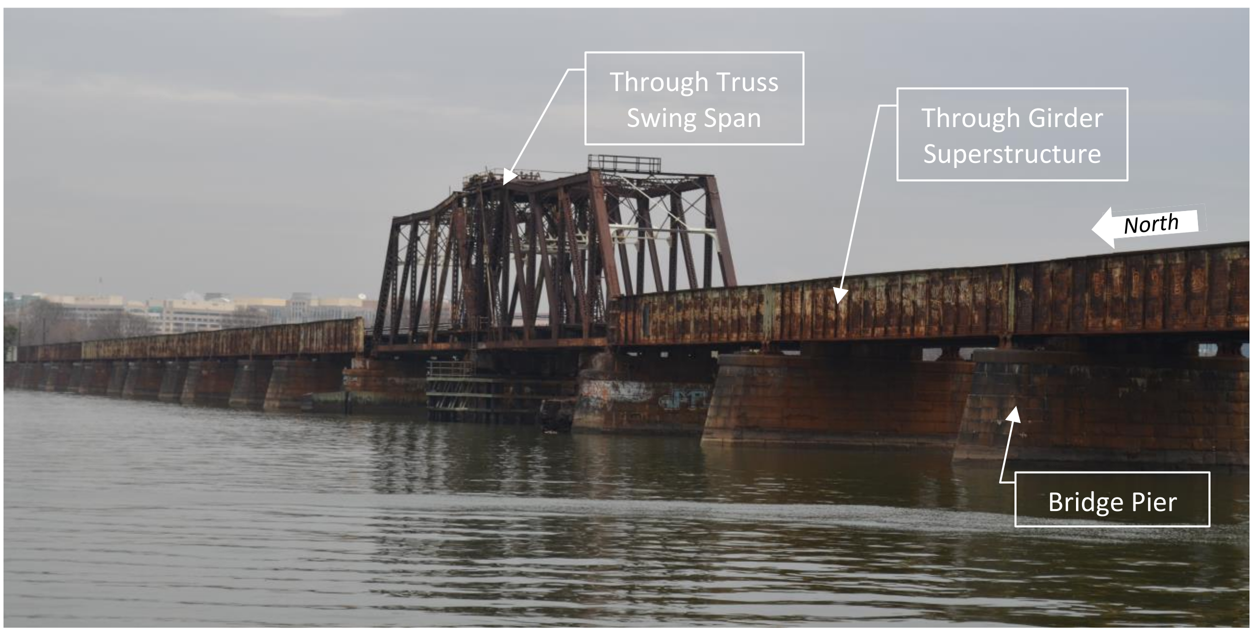
[2] "Channel spans" refer to the two spans that make up the existing swing span, which crosses the navigation channel. "Approach spans" refer to all spans between the south abutment and the swing span and between the north abutment and the swing span. Similar span descriptions are applicable to the proposed structure in this report.

[3] The existing railroad line is referenced as a north-south alignment with RO Interlocking at the southern end of the Project and L'Enfant Interlocking at the northern end. References throughout this study are made to north, south, east, and west in accordance with this track alignment, not cardinal directions.

[4] "Title 33 – Navigation and Navigable Waters: Part 203 – Bridge Regulations: Potomac River at Washington, D.C." 27 Federal Register 7411 (July 28, 1962).

Figure 2-1 | Typical Approach Spans

Figure 2-2 | Swing Span over Channel



The bridge configuration is the same as it has been since the span modifications were made in 1942. The existing bridge span lengths are as follows:

Table 2-1 | Existing Bridge Span Lengths[5]

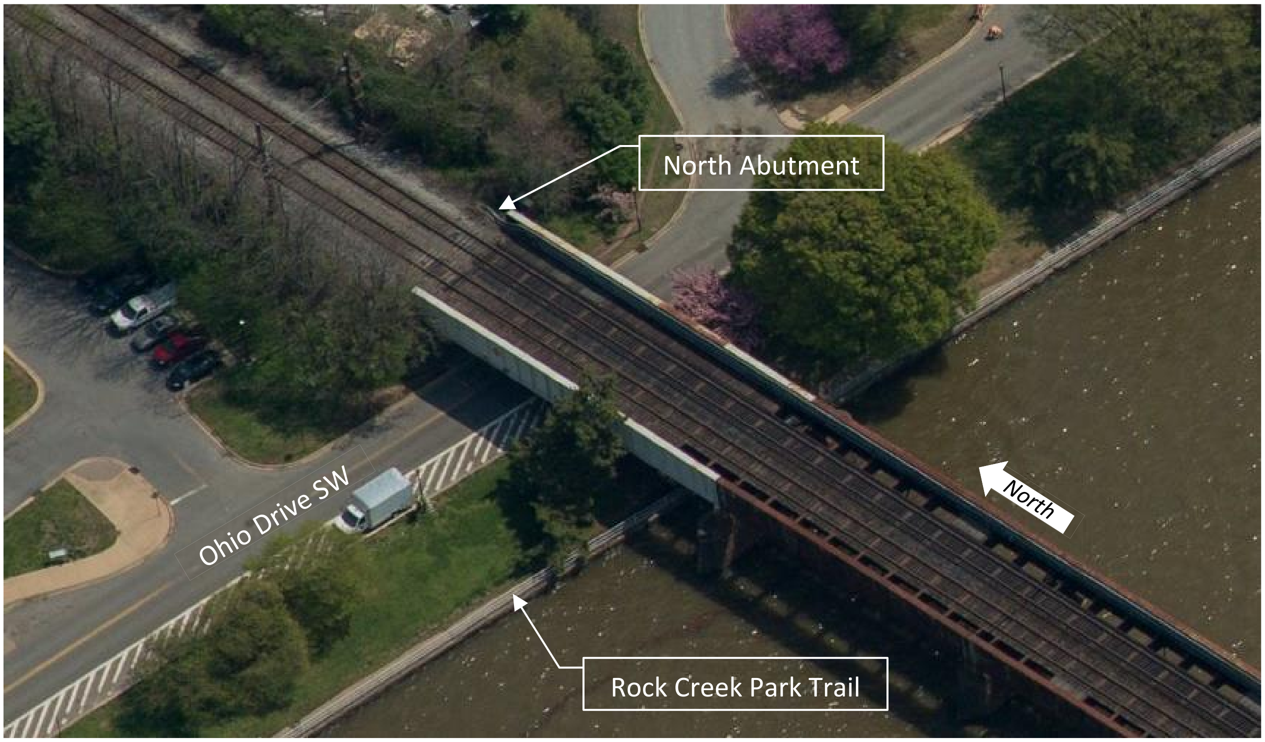
Spans 1-4	Spans 5-8	Spans 9-10 (Channels)	Spans 11-18	Spans 19-22	Span 23	Span 24
85’-1 ½”	108’-1 ½”	140’-3”	108’-1 ½”	101’-9”	92’-0”	111’-6”

At the south end of the bridge, the Mount Vernon Trail passes beneath Span 1. The south abutment and first pier are located on land in this area. At the north end of the bridge, Ohio Drive SW and the Rock Creek Park Trail pass beneath Span 24. Here, only the north abutment is located on land. Both the north and south abutments, as well as each of the existing land piers are located within the 100-year flood zone[6]. All the remaining twenty-two piers are located in the Potomac River.

Figure 2-3 | South End over Mount Vernon Trail

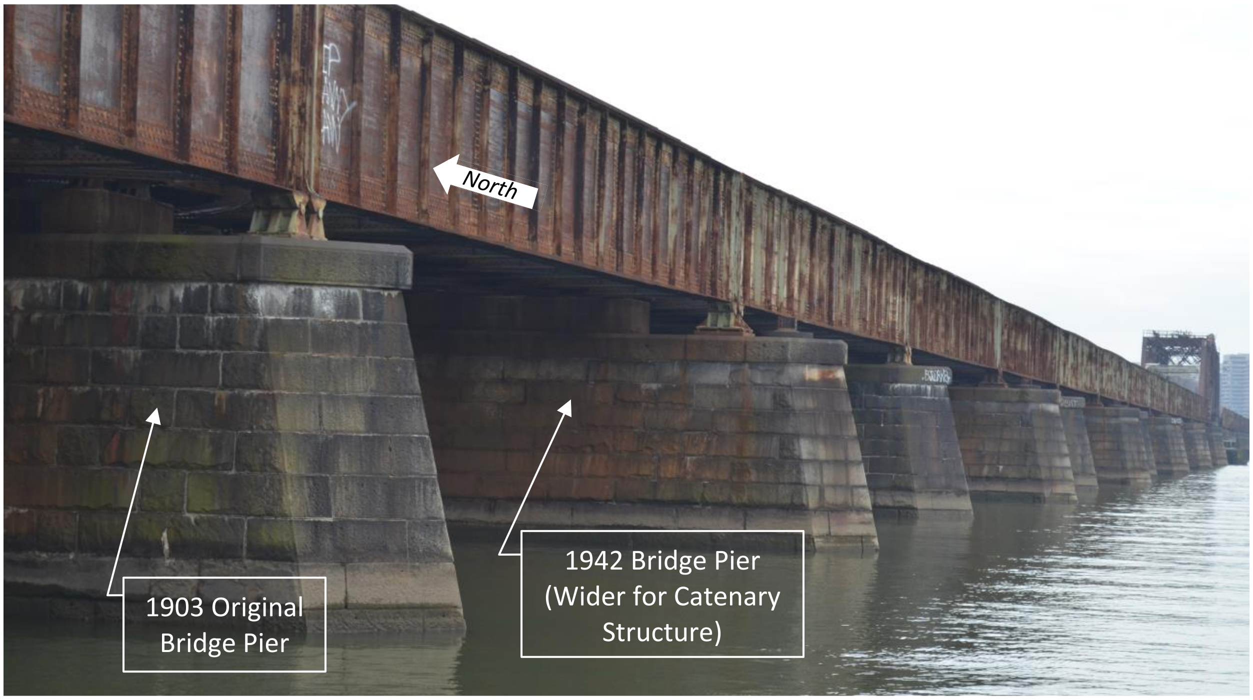
[5] For this study, the existing spans are numbered in the direction of increasing track stationing, from south to north.
[6] National Flood Insurance Program, Flood Insurance Rate Map Panel 0081C (Map Numbers 51013C0081C for south end of bridge and 1100010018C for north end of bridge).

Figure 2-4 | North End over Ohio Drive SW and Rock Creek Park Trail



The original piers from 1903 are composed of stone masonry and filled with mass concrete. The piers are topped with a granite coping. The typical piers are supported on unreinforced concrete pile caps with timber piles, and the pivot pier is supported on a solid concrete pneumatic caisson founded on rock. Additionally, the swing span end piers are supported on spread footings. The piers built in 1942 were constructed with stone masonry backed with reinforced concrete and supported on steel piles. As discussed above, the piers built in 1942 are wider than those built in 1903 to carry catenary structures. The result is a staggered pier configuration of alternating widths.

Figure 2-5 | Original 1903 Piers Staggered with Newer 1942 Piers

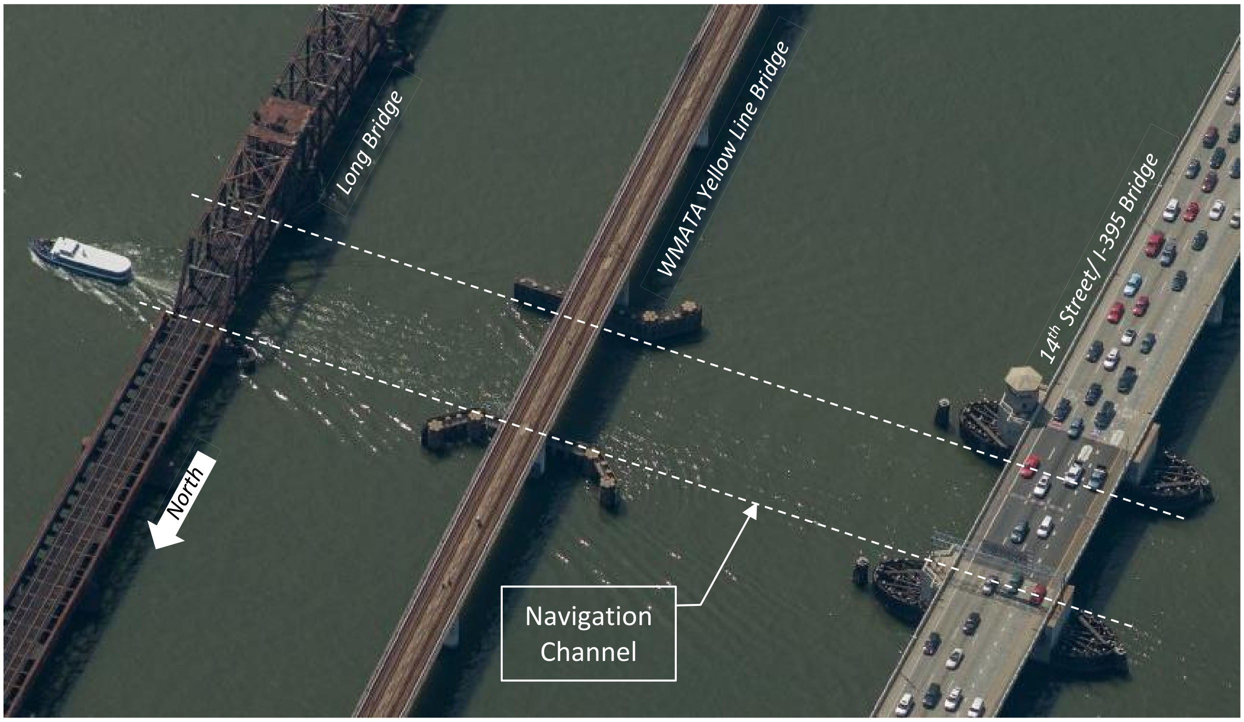


The existing abutments were constructed in 1903 and are composed of granite masonry blocks with rubble backing material. They carry the loads from the bridge superstructure, in addition to the lateral pressure from the soil and tracks directly behind them. The stacked masonry abutment stems and wingwalls are supported on timber piles.

There are twenty-two approach spans in total, eight to the south of the swing spans and fourteen to the north of the swing spans. All of the approach spans are open-deck (no solid deck or ballast beneath the tracks) through girder structures, with two tracks supported on stringers and floorbeams between the two through girders. In addition, a two-span through truss is supported on a pivot pier over the main navigation channel and originally served as a swing span to open the bridge for marine traffic in the navigation channel. The swing span structure is open-deck as well.

Since the two-span through truss pivots at the center, there are two separate channel spans separated by the pivot pier. Each of the channels provide a nominal clearance of 100 feet between the fender systems for marine traffic on the river. The north channel span (Span 10) is in line with the adjacent upstream bridges and serves as the navigation channel. The south channel span is of equal length as the north channel span, but it does not serve as an official navigation channel.

Figure 2-6 | Navigation Channel Span Arrangement of Long Bridge and Upstream Bridges[7]



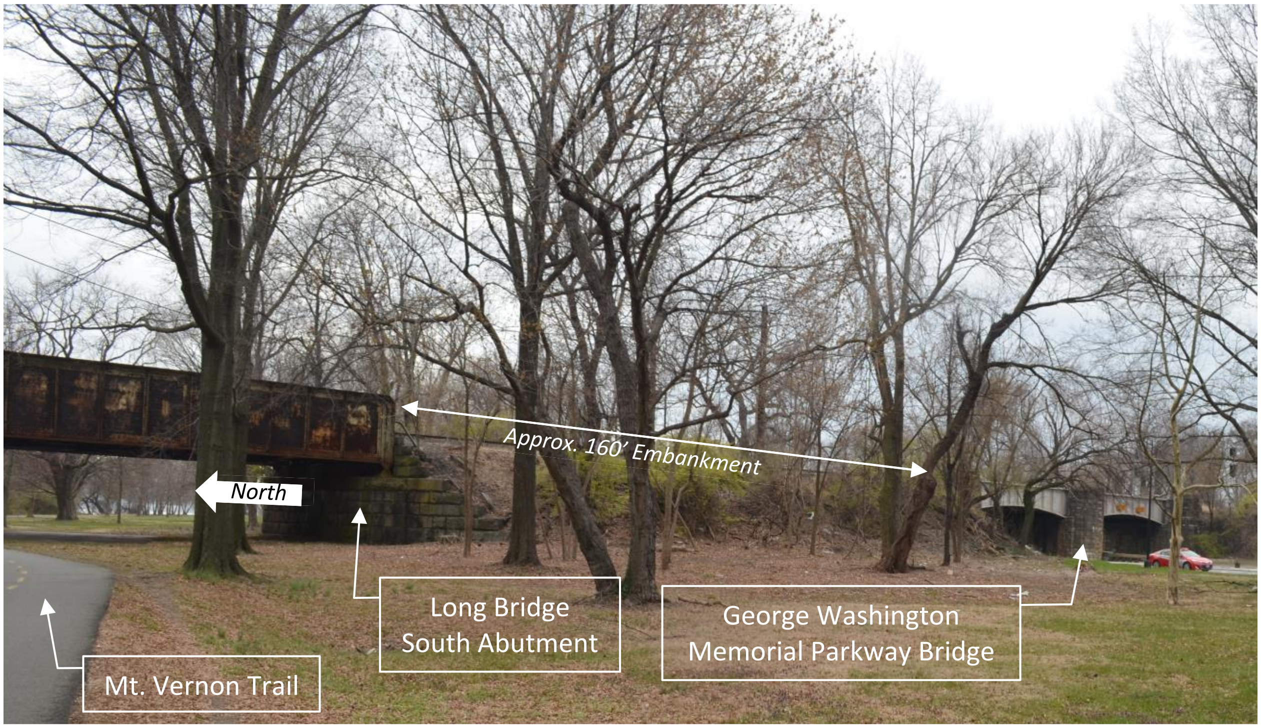
The swing span has not opened since 1969 and the Long Bridge is now considered a fixed bridge, with no ability to open for vessels taller than the maximum navigation clearance. This condition is similar at the nearest upstream bridges, including the Washington Metropolitan Area Transit Authority (WMATA) Yellow Line Bridge and the 14th Street/I-395 Highway Bridge.

The nearest structure, the WMATA Yellow Line Bridge (opened in 1983), is located approximately 175 feet west of the existing Long Bridge, measured between outside faces of the bridge superstructures. The narrowest distance between the two bridges is located at the navigation channel, measuring approximately 115 feet between the fendering systems.

At the south termination of the bridge, the track is carried on a short length of embankment before reaching a two-span, 122-foot deck girder bridge over the George Washington Memorial Parkway. The length of track carried on embankment between the Long Bridge and the George Washington Memorial Parkway bridge is approximately 160 feet.

[7] The Sanborn Map Company, Inc. Accessed from https://oblique.sanborn.com/dcocto_new/?ll=38.874418,-77.040253. Accessed May 2, 2018.

Figure 2-7 | Track Embankment beyond South Abutment



3.0 Proposed Long Bridge Configurations

3.1. Bridge Arrangements

The proposed track configurations include four total tracks across the Potomac River. For the proposed configurations, two Action Alternatives have been deemed feasible through the Level 1 and Level 2 Concept Screenings (refer to the **Alternatives Development Report**):

1. **Action Alternative A**: Construct a new two-track bridge upstream and maintain the existing two-track bridge.
2. **Action Alternative B**: Construct a new two-track bridge upstream and replace the existing structure with a new two-track downstream bridge (on same alignment as existing).

For both alternatives, the new bridges would be essentially identical to each other in type and size. Also, for each alternative, a new bridge is proposed upstream from the existing Long Bridge. Therefore, for the purpose of this study, only a single new two-track upstream structure is evaluated[8]. The upstream configuration will run parallel to the existing Long Bridge and the existing WMATA Yellow Line bridge, between the two existing structures. Over the navigation channels, a fixed span is proposed for the new bridge, with no ability to move or open for marine traffic. This fixed span condition would be similar to the adjacent upstream bridges.

The lateral offset of the proposed upstream bridge from the existing bridge will be developed during Conceptual Engineering. The offset will be driven by horizontal track alignments as well as necessary clearances from the existing Long Bridge structure and foundations. Sufficient lateral clearances between the proposed bridge and the adjacent WMATA bridge will be provided to avoid direct conflict with the proposed and existing bridge foundations and avoid damages due to vibrations resulting from the construction activities. The proposed bridge design will comply with the WMATA *Adjacent Construction Project Manual*. The lateral clearance will need to be sufficient for access during construction, inspection, and future maintenance.

The final pier locations will be developed upon selection of the Preferred Alternative as replacing the existing Long Bridge provides additional flexibility in pier locations for both bridges where retaining the existing bridge does not. channel clearances, pier locations, and navigational requirements are further discussed in the Project's Navigation Study Report completed in June 2018.

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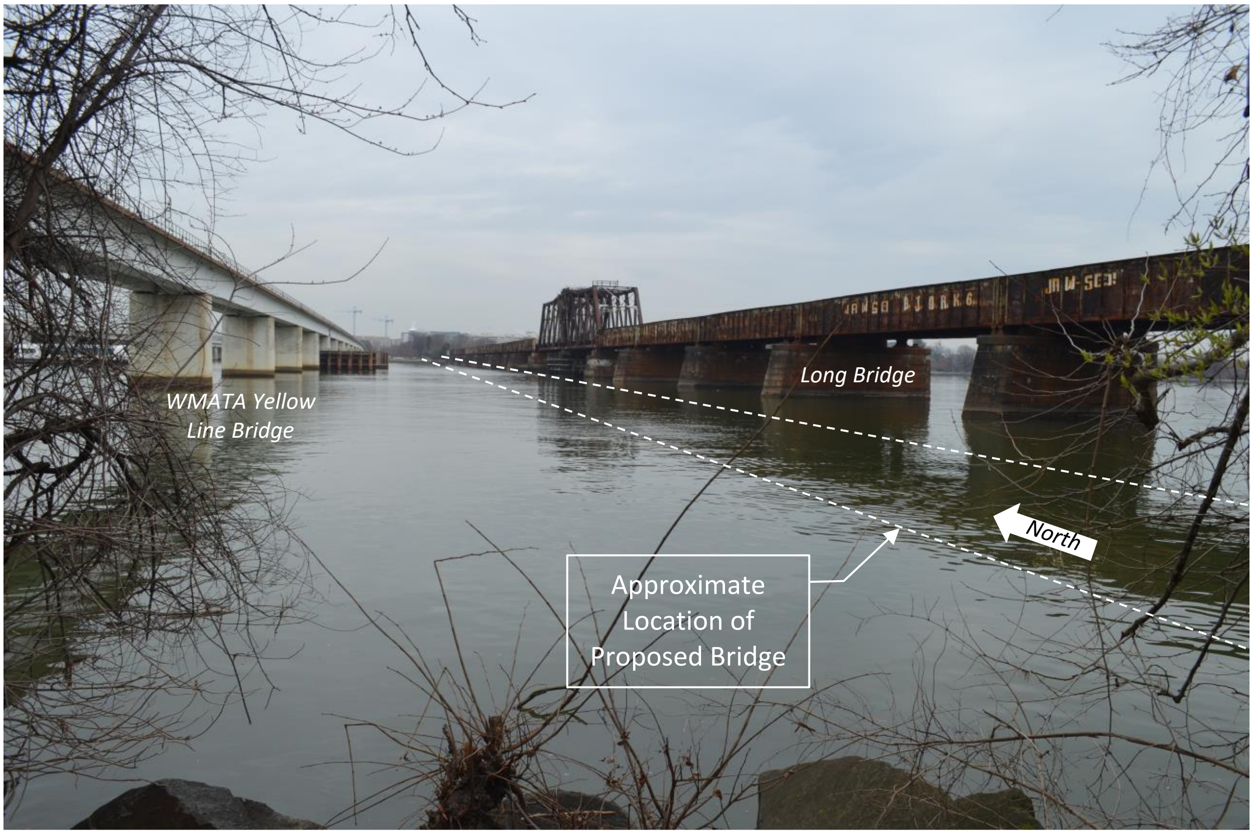
[8] For Action Alternative A, repairs or modifications to the existing bridge are not evaluated in this report. Based on discussions with CSXT and other stakeholders, it is expected that the existing structure does not require any major changes as part of this project. For Action Alternative B, it is assumed that constructability and other considerations for the new downstream bridge would be similar to the new upstream bridge. Therefore, for Action Alternative B, no additional discussion of the proposed downstream bridge is provided in this report.

Figure 3-1 | Approximate Location of Proposed Upstream Bridge (looking north)



3.2. Span Lengths and Pier Locations

For Action Alternative A, the locations of the new bridge piers in the Potomac River are proposed to remain in the same relative arrangement as the existing Long Bridge with nearly identical span lengths. Modifying the pier locations would create a staggered configuration between the existing bridge and the new upstream bridge, resulting in obstructions to marine traffic and hydraulic flow of the river. The vulnerability of all piers to scour will be assessed during later phases of design. Therefore, it is assumed that, except for some small adjustments for optimization, the proposed span arrangement will match that of the existing bridge. In addition, the proposed bridge abutments are also assumed to remain in the same configuration as existing for this study. The proposed span lengths are as follows:

Table 3-1 | Proposed Bridge Span Lengths

[9]Spans 1-4	Spans 5-8	Spans 9-10 (Channels)[10]	Spans 11-19	Spans 20-23	Span 24
85'-0"	108'-0"	140'-0"	108'-0"	100'-0"	108'-0"

If Action Alternative B is selected, and the existing bridge is replaced with a new bridge, the span lengths for both new bridges could be optimized, although the spans for both bridges would remain identical to each other. Further investigation into span optimization will be made during preliminary design.

Because the new bridge will be fixed over the channel, a large pivot pier is no longer needed. As such, the main channel pier will likely be smaller than the existing large pivot pier. All spans of the new bridge will be simply supported at the piers and abutments in accordance with the CSXT Undergrade Bridge Criteria[11].

To meet the longitudinal loads and seismic requirements of the modern design codes, foundation and pier sizes of the proposed structures will be larger than the ones supporting the existing structure. To maintain or improve the width of the existing navigable channel, a span longer than 140 feet may be necessary over the navigation channel. This may be needed due to wider piers and wider fender systems. If this navigation channel span length increases, the immediate adjacent spans (to the north and to the south) will have to be shortened to avoid repetitive staggering of existing and proposed piers. The north channel span will cross the navigation channel, in line with the existing upstream bridges.

3.2.1. Additional Considerations

The District of Columbia Water and Sewer Authority (DC Water) is in the process of implementing its Combined Sewer System Long Term Control Plan (LTCP). As part of the LTCP, a Potomac River Tunnel (PRT) is planned, with its alignment passing beneath the northern end of the Long Bridge in the river[12]. The precise alignment is yet to be determined, but it assumes the existing Long Bridge to be in place. This is further reason to match the proposed pier locations with the existing bridge piers, ensuring clearance of the PRT.

As discussed, this study assumes the proposed pier and abutment locations will match existing. However, consideration may be made during design phases to lengthen the span over the navigation channel (see above). In addition, at the southern terminus of the existing bridge, the track is carried on a short segment of embankment before crossing the George Washington Memorial Parkway bridge (see **Figure 2-7**). In the approximate location of the new upstream bridge south abutment, no embankment currently exists. It may be feasible to continue the Long Bridge beyond the existing abutment location and extend the bridge across George Washington Memorial Parkway. In this case, the proposed

[9] For this study, the proposed spans are numbered in the direction of increasing track stationing, from south to north.
[10] While two spans of similar length will exist, the official navigation channel will exist under Span 10 only, similar to the existing bridge.
[11] Undergrade Bridge Criteria. July 2017. *CSXT Public Project Information Manual*, pp.87.
[12] Wone, Moussa. January 12, 2018. *Long Bridge Project Proposed Alternatives DC Water Comments*.

abutment would be on the south side of the parkway and the overall bridge length would be extended by several spans. This concept may be explored further during later phases of design.

3.3. Bridge Clearances

3.3.1. Train Equipment Clearances

On the new bridge, 15-foot track spacing is proposed. In addition, 9 feet of minimum horizontal clearance is required between centerline of track and the nearest obstruction[13]. Therefore, at a minimum, the lateral clearance between obstructions on tangent track is 33 feet. In areas of track curvature, additional horizontal clearance may be needed to accommodate the superelevated train car envelope. At all locations, vertical clearances on the bridge will be made to handle Plate H equipment (double-stacked intermodal containers). For the main structure types considered, discussed in following sections, no overhead obstructions are expected. Additionally, the design will not preclude the potential future installation of overhead contact systems (refer to **Section 7.2**)[14]. Refer to the **Appendix** for typical sections of the bridge.

3.3.2. Navigation Channel Clearances

According to NOAA Nautical Chart US12285, the vertical clearance beneath the existing swing span over the navigation channel is 18 feet measured from mean high water (MHW) to bottom of steel. The new bridge is proposed to provide a vertical clearance over the navigation channel that exceeds existing conditions.

The existing nominal channel clearance, measured between the fender systems is 100 feet. The proposed navigation channel will be located in the same location as existing and is proposed to match or, if practical, improve the existing clearance.

3.3.3. Roadway and Trail Clearances

At the north end of the bridge, Span 24 crosses Ohio Drive SW[15] and the Rock Creek Park Trail. A vertical clearance sign posted on the existing bridge above the road indicates a clearance of 12.5 feet. The DDOT Design and Engineering Manual indicates that the minimum vertical clearance for overhead structures over roadways is 14.5 feet[16]. The new bridge is proposed to meet or exceed the DDOT minimum for this span over Ohio Drive SW.

At the south end of the bridge, Span 1 passes over the Mount Vernon Trail, which is operated by the National Park Service (NPS). Further clarification is required to determine the preferred minimum vertical clearance over the trail, but it is assumed for this study that the proposed vertical clearance will

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[13] Undergrade Bridge Criteria. July 2017. *CSXT Public Project Information Manual*, pp.83-84.

[14] Note that CSXT will not allow any overhead electrification structures to be constructed over the tracks envisioned to be operated primarily by freight trains, nor will it allow overhead electrification structures on any track that it owns and maintains.

[15] Note that there are two segments of Ohio Drive SW within the project limits. This report is only referring to the segment that passes under Span 24 of the Long Bridge. The other Ohio Drive SW crossing is further north, station ahead, and is not discussed as part of this report.

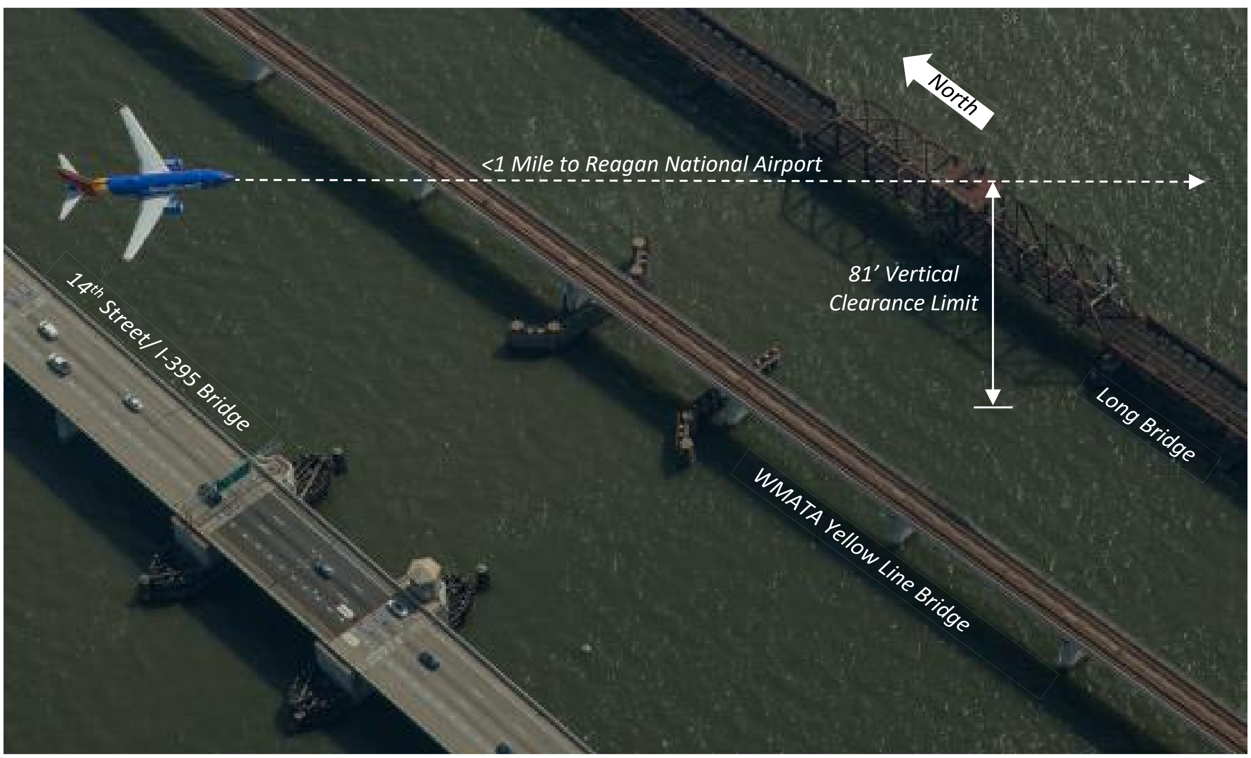
[16] Bridge Geometrics. June 2017. *DDOT Design and Engineering Manual*, pp.13-3.

meet or improve the existing condition. The existing bridge over the George Washington Memorial Parkway is posted as low as 12'-5" and up to 13'-11". If Action Alternative B is selected in which the existing Long Bridge is replaced, then the vertical clearance for the new bridge over the George Washington Memorial Parkway is anticipated to be improved to 14'-6". If Action Alternative A is selected, the existing bridge will remain and the new bridge west will meet or exceed the maximum existing vertical clearance. The existing fascia girders of current bridge have visible impact damage from over-height vehicles and any clearance improvements would be beneficial in reducing the likelihood of impact from over-height vehicles.

3.3.4. Overhead Aviation Clearances

The Long Bridge site is less than a mile from Ronald Reagan Washington National Airport (DCA). A common flight path for plane landings passes directly over the existing and proposed bridges. Given the proximity to DCA, the Federal Aviation Administration (FAA) has stringent vertical clearance limits for all structures and any construction equipment. At the Long Bridge site, the upper limit of this vertical clearance is measured 81 feet above mean sea level[17]. The proposed bridge structure and any construction equipment are prohibited from breaching the clearance limit at any time.

Figure 3-2 | Bridge Relative Proximity to Airplane Flight Paths[18]



[17] Schwenke, Erik N (Metropolitan Washington Airports Authority). "Re: Long Bridge Project EIS Scoping." Message to Amanda Murphy (FRA). 06 October 2016. E-mail.
[18] The Sanborn Map Company, Inc. Accessed from https://oblique.sanborn.com/dcocto_new/?ll=38.874115,-77.039939. Accessed May 1, 2018.

3.4. Track Profiles

The vertical clearances beneath the bridge are restricted at the navigation channel, Ohio Drive SW, the Rock Creek Park Trail, and the Mount Vernon Trail. In order to meet the proposed vertical clearances over each of these facilities, the track profile of the new bridge will be higher than existing. The increase in profile is a result of several considerations:

- The existing bridge is an open-deck structure, and the proposed bridge is a ballasted deck structure (see **Section 4.0** for discussion of necessity for ballasted deck). This requires the new bridge to have a solid deck, in addition to twelve inches minimum of ballast. These added depths result in increased track profiles.
- The addition of ballast and the solid deck increases loading on the span, and this requires deeper girders to carry the load.
- Modern live load requirements of CSXT demand significantly deeper girders than the existing bridge (see **Section 4.0** for discussion of the loading requirements).
- The proposed clearances and proposed structure types over the George Washington Memorial Parkway (next crossing south of Long Bridge) and I-395 (next crossing north of Long Bridge) affect the track profile along the north and south approaches of the new Long Bridge. The requirements at each approach result in overall track profile raises.

For each of the structure types considered in this study, the effects of the structure depth are discussed in the following sections. During later phases of design, track and bridge construction staging will be further developed to address changes in track profiles during construction and in final condition.

4.0 Structure Types Considered

Two main structures types for the proposed bridge are considered in this study, including a steel through girder bridge and a steel deck girder bridge. These are common structure types for railroad bridges in the United States and are the two standard types used by CSXT. In addition, these structure types are considerably more cost effective than other structure types. The shallow depth of the structure over the navigation channel precludes the use of concrete girders at this location. For uniformity, only steel girders are proposed, but concrete girders could be utilized where the depth of the structure is not limited by vertical clearance. Additionally, a concrete superstructure would require deeper and heavier girders, resulting in significantly larger substructures and foundations. The result would be an uneconomical structure.

The deck girder and through girder bridge types are investigated for the approach spans as well as the channel spans. It is expected that all of the approach spans will be of a similar structure type, either all deck girders or all through girders, unless vertical clearance requirements over the roadway network require through girder construction for a specific span. The main navigation channel span structure type may deviate from the approach spans. Each of these considerations are discussed in the following sections.

For assessing the structure types in this study, CSXT Undergrade Bridge Criteria, as specified in the Public Project Information Manual, are followed. These criteria include several specific considerations that have significant implications on the structural design, including[19]:

- Live loads shall consider Cooper E-90 loading[20].
- Bridges shall be designed with non-composite interaction between the superstructure and concrete deck[21].
- Dead load shall consider weight of one foot of ballast plus an additional two feet of future ballast below the tie.
- Bridge decks shall include a ballast walkway on the outsides of the clearance envelope.
- Exterior walkways shall be equipped with a 72-inch-tall parapet wall.
- Concrete deck overhang shall not exceed 18 inches from centerline of girder to edge of deck.
- For through girder bridges, no intermediate girder is permitted between the tracks.

Regardless of the superstructure type selected for design, the bridge is expected to carry ballasted tracks on top of a closed deck system. An open deck bridge is not considered for this study since it will not meet the requirements of CSXT standards and may preclude the use of future high-speed trains. In

[19] The criteria listed is taken directly from various sections of the CSXT Public Project Information Manual, Appendix for Undergrade Bridge Criteria.
[20] Cooper live loading is the standard basic live load used for railroad bridge design. The American Railway Engineering and Maintenance-of-Way Association (AREMA) typically uses Cooper E-80 loading and is common industry-wide for most United States railroads. The Cooper E-90 loading preferred by CSXT is greater than the typical E-80 loading by a factor of 90/80 = 1.125. The increased loading results in larger structural members.
[21] Non-composite means that the steel girders of the bridge are not fixed to the concrete deck, thereby eliminating the ability of the steel and concrete to share superimposed loads. This design approach results in larger and deeper bridge girders.

addition, the bridge is expected to allow for maintenance access and emergency passenger egress either through ballasted walkways or structure-mounted walkways on the bridge. The details and locations of the walkways will be determined during design. The two evaluated structure types are discussed in the following sections, followed by a comparison of advantages and disadvantages of each.

4.1. Steel Deck Girder Bridge

The first structure type considered in this study is a steel deck girder bridge. For this type, the superstructure is composed of a reinforced concrete deck carried on multiple longitudinal steel plate girders. In accordance with the CSXT Undergrade Bridge Criteria, the steel beams and concrete deck are designed as non-composite and includes a 72-inch-tall concrete parapet on each side of the bridge. Steel cross frames and bracing are expected to be integrated into the bridge to provide stability and resistance to lateral loading.

The load path from the tracks is through the ballast to the concrete deck, then directly to the girders, and finally to the substructures. This load path allows multiple girders to share the load from each track. As such, an optimal configuration of the bridge superstructure may include six girders per span.

Typically, deck girders are preferred in locations where vertical clearance is not a concern, as they provide a redundant structure. For this design type, the top of the girder can support the deck, thereby eliminating the need for a floor system (as is required by a through girder bridge). Where the track profile is limited, the deck girder option presents difficulties in providing sufficient vertical clearance beneath the bridge and through girder systems shall be considered. For the new Long Bridge structure, there is sufficient vertical clearance for deck girder construction over the river spans, but the track profiles need to be higher across the bridge and along the north and south approaches. Through girder construction is anticipated for specific land spans to provide sufficient vertical clearance over Ohio Drive SW and the Rock Creek Park Trail.

The CSXT design criteria limits the concrete deck overhang to 18 inches, measured from centerline of fascia girder to the edge of concrete. Evaluation should be made during preliminary design to waive this criterion, as the superstructure could be made more efficient with larger overhangs. Refer to the **Appendix** for typical sections of the steel deck girder bridge concept.

4.2. Steel Through Girder Bridge

The second type of structure evaluated in this study is a steel through girder bridge. This structure type comprises two longitudinal deep fascia girders with closely spaced transverse floorbeams spanning to the girders. A steel deck plate is supported on the floorbeams and functions to carry the ballasted tracks. Additionally, tapered floorbeam brackets, or knee braces, are anticipated to resist lateral loading applied to the girders. These brackets infringe on the space between the girder and the track, requiring the bridge to be widened to provide sufficient clearance.

For this design type, the load from the tracks is carried through the ballast to the steel plate, then to the floorbeams, to the through girders, then to the substructures. Each of the two girders would essentially carry all loading from a single track. As such, the through girders are very deep for the proposed span lengths.

The advantage of a through girder bridge is the shallow depth of the structure beneath the tracks. Because the main load carrying members are placed on the outside of the tracks, the only members governing the floor system depth are the floorbeams. However, this also makes the through girder bridge less economical than deck girders due to the considerable amount of steel and labor needed for the floorbeams and deck plates. To minimize the length of the floorbeams, the walkway could be mounted along the outer side of the fascia girders. Refer to the **Appendix** for typical sections of the steel through girder bridge concept.

4.3. Previously Studied Structure Types

A previous Long Bridge Study[22], performed in January 2015, presented four other structure types: tied arch bridge, through arch bridge, extradosed/cable-stayed bridge, and a deck arch bridge. Each of these structure types would be considered signature bridges, with construction costs expected to be greater than a deck girder or through girder bridge.

A detailed evaluation of the structure types proposed during the previous Long Bridge Study is not part of this report. However, each of those structure types can be dismissed for being impractical or infeasible for this project, for both approach spans and channel spans, as described in the following sections.

4.3.1. Tied Arch Bridge and Through Arch Bridge

The tied arch bridge and the through arch bridge concepts previously presented had conceptual structure depths of 57’-6” and 62’-6”, respectively, measured from bottom of tie-girder to top of the arch. Including the vertical clearance of the channel, both structure types would exceed the FAA clearance limits during construction during the erection process and given these are only concept structure depths, possibly also in final condition. In addition, these structure types would be cost-prohibitive due to their complex design and major constructability challenges.

4.3.2. Extradosed/Cable-Stayed Bridge

The extradosed/cable-stayed bridge concept that was previously presented is technically impractical and presents significant structural challenges. The modern design and loading requirements would result in major fatigue concerns in the cables, which is a reason that this structure type is very uncommon in the United States for railroad crossings. This structure type would also have a height that exceeds the FAA clearance limits. Like the tie arch and through arch types, the extradosed/cable-stayed concept would be significantly costly when compared to the deck girder and through girder types.

4.3.3. Deck Arch Bridge

A deck arch bridge is infeasible due to the required height of the structure. The arch ribs would require the top of deck to be much higher than existing, resulting in a track profile that is not feasible. Similar to the other bridge types previously presented, this bridge type would be very costly and would require a significantly longer construction schedule, making it impractical for this project.

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[22] Refer to the “Long Bridge Study”, particularly Appendix G: Engineering Plans, from January 2015, as submitted to DDOT.

4.4. Other Structure Types

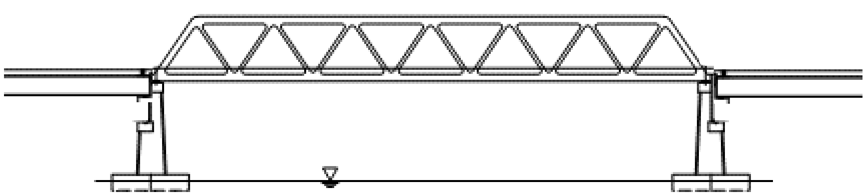
As discussed above, the deck girder and through girder bridge types are preferred by CSXT and are the typical structure types used for railroad bridge design in the United States. These structures are significantly more cost-effective than signature-type or complex structure spans. Two additional bridge types were initially considered for the proposed structures, but each have significant limitations. These bridge types include a through truss bridge and a delta frame bridge. Both are described in the following sections but are not further evaluated in this report due to the limitations of their design and construction for this project, as well as cost implications.

4.4.1. Through Truss Bridge

The simplest and most common alternative span type for railroad loading is the through truss bridge. This structure type comprises multiple steel members that connect together to form triangular openings. A single truss is provided on each side of the bridge, with transverse floorbeams supporting the track structure. Additionally, transverse struts span between the tops of each truss, providing lateral strength and stability.

A truss bridge is advantageous because it can be composed of efficiently sized steel members to carry heavy loads over long span lengths. Most railroad entities are very familiar with trusses with regard to inspection, maintenance, and repair work. In addition, a truss can incorporate a shallow floor system that would essentially match that of the through girder bridge option. This bridge type would have the ability to eliminate the central pier between the two channel spans, resulting in a single, longer span. Alternatively, in the approach spans, piers could be eliminated due to the ability of the truss to span longer lengths.

Figure 4-1 | Through Truss Bridge Concept



Several drawbacks to a truss bridge exist for this project. A truss is only economical for long spans. As such, it would only be practical for spanning over the channel or in the approaches if piers are eliminated to lengthen the spans. Trusses in the approach spans would have a significant impact on the aesthetics of the bridge and the surrounding environment. Also, while a truss over the channel would be similar in appearance to the existing bridge, it may still be undesirable from an aesthetic perspective.

Another disadvantage of this bridge type is that members of the truss are fracture critical[23] and trusses are not as redundant as other systems such as the deck girder bridge.

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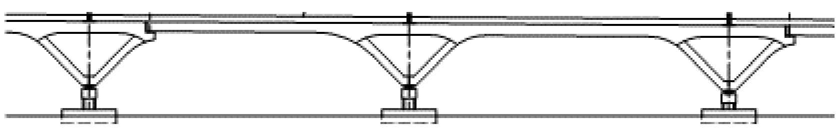
[23] The term "fracture critical", as used throughout this document, refers to steel members in tension whose failure would be expected to result in collapse of the bridge span. In general, structures with fewer main load-carrying members are more susceptible to being fracture critical. A span with more than two main load-carrying members

In terms of constructability, the truss would have to be stick built over the channel with the use of small cranes. The stick building method will a require long-term closure of the navigation channel. Another construction method could consist of assembling the truss on the shore line and moving it along the track alignment to its final location. Regardless of construction methods, the overhead FAA clearance will limit the size of cranes and may complicate the ability to construct a truss span. The overall structure height of the through truss would be greater than the through girder or deck girder options.

4.4.2. Delta Frame Bridge

A delta frame bridge would deviate significantly from the deck girder or through girder span types. This structure type comprises triangular shaped steel frames with girders spanning between them. The triangular shapes form a delta frame that would be supported on shallow height concrete piers.

Figure 4-2 | Delta Frame Bridge Concept



This bridge type may be able to span longer lengths than the deck girder bridge with shallower girders. Since the delta shapes impose on the clear span between piers, it would be required to modify the span arrangements from existing to a more efficient layout.

Several challenges with the delta frame bridge seem to make the structure type infeasible for this project. First, the track vertical profile would have to be raised significantly to make the delta shape appealing. Second, the lower portions of the steel superstructure would be more readily accessible to the public, which has serious safety and security concerns. Third, the vertical clearance at the navigation channel would require the span length to be increased due to the delta shape at the piers. Lastly, the delta shape is likely to present hydraulic issues during high water conditions.

has greater structural redundancy than a span with only two load-carrying members. Fracture critical spans require additional material testing and fabrication costs, additional steel to provide internal redundancy, and increased life-cycle costs due to more stringent inspection requirements.

5.0 Structure Type Comparison

The deck girder bridge and the through girder bridge are the most appropriate structure types that accommodate this project, and therefore are the recommended options for further evaluation. Advantages and disadvantages exist for both the deck girder and the through girder structure types considered. In particular, variations in the geometry, fabricability, constructability, and aesthetics for the two types may influence the final structure selection.

5.1. Structure Geometry

The following table lists approximate geometric information (based on conceptual-level design) for both the deck girder bridge type and the through girder bridge type, and dimensions are provided for the typical approach spans and the channel spans. These dimensions may be refined during later phases of design. Note that the through girder depths are significantly larger than the existing bridge due to widened track spacing, increased design live loading, and increased dead load due to the ballasted track (existing is open-deck).

Table 5-1 | Approximate Dimensions of Evaluated Structure Types

		Girder Depth	Visible Depth[24]	Floor System Depth[25]	Superstructure Width[26]	Pier Width
Approach Spans	**Deck Girder**	7'-6"	14'-6"	8'-6"	36'-0"	42'-0"
	Through Girder	11'-6"	11'-6"	4'-9"	41'-0"	48'-0"
	***Existing**	*10'-6 ½"*	*10'-6 ½"*	*4'-11 ½"*	*36'-6"*	*60'-0" (±)*
Channel Spans	**Deck Girder**	10'-0"	17'-0"	11'-0"	36'-0"	42-0"
	Through Girder	17-0"	17'-0"	4'-9"	41'-0"	48'-0"

**Existing structure depths provided for approach spans for comparison. Existing channel span is a through truss and is not comparable to proposed spans.*

In order to provide the required vertical clearances over the Potomac River, the bottom of girder elevations must be held to specific elevations. Therefore, as the floor system depth increases, the track profile elevations also must be raised. It is prudent to keep the track profile as close to existing as possible to avoid unnecessarily steep track grades from the approaches leading up to the river bridge. Therefore, it is also ideal to minimize the floor system depth as much as possible. During Conceptual

[24] Visible Depth is measured from top to bottom of superstructure. This is the resulting depth of superstructure that is visible in elevation view of the bridge to an outside viewer. For the deck girder option, this is measured from top of parapet to bottom of girder. For the through girder option, this is measured from top to bottom of the girder.

[25] Floor System Depth is measured from top of deck to bottom of steel girder. This is the structural depth that varies between bridge types and design criteria in meeting vertical clearance over the Mean High Water (MHW) elevation and adjusting the track profile elevations. The depth of stone ballast, timber ties, and steel rails are all constants.

[26] Superstructure Width is the minimum possible dimension on tangent track, measured out-to-out of the superstructure.

Design, the allowable floor system depth will be determined based on vertical clearances and track profiles.

Because the deck girder bridge option comprises deeper longitudinal girders beneath the tracks, this structure type has a deeper floor system depth (measured from top of deck to bottom of steel superstructure). The result is a track profile with higher elevations. Limitations in track profile grades may cause design challenges for the deck girder option. This will be further evaluated during design.

On the other hand, the steel through girder bridge utilizes deep longitudinal girders on the outside of the track envelope (one girder on each side). For the through girder bridge, the floorbeams dictate the floor system depth, and the result is a shallower system. This allows the track profile to be lower, more closely matching existing conditions. The lower profile may result in minor cost savings due to slightly reduced embankment fill, shorter abutment heights, and shorter retaining walls in the approaches. These cost differences will need to be compared with differences in steel fabrication and erection costs as well as increased superstructure and pier widths as outlined in **Table 5-1** above.

At the northernmost span (Span 24) of the proposed bridge, the vertical clearance over Ohio Drive SW is proposed to be improved from existing conditions. For this span, and any other spans over roadways and trails, the through girder may prove advantageous. Even if the typical approach spans are deck girder spans, through girders can still be used over the roadways to improve the track profile, while maintaining sufficient vertical clearances.

The superstructure width varies between the deck girder and through girder options. For the deck girder option, the width is primarily dictated by the track spacing and the horizontal clearance to the inside face of the concrete parapet. The through girder superstructure width is similarly determined, but the width is increased slightly to provide clearance for the knee braces.

5.2. Structure Fabricability and Material Transportability

The conceptual deck girder bridge is not expected to face any fabrication or transportation issues for either the approach spans or the channel spans. The plate depths and thicknesses are within common limits and could be handled and manufactured by a typical steel shop.

The steel plate girders for the through girder approach spans are reaching the size of the largest girders fabricated regularly by steel fabricators and transported by truck. For the through girder channel spans, however, the girders are nearly 17’-0” deep. This presents several fabrication and transportation challenges. The depth of the web exceeds the maximum size of the plates commonly produced by steel mills. Splicing the web longitudinally either by field bolting or shop welding will be required. Welds of this type may be manageable but are undesirable. To keep the thickness of the web plate reasonable and the weight manageable, longitudinal stiffeners will be required to prevent buckling. In addition, the handing of girders this size would be challenging to handle in the shop and even more challenging to handle in the field due to the 81-foot FAA clearance.

5.3. Constructability

Constructability is an important consideration for selection of structure type for the proposed bridge. Environmental protection rules, physical site constraints, and site accessibility limit the size of the bridge members and the type of construction equipment that can be mobilized. The proposed bridge is located between the existing Long Bridge and the upstream WMATA Yellow Line bridge, resulting in limited horizontal clearance for construction activities.

The navigation channel must remain open during most of the construction. It is anticipated that only temporary restrictions of the use of the navigation channel will be required during delivery of large equipment or material, installation of the channel span steel superstructure, and installation of the protection system for the piers adjacent to the channel. Long-term restrictions to marine traffic will only be required in the area of the proposed approach spans for safe construction operations. It is also important to note that recreational and non-motorized vessels use the approach spans extensively and access for these uses will need to be maintained during construction.

Typically, the use of large cranes is required for installing deep foundations, placing rebar cages, lifting girders, and moving other heavy materials. As discussed above in **Section 3.3**, the FAA has established clearances requirements that limit the length of the boom of the cranes. The characteristics of 80-foot boom cranes may not meet the typical requirements for installation of deep foundation and erection of steel girders. It will also be difficult to maneuver a barge-mounted crane of the size required under the existing span.

In addition, shipping in materials on the Potomac River is limited by the vertical clearance of the existing navigation channel at the existing Long Bridge, as the existing bridge is to remain in service at all times. Material barged in cannot exceed the vertical clearance and may be required, in some instances, to be brought into place from landside access points.

Other means and method of construction may be considered during the design of the structure, including the following:

- Crane with telescoping booms if the FAA limit can be increased during short windows or under certain wind conditions.
- Temporary trestles and finger piers to optimize placement of the cranes and reduction of their reach.
- Rolling gantry supported on temporary piles in the water.
- Incrementally-launched bridge spans.

Temporary closures or diversions of the Mount Vernon Trail may be required during installation of the proposed superstructure in the area. Similarly, temporary closures of the Rock Creek Park Trail and Ohio Drive SW are expected.

5.3.1. Deck Girder Bridge Constructability

For the deck girder bridge type, constructability is not a major concern. The superstructures of this type of bridge are erected span by span, girders after girders. Cross frames and lateral bracing would then be attached. Temporary forms would be installed and the concrete deck poured in place. To accelerate the construction of the deck, full depth precast panels should be evaluated. They could be delivered by the rolling gantry if this equipment was used for earlier construction phases.

The proposed 7’-6” deep and 10’-0” deep plate girders can be delivered to the site by trucks in their final vertical position and erected with one of the methods discussed in **Section 5.3**. Vertical clearance beneath the existing Long Bridge is sufficient for final delivery on barges as well. Compared to the through girder, this deck girder option with its multiple line of beams reduces the weight of the crane picks.

5.3.2. Through Girder Bridge Constructability

The through girder bridge option faces greater constructability challenges than the deck girder option. The 11’-6” deep approach span plate girders reach the limit of sizes that can be transported by truck or delivered by barge under the existing Long Bridge. Due to their size and weight, erection by crane under the FAA overhead clearance limit is not practical. The 17’-0” deep channel through girders cannot be delivered by truck or barge in a single piece, and their handling in the field seems infeasible under the FAA vertical clearance.

The channel through girders will not fit beneath the existing bridge vertical clearance in the navigation channel and would have to be transported in a lay-down position. Transporting the girders on their side is not preferred due to the potential to induce undesirable lateral-torsional loads during handling. As such, it is likely that these deep girders would have to be assembled on the shoreline and delivered to their final location with a rolling gantry.

Installation of the large number of floorbeams and deck plates is labor intensive. The deck plate has to be bolted or welded to the tops of the floorbeams throughout the bridge. This work requires temporary work platforms beneath the span for access to the underside of the bridge.

5.4. Aesthetics

Given the location of the bridge and its proximity to major landmarks and trails, the aesthetics of the proposed bridge should be considered in the design. The main difference between the two structure types in terms of aesthetics is the visible structure depth. For the deck girder design, roughly half the depth is the steel girder and the other half is the concrete deck and parapet wall (refer to the **Appendix** for detail). For the through girder bridge, the entire visible depth is steel. The concrete deck and parapet of the deck girder option may be cast with a decorative form liner to economically give an aesthetic finish to the parapet. The through girders can be painted to enhance the bridge appearance, however the operating railroad often do not paint their steel bridges. The final details on aesthetics will be determined in future design phases after a Project Sponsor, construction funding sources, and corridor ownership are identified.

The visible depths, as listed in **Table 5-1**, vary between the approach spans and the channel spans for both evaluated structure types. For the deck girder design, the bottom of the channel span would sit lower in elevation than the approaches, while the top of the channel span would be uniform with the approaches. This is because the channel span is deeper, and the extra depth is made up beneath the deck. On the contrary, the top of the channel span for the through girder option would sit higher in elevation than the approaches, while the bottom of the channel span would be uniform with the approaches.

Both evaluated structure types would be viewed as traditional railroad bridges in appearance. These would not have any signature spans that would be greatly stand out among the surrounding bridges.

5.5. Additional Considerations

Several factors shall be considered when comparing the deck girder bridge option with the through girder bridge option. These considerations include load path, structural and internal redundancy, accessibility for inspection and maintenance, and life-cycle costs.

Efficient load path and structural redundancy are desirable properties of bridge construction to ensure safety. In the extreme event of structural failure of one of the main load carrying members, a redundant structure is able to redistribute the loads and avoid catastrophic failure. Multi-girder bridges, such as the deck girder option, are the most recognized redundant system and none of their girders are classified fracture critical. The through girder option, on the other hand, is a non-redundant structure because the failure of a single girder would result in failure of the span. The through girders would be classified as fracture critical members. Therefore, deck girder construction would provide an additional level of redundancy in the event of a marine vessel or debris inadvertently striking the bridge, when compared to through girders.

Accessibility to all parts of the bridge is another important consideration. Bridges require routine inspections throughout their service life, so it is important to provide ease of access for inspectors. Fracture critical members have more stringent inspection requirements than non-fracture critical members. Additionally, over the life of the bridge, maintenance, repairs, repainting, and component replacement are very likely. The deck girder bridge allows for simple access to all components of the bridge due to relatively wide spacing between the girders. The through girder bridge contains closely spaced floorbeams which make access for inspection, maintenance, and repairs more difficult. In addition, the steel deck plates and knee braces of the through girder bridge are very difficult to access for inspection and maintenance. As such, the resulting life-cycle costs are greater for the through girder option.

6.0 Substructure and Foundation Types Considered

Regardless of the selected superstructure type, the proposed bridge substructures and foundations are likely to be similar.

6.1. Piers and Abutments

The substructures will comprise reinforced concrete piers in the river and abutments on shore at the north and south ends of the bridge. The piers may be constructed as solid walls. Their height is too small to consider the use of hammerhead-type piers. A two-column bent pier may be another feasible solution. However, the adjacent upstream bridge piers are all solid wall types to handle ice flows on the river, so the solid wall type is most likely for the new Long Bridge. The proposed bridge abutments are expected to be of solid cantilever wall construction. Additional evaluation for potential aesthetic improvements to the substructures can be performed during future design efforts.

6.2. Foundations

To support the piers and abutments, two basic types of foundations are expected. These basic foundation types include spread footings and deep foundations. Based on the construction of the existing bridge, which includes a combination of both spread footings and deep foundations, it is possible that the proposed bridge will similarly have a combination of the two foundation types. However, in most locations, deep foundations are expected. As a part of the Project, a geotechnical investigation is being performed. Scour and hydraulic analyses, which may influence the foundation type, will be produced during later engineering design phases. Refined recommendations of foundation type will be provided during later phases of design.

Construction of the proposed bridge foundations will require coordination with existing utilities in the river, as well as proposed utility projects. The original bridge drawings for the existing bridge show submarine cables running parallel to the existing structure. The installation of new foundations will require identification, location, and avoidance or relocation of any existing submarine cables.

Additionally, historical reports suggest that the foundations for previously demolished upstream bridge have been removed in their entirety[27]. However, verification should be made during later design phases to confirm that no obstructions exist in the footprints of any proposed foundations. If any obstructions do exist, they may be removed, or the proposed footings could be relocated or designed to incorporate the obstructions.

6.2.1. Spread Footings

Spread footings are shallow, solid reinforced concrete foundations that sit directly on stable riverbed surface layers. This type of footing is wider than the bridge pier, allowing the loads from above to be spread out over a large area to provide stability. Spread footings require favorable ground conditions that can provide sufficient factors of safety for the given loads. It is unlikely that spread footings will be feasible for the river piers due to subsurface soil conditions, but further geotechnical investigation is

[27] Washington DC Chapter of National Railway Historical Society. Accessed from http://www.dcnrhs.org/learn/washington-d-c-railroad-history/history-of-the-long-bridge. Accessed May 9, 2018.

needed to determine the most economical type of foundation. If spread footings are used in the river, the top of footing would need to be located below the scour elevation.

The construction of spread footings in the river would likely require deeper excavation and a larger footprint during construction. Temporary cofferdams would be needed surrounding the proposed footing in order to allow construction work to occur below the river waterline. Cofferdams create a watertight enclosure to hold back water and would be constructed wider than the proposed footings to provide worker access. Since these cofferdams may be large in footprint, interference with the navigation channel and the proposed Potomac River Tunnel may occur, as described in **Section 3.2.1**. This interference may limit the ability to use spread footings at certain pier locations.

6.2.2. Deep Foundations

Deep foundations incorporate vertical elements, such as piles or caissons, to transfer loads from the pier or abutment down to specific subsurface layers. The vertical elements would likely extend much deeper than the spread footings, but they require minimal footprints to construct. Cofferdams would likely not be required if deep foundations are used, thus minimizing impacts to the navigation channel or any existing utilities in the river. Overhead clearances may limit the use of certain types of piles, but accommodations can be made during design phases to ensure efficient installation of deep foundations.

The use of precast elements for the foundation and the piers shall be investigated during the preliminary design phase. Additionally, acceptable construction means and methods shall be evaluated during the early phase of the Project.

7.0 Additional Considerations

7.1. Bike-Pedestrian Crossing

Separate studies associated with the Project evaluated the engineering feasibility of a bike-pedestrian river crossing. These options include the following:

- Option 1A: Bike-pedestrian crossing located on the upstream side of the new upstream rail bridge over the Potomac River with shared superstructures and substructures.
- Option 1B: Bike-pedestrian crossing located on the upstream side of the new upstream rail bridge over the Potomac River with a separate superstructure on shared substructures.

Two additional options (Options 2 and 3) include a separate bike-pedestrian structure located either upstream or downstream of the rail bridge. These two options are not discussed in this report as they are independent structures of the existing and proposed rail bridges.

The studies have determined that no bike-pedestrian crossing will be connected to the new railroad bridge, and therefore this aspect is not a consideration for the bridge type.

7.2. Future Electrification on Bridge

As part of the Project, considerations are being made to potential future installation (as a separate project along the corridor) of electrification through an Overhead Contact System (OCS). The inclusion of OCS is not a part of this study but should be considered for the design. It should be noted that CSXT has expressed that overhead electrification structures will not be permitted over the tracks envisioned to be operated primarily by freight trains, nor will CSXT allow overhead electrification structures on any track that it owns and maintains. Considering future ownership and operations of individual tracks have not been established for the Project, implications of this potential future installation of OCS is discussed below.

Installation of OCS structures could be accommodated in two ways: support catenary poles on the bridge piers or support them on cantilevered brackets on the steel girders. Pier-mounted OCS would require the proposed bridge piers to be wide enough to allow for steel baseplates and catenary poles outside of the proposed superstructure. In this configuration, the OCS would be carried on a steel frame outside the train clearance envelope, and the steel frame would be supported on the bridge piers. This is typically the preferred method to support OCS facilities on bridges.

The other concept, which could accommodate catenary poles on the steel deck girders, would require the girders to be designed with the possible future OCS loads included. In this configuration, the poles would be supported on steel brackets aligning with the bridge cross frames, cantilevered off the sides of the bridge girders. This concept would likely not be feasible with the through girder option.

To not preclude the future installation of OCS structures, either the proposed bridge piers would be sufficiently wide to accommodate the steel frames and base plates, or the steel girders would be designed to handle OCS loading. In both cases, the structure would be over-designed to a certain extent until OCS is added, if ever. Additionally, further consideration will be made during later phases of design to ensure the vertical clearances on the proposed bridge provide sufficient space for future OCS wires.

8.0 Conclusions

This report serves to provide the information needed to make an informed decision on bridge type and arrangement. The proposed location of the new bridge is upstream from the existing Long Bridge, with the precise location to be determined during Conceptual Design. This location will be as close to the existing bridge as feasible, while providing sufficient clearance between the existing and new bridges for construction and future maintenance access.

The span configurations of the new bridge are expected to match the existing bridge configuration. In addition, the proposed navigation channel will match the existing clearances. The new superstructure will accommodate 15-foot track spacing with a minimum of 9-foot lateral clearance from centerline of tracks to the nearest obstructions.

For the proposed bridge, two primary structure types were recommended and evaluated. These include a steel deck girder bridge and a steel through girder bridge. Both structure types offer advantages and disadvantages, particularly for the channel spans where the structural depths are greater. A summary matrix comparing the two structure types follows in **Section 9.0**.

At the proposed bridge channel spans, the deck girder bridge type is feasible, but the through girder bridge reaches toward the upper limits of feasibility due to the necessary size of the steel plate girders.

9.0 Structure Type Summary Matrix

Table 9-1 | Structure Type Summary Matrix

	Steel Deck Girder Bridge	Steel Through Girder Bridge
Structure Geometry	• Approximate floor system depth = 11’-0” (from top of deck to bottom of girder) • Raised track profile required • Reasonably sized structural members • Girder depth (approaches) = 7’-6” • Girder depth (channel) = 11’-6”	• Approximate structural depth = 4’-9” (from top of deck to bottom of girder) • Track profile can be closer to existing • Extremely deep and heavy girders for the channel spans • Girder depth (approaches) = 10’-0” • Girder depth (channel) = 17’-0”
Fabricability	• Conventional fabrication, steel plate sizes within common limits	• Complex fabrication, steel plate sizes exceed common limits
Constructability	• Typical shipping of materials • Girders can be delivered to site by river • Telescopic boom crane may be able to lift girders • Rolling gantry may be required • Need to construct concrete deck in place • Temporary closures of navigation channel to erect girders, long-term closures of approach span areas of river	• Difficult to ship girders due to size • Girders too deep to deliver by river • Extensive on-site fabrication and welding • Very large crane sizes for lifting steel girders will not be able to operate under the FAA requirements • Large rolling gantry required • No concrete deck needed, but steel deck plate must be welded to floorbeams • Temporary closures of navigation channel to erect girders and floorbeams, long-term closures of approach span areas of river
Aesthetics	• Well-proportioned steel and concrete member for approach spans and channel spans • Tall concrete parapets required per CSXT criteria, possible opportunity for aesthetic treatments	• Very deep steel girders for channel span, but in proportion to the approach spans • No concrete parapets required
Redundancy	• Redundant structure due to multiple girders per track	• Non-redundant structure due to single girder per track
Accessibility	• Larger clearances for inspection and maintenance of superstructure	• Very narrow access between floorbeams for inspection and maintenance

APPENDIX

Long Bridge Girder Type Typical Sections

REG	STATE	PROJECT	SHEET NO.	TOTAL SHEETS
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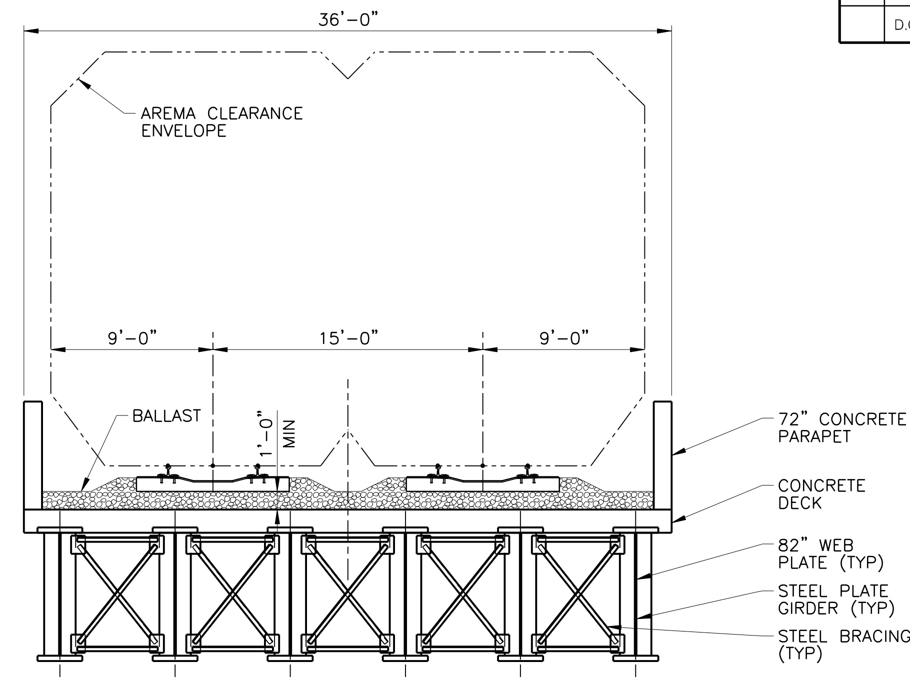

TYPICAL SECTION - DECK GIRDER APPROACH SPAN

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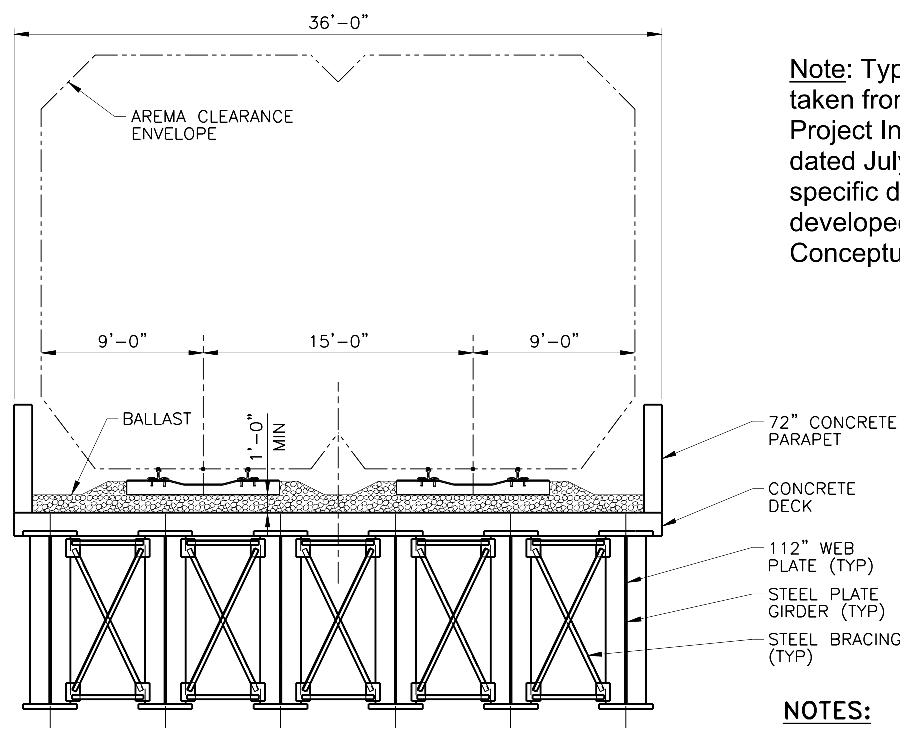

TYPICAL SECTION - DECK GIRDER CHANNEL SPAN

N.T.S.

Note: Typical sections are taken from the CSXT Public Project Information Manual dated July 2017. Project specific details will be further developed during the Conceptual Engineering.

NOTES:

1. DIMENSIONS AND MEMBER SIZES SHOWN ARE APPROXIMATE.
2. AREMA CLEARANCE ENVELOPE IS SHOWN FOR TANGENT TRACK WITHOUT CURVE CORRECTIONS.

DRAFT - WORK IN PROGRESS

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NO.	DESCRIPTION	NAME	DATE
	REVISIONS		

D.C. DEPARTMENT OF TRANSPORTATION

INFRASTRUCTURE PROJECT MANAGEMENT ADMINISTRATION

PROJECT MANAGEMENT DIVISION

LONG BRIDGE PROJECT EIS

LONG BRIDGE STRUCTURES

SUMMARY REPORT

PROJECT ENG. ______
DESIGNED BY HNTB
CHECKED BY MJR
DRAWN BY JJR
PROJECT MGR. ______

LONG BRIDGE

DECK GIRDER OPTION

TYPICAL SECTION

DIVISION CHIEF

DATE JUNE 15, 2018

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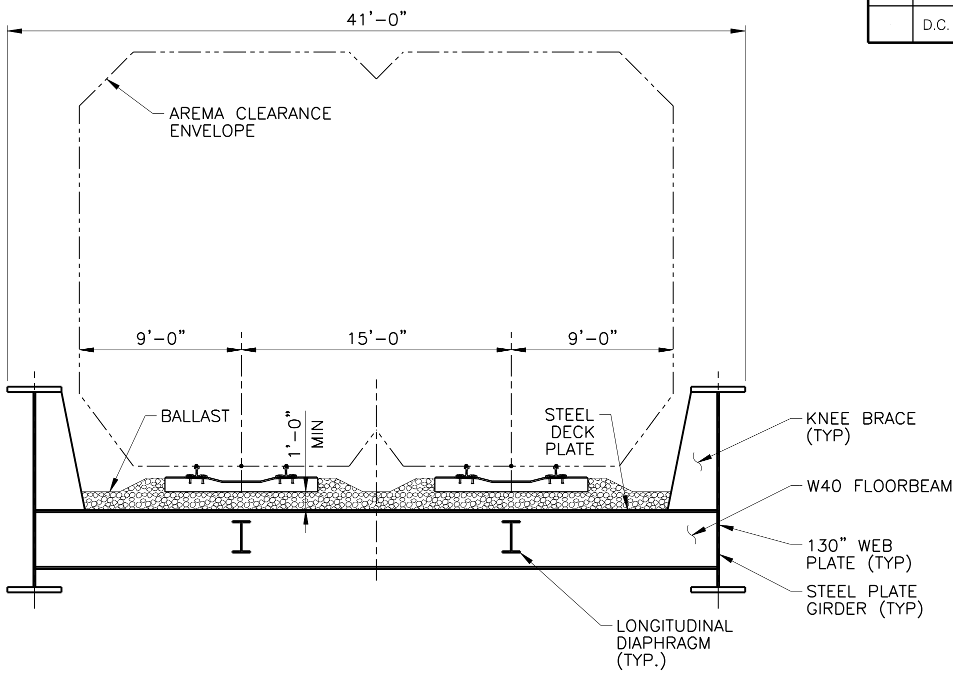

TYPICAL SECTION – THROUGH GIRDER APPROACH SPAN

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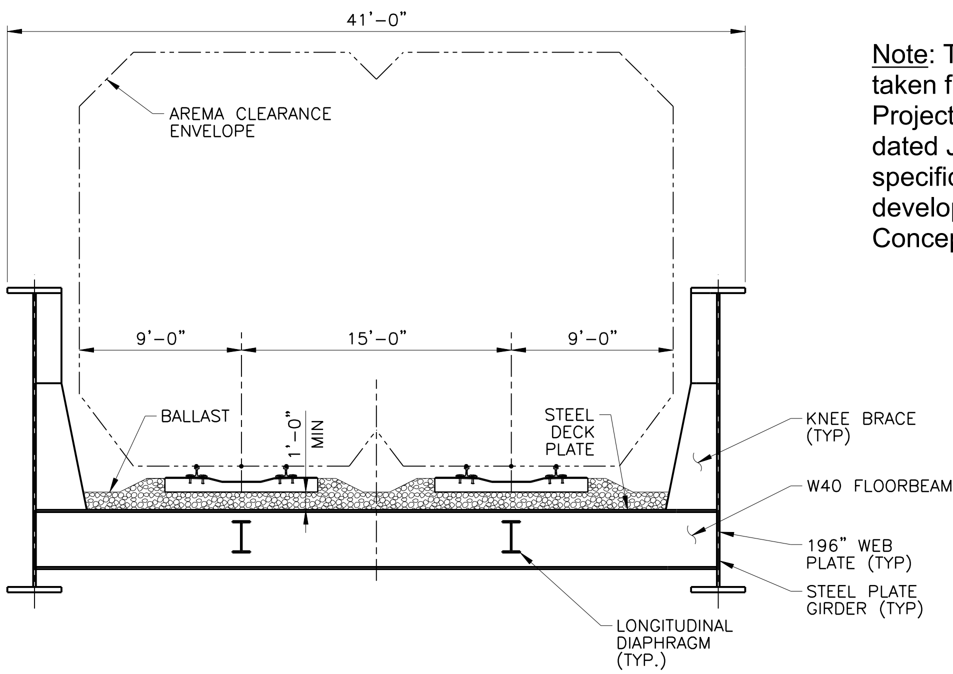

TYPICAL SECTION – THROUGH GIRDER CHANNEL SPAN

N.T.S.

<u>Note</u>: Typical sections are taken from the CSXT Public Project Information Manual dated July 2017. Project specific details will be further developed during the Conceptual Engineering.

NOTES:

1. DIMENSIONS AND MEMBER SIZES SHOWN ARE APPROXIMATE.
2. AREMA CLEARANCE ENVELOPE IS SHOWN FOR TANGENT TRACK WITHOUT CURVE CORRECTIONS.

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PROJECT MANAGEMENT DIVISION

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LONG BRIDGE STRUCTURES
SUMMARY REPORT

PROJECT ENG. ______
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SHEET 2 OF 2