SHEPHERD BRANCH TRIAL PEDESTRIAN BRIDGE OVER PENNSYLVANIA AVENUE

Pedestrian Bridge Options

The proposed Shepherd Branch Trail alignment spans over Pennsylvania Avenue necessitating a pedestrian bridge to carry users safely from one side of the trail to the opposite side. Two bridge options were considered, a Two-Span option and a Three-Span option.

1. Feasible Bridge Types

1.1 Geometrics

The new pedestrian bridge will span over Pennsylvania Avenue at a skew angle running parallel to Fairlawn Avenue, SE. The total span length of the proposed bridge is approximately 367 feet. Based on this length, multiple intermediate piers would be required for conventional beam-slab bridges. At least two intermediate piers and deep beams would be required and the profile will need to meet the vertical clearance restriction of 17 feet – 6 inches minimum over Pennsylvania Avenue. For this reason, conventional beam-slab bridge was not further considered.

Using at least one intermediate pier, truss-type bridges can easily span Pennsylvania Avenue and meet the vertical clearance restriction. In this case, a pier could be placed in the concrete island separating the on-off ramps to Route 295. Using two intermediate piers would require one pier to be located in the median of Pennsylvania Avenue, which is similar to the design of Route 295 over Pennsylvania Avenue. The ramps at the bridge approaches must be ADA compliant. The proposed cross-section shows a fence on both sides of the bridge and a fence or railing will be appropriate along the approaches (see Drawings S-1 to S-4.) These designs are compliant with Section 19 of the DDOT “Design and Engineering Manual.”

1.2 Site Constraints

The existing topography does not present issues for the construction of the pedestrian bridge. There is one overhead powerline close to the proposed alignment. There is adequate clearance between the bridge and the overhead powerline but would need to be monitored during construction. The existing Route 295 on- and off-ramps present the greatest challenge which limited the geometric design.

There are storm drains near the intermediate piers located in the median of Pennsylvania Avenue and the island near the on/off ramps. While this does not appear to be an issue, further investigation and drainage system modifications may be required during final design to avoid conflicts.

3310 Noble Pond Way
Suite 201
Woodbridge, Virginia 22193

Structural/Civil Engineering Company

Tel: (703) 897-0102
Fax: (703) 897-0103
mail:admin@dadsonconsulting.com

1.3 Superstructure Types & Layouts

Based on the proposed shared use path alignment, profile, and proposed span configurations for this bridge, two viable alternatives have been identified. Option 1 locates a drilled shaft pier in the median of Pennsylvania Avenue and another within the concrete island between the on/off ramps to Route 295 for a 3-span option. The span configuration is 145 feet, 111 feet, and 111 feet long for a total bridge length of 367 feet. Though conventional beam-slab bridge is feasible, the vertical clearance requirement would require taller substructure elements and longer approach ramps. Therefore, a steel truss using tube steel has been proposed for this option as a more practical and feasible solution.

The Option 2 has just one intermediate pier within the concrete island between the on/off ramps to Route 295 resulting in a 2-span bridge. The span configuration is 230 feet and 137 feet long for a total bridge length of 367 feet. Similarly, conventional beam-slab bridge was considered but identified as being impractical due to the even longer spans and vertical clearance requirements.

Both proposed options use steel trusses that could be manufactured off-site and erected into place, likely in two field sections per span. Other long span structure types, including cable stayed, suspension and arch bridges, were not considered preferable for this site based on overhead restrictions and potential viewshed consideration; however, a more decorative bridge (such as a cable stayed bridge) could be considered if it is found to be acceptable by DDOT and desired by the community. A 1% cross-slope on the main truss spans and minimum vertical clearance of 17 feet – 6 inches are proposed for both options. The typical bridge section is shown on Drawing S-3 for both options.

2. Substructure Alternatives

2.1 Foundations

This pedestrian bridge is not anticipated to require any special foundation types. The piers for Option 1 are two-column structures with a pier cap connecting the two columns. The connecting pier cap provides rigidity to the pier. A more detailed structural analysis will be required as the design advances if there is a desire to explore the possibility of using two isolated piers at each location and eliminating the long pier cap. The pier for Option 2 is a hammerhead with a circular shaft as part of a drilled shaft foundation for both structural and aesthetic reasons. The drilled shaft and pier column have the same diameter but different diameters could be considered after detailed analysis is performed justifying the change.

The trusses will be supported on concrete cantilever abutment walls through bearing pads. Presently, there are no geotechnical reports or soil borings to refer to for the proposed substructure, but spread footing foundations were assumed for the preliminary cost estimate for the abutments. A single or multiple drilled shafts would be most appropriate for the intermediate piers due to constraints primarily from the existing roadways.

The approach ramps assumed in this study use fill material enclosed inside two parallel concrete wingwalls and abutment wall overlaid with 4-inch thick concrete slab. The proposed walls were assumed to be made of concrete cantilever, but MSE walls could also be used. Wall supported ramps will result in large exposed areas that may require architectural treatment for aesthetics, but may also create opportunities for murals or other gateway/branding treatments that may be identified through the public engagement process.

The proposed approach ramps measure approximately 260 feet long on the east end and 300 feet long on the west end. Viewshed is not expected to be a concern for these ramp lengths and heights because Route 295 already obstructs the viewshed towards downtown Washington DC. However, sight lines for bicyclists and pedestrians along Pennsylvania Avenue and along the shared use path may be obstructed by the wingwalls and abutment walls approaching that connection. An option to address viewshed issues is to introduce another bridge inside the ramp section. The ramp bridge would span approximately 100 feet and address viewshed concerns. The ramp bridge will likely be more costly than a fill ramp due to the cost of the new superstructure, the proposed abutment replaced with an intermediate pier with larger dimensions, and a new abutment at ramp entry points. Therefore, from a purely comparative cost analysis standpoint, the fill ramp is the recommended option.

2.2 Piers

Option 1 has two-column piers while Option 2 has a single column. Option 1, which has the 3-span bridge, calls for smaller diameter columns as extensions of drilled shaft foundations with one pier located in the median of Pennsylvania Avenue. Option 1 piers are skewed to make them parallel to Pennsylvania Avenue. This is necessary to provide a greater horizontal clearance from the roadway edge to the pier cap. Option 2 with the 2-span bridge uses a larger diameter pier located in the concrete island between the Route 295 on/off ramp. The substructure of this option does not need to be skewed since the single pier is located in the island between the on-off ramp to Route 295 and there is no apparent horizontal clearance limitation. The piers in both Options especially the pier in the median of Pennsylvania Avenue, will need to be protected from vehicular impact since they are critical members that support the superstructure. During construction it might be necessary to shut down one travel lane in each direction on Pennsylvania Avenue. This median pier proposed for the 3-span option will require a more detailed Maintenance and Protection of Traffic plan.

3. Structure Type Evaluation

Our investigation has determined that there are two feasible options for the proposed new bridge. These alternatives are based on the parameters identified for design, construction, aesthetics, life cycle cost, maintenance and inspection. The two options are both steel trusses but have different span arrangements. A conventional beam-slab bridge would have required more costly substructure elements based on the constraints, specifically vertical clearance over Pennsylvania Avenue. Other considerations include the long spans necessitating deep beams and longer approach ramps.

3.1 Construction Cost

For the two options developed, a preliminary construction cost was developed for each. These estimates were based on proposed span configurations, out-to-out width and substructure types and are presented below.

Construction Cost Comparison

Bridge Construction Costs			
Options	Description	Initial Construction Cost (2019 Dollars)	% Greater than Lowest Option
1	3-Span Steel Truss	$4,048,516	2.93%
2	2-Span Steel Truss	$3,933,191	

Option 1, the 3-span prefabricated truss option, is slightly more expensive (less than 3%) to construct than Option 2, the 2-span option. Considering that the material costs of steel and concrete rise and fall relative to each other rather frequently, either bridge option can be considered as a cost-efficient solution.

3.2 Constructability

Option 1 requires the construction of a pier in the median of Pennsylvania Avenue; therefore, traffic will have to be closed in the two adjacent lanes to construct this pier and protection. A Maintenance and Protection of Traffic (MPT) plan will be required for the pier construction and for the placement of concrete over the metal deck. The nearby overhead lines will need to be monitored during construction. For Option 1 and Option 2, the truss would be fabricated off site and lifted into place in field sections using cranes. This truss placement will require a MPT plan for both Options, which will likely require temporary closure of Pennsylvania Avenue for the placement period.

3.3 Life Cycle Costs

The two proposed options use the same materials and only differ in member sizes and span configuration. Therefore, it is not expected that the life-cycle cost will differ by much to render one option better than the other.

3.4 Environmental considerations

This bridge is not anticipated to require any special permits. It is not located near any known wetlands.

3.5 Maintenance, Inspection and Future Modification

Both proposed options have the potential advantage of limited long-term maintenance. Depending on the type of paint used on the steel truss members, paint repairs may be limited. If non-painted weathering steel is used, the patina that forms on the surface of the steel will

protect the steel from corrosion and paint repairs will not be required. The proposed visible superstructures of both options will make inspections easy to conduct.

3.6 Aesthetics

The span arrangement and steel truss offer clean, slender lines in elevation. A pedestrian's view of the trusses would be less hindered with the widely spaced vertical members. The truss structure is directly incorporated with the pedestrian railing and fence to address pedestrian safety issues. The steel truss can be made as bold or inconspicuous as desired by the choice of surface color. The approach ramps and bridge crossing for both options will utilize light standards and railings in compliance with the DDOT Architectural Design Standards.

4. Recommended Structure Type

Based on a review of all the parameters identified for design, construction, aesthetics, maintenance and inspection, it was determined that both steel truss options are virtually interchangeable and the best candidates for a new, cost efficient pedestrian crossing over Pennsylvania Avenue. The trusses can easily be lifted into place due to easy access to the site from the Interstate highway nearby. The median at this junction of Pennsylvania Avenue is relatively flat. It will be easy for a crane to lift the trusses. Hauling the long truss members is not anticipated to require any special handling because the trusses can be transported and brought to the site on the interstate system.