
CHAPTER 5

NEW RIVER CROSSING

5.1 EXISTING CONDITIONS AND CONTEXT – NEW RIVER CROSSING AND THE EXTRADOSED BRIDGE

The alignment for the proposed river crossing runs southwest-northeast, approximately perpendicular to the river, about one mile south of the Stillwater Lift Bridge in the City of Oak Park Heights. On the west side of the river the Minnesota terrain slopes gradually down from west to east, terminating in a high quality wooded wetland adjacent to the river, and a lower quality wetland west of the high quality wetland. Land uses include the Sunnyside Marina and Condominiums (to the north) and the Xcel Energy coal-fired King Power Plant (to the south). At the top of the bluff, there is a mixture of residential, institutional and commercial development which opens to a broad vista of the river valley. Minnesota TH 36 curves vertically and horizontally as it approaches the river from the west. Along the proposed alignment of TH 36 and its approach ramps, there are local roads that run north into Stillwater and south into Oak Park Heights, a rail line, a water treatment plant, storage yards for the King plant, and TH 95 (Figure 5.1).

On the east side of the river, the Wisconsin bluff slopes steeply down from east to west, from Wisconsin STH 35 at the top of the bluff, to a sandy shore at the east edge of the river. The slope is heavily wooded with a row of houses west of STH 35 at the top of the bluff.

The St. Croix River is about 2850 feet wide at the alignment of the proposed crossing, and maintains this width for about a mile downstream (south); the river narrows gradually to the north. The banks on both sides are forested but punctuated by the Lift Bridge, the City of Stillwater, Sunnyside Marina, houses on the Wisconsin bluff, and the tower of the King plant.

The St. Croix River Crossing Project SFEIS reviews the bridge types that were considered during the Stakeholder Group and environmental review process—cable stayed, extradosed, and haunched concrete box girders were among the universe of bridge types considered. The extradosed bridge was identified as the preferred structure type within the Preferred Alternative Package, because the extradosed bridge best balances the different features and requirements on the preferred alignment within the project’s environment. Concerns in that selection process included visual dominance (preferred to be low), tower heights for the cable-supported bridge types (also preferred low), and the number of piers in the water (preferred to be limited to 4 to 6 within the river). The SFEIS contains a complete description of this process.

5.2 EVALUATION CRITERIA AND GUIDANCE FOR DESIGN OF THE RIVER CROSSING

At the most basic level, aesthetic treatment guidance for the new river crossing bridge must be consistent with the EIS decision-making process; that is, an extradosed bridge with 4 to 6 piers in the water. In the process of developing architectural concepts with the VQRC, the following visual and functional criteria emerged:

- **Visual Criteria for the New Bridge** – The bridge should be friendly and inviting; a local asset and amenity; interesting and expressive; quietly elegant and graceful; slim and light; and capable of providing stimulating or positive user experiences for drivers, pedestrians, bicyclists, boaters, and viewers.

- **Functional and Engineering Criteria for the New Bridge** – The construction cost should be within budget, cost/bid risk should be minimized, and factors that could adversely impact the project objectives should be identified and managed; construction means and methods should be practical and
conventional; implementation cost/bid risk should be minimized; maintenance should follow established practices; and the architectural form should be suitable for pedestrian and bicycle use.

Information on how these criteria were addressed is provided in the sections below.

5.2.1 River Bridge Functional Requirements and Constraints

Environmental

For a listing of the site constraints and mitigation package items please refer to the SFEIS. The following are the constraints identified in the EIS process and within the conceptual bridge design process for critical areas:

- **Bluff Impacts** – Because the bluffs are protected as a Wild and Scenic River and are a visual amenity, minimize any impacts on the bluffs.

- **Mussel Beds** – Minimize impact on the potential mussel beds located in the riverbed near the Wisconsin shoreline.

- **High Quality Wooded Wetland** – Minimize impact on the high quality wetland bordering the river along the Minnesota shore.

Structural

Functional requirements have impacts on the visual qualities of the structural elements. A change to the requirements and assumptions used to develop visual treatments included later in this chapter could have unanticipated effects and adverse impacts on the architectural concept. Some background on significant functional requirements is needed to understand their importance.

- **Bearings and Joints** – Expansion joints in the road surface are a high maintenance element on a bridge. Failure of the joints to maintain a waterproof seal can lead to the structural deterioration of other elements located below the deck. Bearings supporting the bridge superstructure are also a maintenance prone element. As far as possible, minimize these elements. Where joints are required, locate them above piers.

- **Foundation Conditions** – The bridge foundation will be supported on bedrock. The bedrock layer slopes steeply away from the Minnesota shoreline, then levels out toward the Wisconsin shore. A thick layer of organic material overlays the bedrock beneath the river.

- **Constructability** – The means and methods used to construct major bridges have an important effect on the cost, cost/bid risk, and schedule for bridge construction. Preliminary and final structural design is beyond the scope of the visual quality planning process and this VQM, however due to the implications on the project objectives these issues were reviewed and are documented in a technical memorandum, titled St. Croix River Crossing Constructability Memo, dated October 17, 2005, which is in the project file in the Mn/DOT Office of Bridges and Structures. At the planning level, one of the goals is to allow viable options to be developed further, and not to limit potentially effective designs and technologies prematurely. One of the most significant such decisions on the St. Croix River Bridge is the choice between using precast segmental construction technology and using cast-in-place segmental construction. The preferred aesthetic treatments have been developed to accommodate both types of construction. (For example, the choice of twin box structures for the superstructure allows weight and
The purpose of this chapter is to provide guidance to future designers regarding the visual intent so that the visual intent can be carried through project development. The bridge plans and visualizations are not intended to provide definitive structural guidance or firmly establish abutment, pier or joint locations.

dimensions of the individual segments to be suitable for precast segmental construction.) If further design development determines that one construction method is preferable to the other, additional design decisions will be required to achieve more optimal results.

FIGURE 5.1
Location Map of Visualizations
While much of the river crossing bridge can be built using the balanced cantilever method of construction, several areas have complex geometry unsuited to this construction method, for example, the area where the width of the superstructure transitions to accommodate the on and off ramps for the interchange with TH 95, and will likely be built on falsework. The recommended visual treatments allow for repetition of dimensions and forming to the greatest extent practical. Because of their low height above the ground and the economics of segmental construction, the western approach spans, and the spans across TH 95, will also most likely be constructed on falsework.

5.2.2 Preferred Visual Treatment

Preferred Aesthetic Concept for New River Crossing

A preferred architectural treatment was selected through this VQM public process including VQRC and general public involvement from several alternative concepts which were derived from or inspired by the characteristics of the place. The resulting selected concept is called “Organic” and was inspired by the natural forms of the setting. This concept was selected and refined by balancing several criteria, within an extended and deliberate decision-making process. After a public open house, the DOTs and the VQRC formally weighed and measured values within three main categories of criteria: (1) visual quality, (2) functional and engineering effectiveness, and (3) public preference. The Organic architectural concept was preferred overall, as well as within each of the three categories of criteria. This aesthetic approach is to be used for the river spans and the approach structures for the river crossing bridge. For design guidance for the grade separation bridges at Beach Road and STH 35 see Chapter 6.

The Organic concept is characterized by curved planes, tapered forms, smooth surfaces, and expressed joints between parts. The parts are to look as if they were found in nature, or shaped by natural forces. The vertical pier forms are reed-like; the girders are rounded and tapered like bones or tree branches; and walls, barriers and railings are curved and blended into the larger forms. Transitions are gradual and smooth; edges are soft and curved; and colors are unified and natural expressions of their materials.

From west to east, the visual form of the bridge has three distinct treatments, the west abutment and the span over TH 95, the Minnesota approach spans – including the on ramp and off ramp – over river terrace forest and wetlands, and the extradosed spans crossing the river.

Span Across TH 95

The proposed structure for the TH 36 main line crossing of TH 95 is twin box girders with a structure depth of about 10 feet (Figure 5.2). At a point above the eastern gutterline of the TH 95 roadway, the depth of the girders tapers gradually to 20 feet in depth at the second pier east of TH 95 (Figure 5.3). The Organic visual treatment for the overpass is a continuation of that of the approach structure and river spans. The box girders have smooth, curved sides and soffits, and integrated traffic barriers.

The west abutment is tall with a battered front face, and a stone masonry treatment. The wingwalls curve from parallel to TH 95 to becoming almost perpendicular to TH 95 as they taper into the roadway embankment. The abutment and wingwalls are curved in plan view and appear as the top of a cylinder that has been tipped, like a geologic fault, so the front face of the walls are sloped away from the roadway and the top of the wall slants into the approach embankment.
Figure 5.2
TH 95 Elevation View
FIGURE 5.2

TH 95 ELEVATION VIEW
figure 5.3
TH 95 Visualization
Figure 5.3
TH 95 Visualization
stone may be a natural limestone veneer, or a simulated limestone masonry and color system. The proposed appearance of the masonry matches the retaining wall on the TH 95 approach to Stillwater that is located approximately one half mile north of the abutment location (Figure 5.4).

The piers directly adjacent to TH 95 are rectangular columns with battered faces, and support bearings to accommodate longitudinal movement. The concrete texture is a formliner treatment that provides a horizontal wood board texture.

**Approach Spans of New River Crossing**

The proposed structure for the approach spans is box girders with span lengths varying from about 180-300 feet (Figure 5.5). The girders supporting the roadway are the same shape as those of the main river spans, but are not tied together (Figures 5.6 and 5.7). The 20-foot depth of the box girders starts at pier 2 as described above. The on and off ramp structures are box girders that are narrower than the main line but also 20 feet deep.

The vertical supports for the approach structures are doubled, curved, tapered piers located under the center of each box girder. The piers of the main line bridge and the ramps will be approximately in a radial line at each pier line, so that the columns present a coherent appearance, and do not appear to be randomly placed on the ground below the bridge.

The Organic visual treatment for the approach structures and on and off ramps is shown in the curved, smooth, and tapered forms of the other structural elements. The sides and soffits of the box girders are curved, and the sides are unified with the barriers in a smooth curve. The piers are curved in plan and tapered in elevation. The box girder transitions between wider and narrower sections are gradual and smooth. The on and off ramps are smoothly integrated into the main structure. Trees and vegetation will screen portions of the approach spans and piers as described in Chapter 3 (Figure 5.8).

The abutments for the ramps are conventional abutments, with parallel wingwalls. The surface texture is areas of simulated limestone masonry described in Chapter 6 intended to replicate natural stone masonry. The abutment heights should be as short as possible, given the topography and the span arrangements that are possible.

**Figure 5.4**  
Stillwater Retaining Wall
River Spans

The development of the plans and visualizations for the Organic bridge architectural concept are based on six “wet” piers in the river, and span lengths for the river spans of approximately 480 feet (Figure 5.9). The first pier of the river spans is set adjacent to the wetland along the Minnesota shore. Five piers are spaced uniformly across the St. Croix River. The final pier for the river spans is placed on the Wisconsin shore so that the back span can reach the east abutment without requiring an additional pier. The east abutment location is set to minimize the height and visual impacts of the abutment. Each pier footing will be either below ground or underwater (not visible) and will support the visible vertical columns that are part of the Organic architectural form. The depth of the box structure for the river spans will be about 20 feet and will be held constant. A variable depth (haunched) girder structure was not acceptable to the VQRC.

Each pier location is a collection of three legs or columns below the deck and two towers above, with a cross beam tying the three columns together below the deck (Figure 5.10). The towers above the deck each support a plane of cables that attach to the edge of the deck in a semi-fan arrangement. Cables are anchored at the deck and saddle-mounted at the towers. The deck is formed from two equal parallel box-segments, linked at deck level. Floor beams tie the deck boxes together at each cable anchorage (Figure 5.11).

The Organic visual treatment for the river spans is manifested in the smooth, tapered, curved forms of the towers, legs, deck structure, and bicycle/pedestrian path. The towers are integrated with the outer legs of the piers into single forms that taper from the river to the top of the tower. Each tower and center leg is split laterally to provide structural flexibility. The split opening tapers from narrow at the bottom to wider at the deck (see Figure 5.10).

The box girders are curved on their sides and soffits, and the outside face of the traffic barriers form a smooth curve tangent to the sides of the box girders. Cable anchorages are integrated with the box girders by means of curved projections below the deck (Figure 5.12).

Figures 5.13 through 5.20 show computer visualizations of the river spans from vantage points shown in Figure 5.1.

The Wisconsin abutment is located to be as short and unimposing as practical. The abutment and wingwalls will be screened with dense vegetation as described in Chapter 4. The surface finish will be areas of simulated limestone masonry and single coat color system similar to that described in Chapter 6.

Details

The details of the components are designed to reinforce the “Organic” character of the design. Traffic barriers are integrated with the box girder fascias, curved and smooth. Bicycle/pedestrian railings are curved vertical pickets, designed to extend the profile of the parapets from which they grow out of (Figure 5.21). Bicycle/pedestrian overlooks, located at each of the river piers, are smoothly integrated extensions of the pathway, and their railings are derived from the bicycle/pedestrian railings.

Surface Treatments/Finishes and Colors

The Organic visual treatment will be complemented by colors and finishes that are authentic, direct, and natural expressions of the materials used: smooth, metal-formed concrete; either genuine stone or formed concrete, as appropriate depending on location and budget considerations; and for railing and other metal elements, mill-finish stainless steel or galvanized steel. Where synthetic materials are required, as with vinyl
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PIER NO. 1
NB SB 95

PLAN - APPROACH SPANS

ELEVATION - APPROACH SPANS

See Figure 5.6

See Figure 5.7
FIGURE 5.5
Approach Spans Plan and Elevation Views
Figure 5.6
Approach Spans Transverse View @ EB TH 36 STA 459+00 (Looking West)
FIGURE 5.6
Approach Spans Transverse View
@ EB TH 36 ST IA 499+00 (Looking West)
Figure 5.7
Approach Span Transverse View
@ EB TH 36 STA 466+00 (Looking West)
Figure 5.7
Approach Spans Transverse View
@ EB TH 36 STA 466+00 (Looking West)
Figure 5.8
Approach Spans Visualization for TH 95 NB
VQM

FIGURE 5.8
Approach Spans Visualization for TH 95 NB
FIGURE 5.9
River Spans Plan and Elevation
FIGURE 5.9
River Spans Plan and Elevation
FIGURE 5.10
River Spans – Pier Sections

[Diagram showing river spans with detailed labels for cross beam, cable anchorage, ice breaker foot, and water line at shortest and tallest pier.]
FIGURE 5.11
River Spans – Transverse Box Section (Looking East)

FIGURE 5.12
River Spans – Cable Anchorage Details
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Figure 5.13
River Spans Visualization from Water Level Looking North
Figure 5.13
River Spans Visualization from Water Level Looking North
FIGURE 5.14
River Spans Visualization from Lowell Park
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Figure 5.15
River Spans Visualization from St. Croix Overlook
Figure 5.16
River Spans Visualization from Minnesota Bluff
Figure 5.16
River Spans Visualization from Minnesota Bluff

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Figure 5.17
River Spans Visualization from Driver’s View Approaching STH 35
Figure 5.17
River Spans Visualization from Driver's View Approaching STH 35
Figure 5.18
River Spans Visualization from Driver’s View on Approach Spans
FIGURE 5.18
River Spans Visualization from Driver’s View on Approach Spans
Figure 5.19
East Abutment and Wisconsin Pier Visualization from River
VQM

FIGURE 5.19
East Abutment and Wisconsin Pier Visualization from River
FIGURE 5.20
AERIAL VIEW OF EAST ABUTMENT AND WISCONSIN BLUFF
FIGURE 5.20
Aerial View of East Abutment
and Wisconsin Bluff
cable covers, the colors will complement the natural materials’ colors. Long term maintenance must be considered in the selection of all materials, surface treatments, finishes, and colors.

5.2.3 Bridge Lighting

During the visual quality planning process, lighting of the St. Croix River Crossing was only briefly reviewed. Discussion led by the consultant team offered concepts and opportunities to enhance the architectural attributes of the bridge main spans during nighttime hours. The National Park Service and others expressed concern regarding the negative impact that bridge lighting could have on the scenic river valley.

Lighting to meet required safety levels for roadway, trail, navigation, and aviation will be designed to minimize “spillover” into the riverway. Architectural lighting, if it is to be included, must be thoughtfully designed to enhance the structure without intruding into the sensitive natural environment.

Roadway Lighting

Roadway lighting is currently proposed in the median over the full length of the river crossing including the approach spans. Single davit poles with double mounting arms and “cobrahead” luminaires will be spaced to achieve needed uniform roadway lighting levels across the bridge.

Other considerations regarding roadway lighting were proposed by the design team. In order to differentiate the river crossing from the roadway approaches, a metal halide light source is preferred both for the qual-
ity and color of the light. While high pressure sodium lighting may compromise the aesthetic appearance of the bridge, metal halide will complement the colors and textures of the bridge and will not compete with any possible aesthetic lighting. In addition, the use of an attractive, contemporary pole mounted luminaires will add to the aesthetic character of the river crossing.

**Trail Lighting**

The design team suggested the use of an innovative lighting scheme to light the trail along the upstream side of the river bridge and approach spans. Low level, low voltage systems are available which would provide adequate lighting levels for safe passage of trail users without allowing light to intrude into areas around the bridge.

**Navigation Lighting**

Because this area of the St. Croix River is a wide body of water, also called Lake St. Croix, the U.S. Coast Guard does not require standard navigation channel lighting. However, illumination of the piers above the water line will be required as a matter of safety. No specific lighting system was proposed during the visual quality planning process, but accent lighting of the piers was discussed. The appropriate system will provide the required level of safety. Selecting the proper luminaires, fixture locations, and light levels may wash the surface at the ends of the piers with a subtle glow and may provide the needed illumination for safety. There may be different methods of meeting the safety lighting requirements. Further study during preliminary and final design is needed.

**Aviation Obstruction Lighting**

Standard aviation obstruction lighting to meet FAA regulations will be required at the top of each of the pier towers.

**Architectural Lighting**

Enhancement of structural and architectural elements of the bridge through the use of lighting was briefly discussed in a presentation by the consultant team’s lighting designer to the VQRC. A number of possibilities were presented but time did not permit further exploration of these possibilities. Opportunities to enhance the river crossing through the use of architectural lighting will be addressed during the design phase of the project. The National Park Service and representatives from the surrounding communities will be involved in these discussions.

Until concurrence on any architectural lighting enhancements can be achieved, the lighting design will meet required safety levels for roadway, trail, navigation, and aviation, while minimizing “spillover” into the riverway.

**5.3 Additional Guidance for Preliminary and Final Bridge Design**

**5.3.1 Third Column**

The Organic concept was originally developed with two-column piers on the river spans. A comparative investigation of existing extradosed bridges worldwide indicated a need for an additional structural support at each of the river span piers. Therefore, this VQM shows a center third column for the Organic architectural concept. While the VQM shows the center (third) column, the VQRC’s preferred visual treatment is for the piers supporting the cables on the river spans to have two columns. The preliminary bridge design phase will examine the feasibility of a two-column option. If structural, constructability, and serviceability concerns
cannot be satisfactorily addressed with a two-column option, then the three-column option will be carried forward to construction. The simple and elegant design intent for the Organic concept will continue to be of paramount importance as the project develops.

5.3.2 **Cable Anchorages**

Cable anchorage details and methods have been developed on a conceptual basis. Further refinement of the anchorages will be determined in the preliminary and final bridge design phases. Details for the cable end anchorages (as shown in Figure 5.12) will need to be assessed based upon engineering constraints, and then visual quality of the treatment determined.

5.3.3 **Roadway Alignment and Geometry – Minnesota Approach**

The roadway and bridge geometry developed for the SFEIS for the eastern on and off ramps of the TH 95 interchange will be reviewed and optimized for the constraints of the proposed bridge. As the preliminary structural design for the bridge is being developed, the ramp alignments, tapers, and shoulder widths will be re-evaluated and adjusted slightly, if warranted. The goal is to simplify the structural design and improve the constructability of the bridge. The areas of greatest interest are the back span from the tower closest to the Minnesota shore and the transition span adjacent to the back span. The acceleration lane taper on the existing geometry extends past the first river pier near the Minnesota shore.