BRENT SPENCE
BRIDGE CORRIDOR

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BRENT SPENCE BRIDGE PROJECT

PROCUREMENT OPTIONS FOR THE EXISTING BRIDGE

APRIL 2014

STATE OF OHIO DEPARTMENT OF TRANSPORTATION

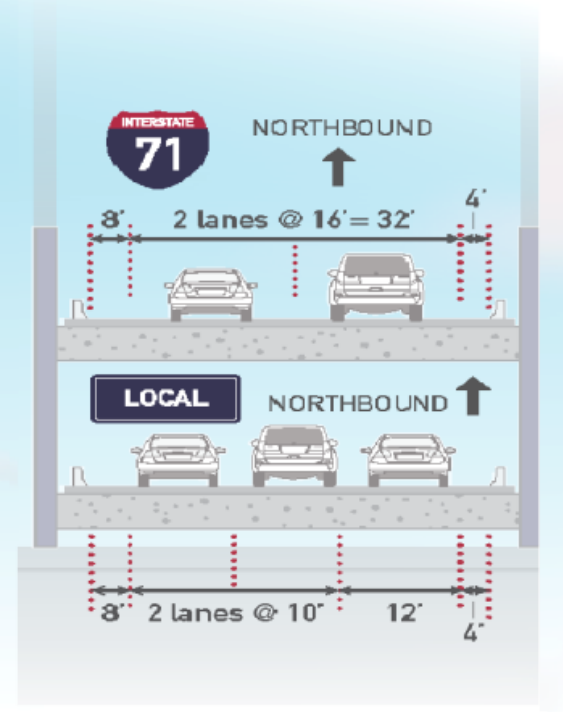
KENTUCKY TRANSPORTATION CABINET

TABLE OF EXHIBITS

1. INTRODUCTION

As part of the Brent Spence Bridge Project (the Project), the existing bridge will be retained (following rehabilitation work). Upon completion of the Project, the traffic pattern on the existing bridge will be amended to provide the lane configuration as identified in **Exhibit 1-1** (This configuration is referred to as Alternative I-A).

Exhibit 1-1: Lane Configuration on Brent Spence Bridge in Alternative I-A



Based upon the preliminary engineering studies undertaken to date (and included within the project cost estimate) the rehabilitation work would include:

1) Re-painting the existing bridge superstructure;
2) Removal and replacement of the existing concrete bridge decks; and
3) Structural rehabilitation work to the existing bridge superstructure.

The cost estimate for this work has been estimated as approximately $73 million including contingencies (see Table 66 of Environmental Assessment and a 2010 estimate prepared by Parsons Brinkerhoff for KY Contract 8).

This paper provides further consideration of the extent of rehabilitation work that may be considered for the Existing Brent Spence Bridge, based upon its condition and the findings of completed reports. The report then considers the advantages and disadvantages of different procurement methods, taking into consideration the characteristics of the work to be undertaken.

2. PREVIOUS STUDIES AND SCOPE OF WORK FOR EXISTING BRIDGE

In a report dated January 2013 entitled: "Technical Feasibility Review and Findings Memo", HNTB undertook a preliminary life cycle cost analysis that compared the life cycle cost of "Preferred Alternative I" to an "Alternative 123" (See Section 4.2 of the 2013 report). As a result of that study, it was reported that replacement of the existing bridge superstructure may have a life cycle benefit as compared to its rehabilitation. However, the 2013 report did not consider the additional user costs associated with replacement of the superstructure and was based on preliminary engineering analysis. For the purpose of this paper, rehabilitation of the existing bridge is assumed, in line with the cost estimates identified above and the assumptions in the Environmental Assessment.

It is understood that the preliminary traffic management plan for the project contemplates the work to the existing bridge being undertaken in a final phase that involves shifting northbound I-75 to its final location on the new Brent Spence Bridge, allowing the connections to Fort Washington Way and Ohio's 2nd Street to be constructed (See Section 4.12.10 of the Environmental Assessment). However, other traffic management alternatives may be possible including the total closure of the existing bridge and the temporary re-assignment of all traffic to the new Brent Spence Bridge. This would allow the rehabilitation work to be undertaken with no traffic, or phasing of some rehabilitation work to the existing bridge before completion of the new Brent Spence Bridge.

2.1 PROJECT DEVELOPMENT BACKGROUND

The Project is being developed jointly by Kentucky and Ohio under the terms of a bi-state development agreement dated December, 2012.

The existing bridge and its southern approach, which carries the I-71/75 over the Ohio River is owned and maintained by Kentucky and would remain a Kentucky-owned asset after rehabilitation and completion of the Project. The northern approach to the existing bridge, beginning at but not including pier 1 (Survey Station 602+10.5) is owned and maintained by Ohio.

The states are developing a plan of finance that adopts a "two States one Project" approach to procurement of the road and bridge work[1]. The Project is presently being considered for delivery using a design-build-finance-operate-maintain (DBFOM) approach via an availability payment (AP) form of a public-private partnership to construct, operate, and maintain the Project. Funding is expected to be derived primarily from Project tolling, with financial support for development activities provided by both states. The DBFOM approach is further described in the Brent Spence Bridge Corridor Options Analysis dated October, 2013[2] and the Initial Financial Plan dated December 2013[3]

2.2 STRUCTURAL REPORTS STUDIED

HNTB studied the following reports in order to form the basis of our recommendations: 1) Underwater Bridge Inspection Report by FMSM Engineers dated October 10, 2007; 2) Fracture Critical Inspection Report by Entran, PLC, dated December 29, 2010; and 3) Load Capacity Rating and Fatigue Life Analysis by Burgess & Niple, Inc., dated June 2004. We have identified in these reports, certain critical items that form the basis of our recommendations.

[1] http://www.brentspencebridgecorridor.com/uploads/pdfs/BSB%20Executive%20Summary.pdf

[2] http://www.brentspencebridgecorridor.com/uploads/pdfs/2013-10-01%20BSB_Options_Analysis%20FINAL.pdf

[3] http://www.brentspencebridgecorridor.com/uploads/pdfs/BSB%20IFP_12.31.13.pdf

2.3 EXISTING BRIDGE DESCRIPTION

The existing Brent Spence Bridge carries I-75 and I-71 between Covington, Kentucky and Cincinnati, Ohio over the Ohio River. The bridge was opened to traffic in 1963 and was originally configured to carry six lanes of traffic and designed for HS20-44 truck loading. The main spans consist of a three span, double deck, cantilevered through truss (453' anchor spans and 830.5' main span). The upper (southbound) and lower (northbound) decks each were designed to carry 3 lanes of traffic. An overlay was added to the deck in 1977. Then in 1985, the roadway was reconfigured to carry an additional lane of traffic on both the northbound and southbound decks. A second overlay was applied to the deck in 1998. The majority of the truss members are riveted or bolted built-up steel members.

Exhibit 2-1: The Existing Double-decker Brent Spence Bridge

3. OBSERVATIONS ON STRUCTURAL REPORT FINDINGS

The Load Capacity Rating and Fatigue Life Analysis report conclude that the strength and remaining fatigue life of the bridge are acceptable. The analysis and conclusions seem to be done properly and with sound application of computations and field instrumentation data. However, the Fatigue Life Analysis has its limitations.

It should be understood that the remaining fatigue life analysis procedures, as detailed in the AASHTO *Manual for Bridge Evaluation*, is a probability-based calculation. Variability of this calculation is based on several factors including estimated vs. actual truck cycles, actual weights of the trucks vs. the 72,000 pound theoretical fatigue truck, actual section properties of the members vs. theoretical section properties, and actual loads in members vs. the analysis based loads. In order to increase the reliability of the fatigue analysis, the above report states that strain gauges were used to calculate the actual loads in the members (calibration of the structural model). The other variables were not addressed in the remaining fatigue life assessment. This report reviews the risk that the actual remaining fatigue life is less than predicted and looks at how this risk may influence the procurement and maintenance approach and how this risk may best be mitigated.

The Fracture Critical Inspection Report notes the following:

1) Deck Rating = 6; Superstructure Rating = 6; Substructure Rating = 7
2) Last painted in 1991
3) Deck has spalling, exposed rebar, and transverse cracking
4) Floorbeams have section loss and surface rust throughout the bridge
5) Interiors of verticals have section loss
6) Gusset plates have pack rust around edges causing prying action on the plates

The inspection report, as noted above, indicates some section loss in the members as well as pack rust at the connections. As detailed in the construction documents, the connections may have had infinite fatigue life based upon their condition at the time of the analysis, as was concluded in the report. However, continued deterioration of the connections will cause an increase in the actual stress range, eventually moving the stresses to a range where the fatigue life will no longer be infinite. Left unarrested, pack rust and section loss decreases available fatigue life of the connections.

This report is based on the principle that Kentucky would be responsible for ongoing operations and maintenance of the existing bridge after its rehabilitation. Consequently, even though evidence for infinite fatigue life may no longer be applicable due to deterioration, the situation can be managed. Kentucky would mitigate the fatigue life risk by including, within the rehabilitation work, inspection of critical locations, an assessment of the degree of section loss in the plates, and the necessary rehabilitation to ensure that stresses due to deterioration are brought back into an acceptable range. Kentucky would also be in a position to manage any further deterioration through ongoing inspections and action over the life of the structure. If adopting this approach, additional fatigue life analysis would not be needed.

It is not possible, based on current information, to accurately assess the amount and cost of structural rehabilitation needed to be certain of achieving an infinite fatigue life condition, and it is not known whether the $1 million allowance in the current estimate would be sufficient to achieve this condition. In addition to fatigue life condition, the remaining life of the floorbeams and stringers is not known, but the inspection report notes that some floorbeams had section loss and had not been painted since 1991. This issue would need to be studied to determine if the floor system needs rehabilitation or replacement. However, the

strategy of rehabilitation is reasonable, provided Kentucky accepts the need for structural rehabilitation and ongoing monitoring in order to fix as-yet unidentified problems and achieve a reasonable fatigue life.

If Kentucky were to attempt to transfer the responsibility of O&M to a Developer under a DBFOM contract, a fatigue life analysis using reduced effective section properties of the members at critical connections based on their current condition would be needed to more accurately determine fatigue life. Such an evaluation would require either an assessment of the degree of section loss in the plates, or on-site measurement of critical locations. The inherent variability in the Fatigue Life Analysis coupled with the age and known issues with this bridge would pose a risk to any Developer that is being asked to take life cycle risk over 35 years and handback risk over a period beyond that. If a DBFOM contract were to be initiated in which the Developer was required to take maintenance responsibility for the existing structure, this risk would be reflected as a significant risk premium in the proposal and as noted later in this report may represent an unbiddable risk.

The following Exhibit 3-1 identifies technical questions identified and a recommendation on their resolution.

Exhibit 3-1: Technical Questions and Suggested Resolution

Technical Question	Suggested Resolution
What should be done about the section losses reported in the Fracture Critical Inspection Report and can the necessary work to restore section be adequately specified?	This risk can best be handled by Kentucky retaining O&M responsibility for the existing structure and managing the risk through as needed structural rehabilitation
What should be done about the reduced fatigue life resulting from the section losses and would restoration of the sections allow assurance that a rehabilitated structure has infinite fatigue life?	There is reasonable assurance that adequate fatigue life can be achieved, but not possible to accurately assess amount of expenditure necessary to achieve this
Are there rivets and/or gusset plates that need to be replaced?	This will be determined as part of further surveys prior to delivering the rehabilitation plan – the extent of work may vary depending on existing conditions after revealing extent of deterioration.
How accurately can cleaning and painting be estimated taking into consideration environmental issues and would further paint system interventions be needed at intervals	
Will the drainage system need to be cleaned and repaired?	
Cost estimate allows for deck to be replaced – How realistic is this estimate and does it include for replacement of floor beams and stringers that can't be fully assessed for condition?	

4. PROCUREMENT OPTIONS FOR WORK TO EXISTING BRIDGE

For the purpose of this paper, it is assumed that the Work associated with the Project, including the Ohio approaches, the new Brent Spence Bridge and the Kentucky approaches will be procured as a single P3 contract that would include private finance. The contract would include a 35-year O&M / life cycle and handback responsibility for a significant part of the work. As identified in Section 3, it would be more economical for Kentucky to retain O&M and life cycle responsibility for the existing bridge, rather than transferring O&M / life cycle and handback responsibility to the Developer. The rehabilitation of the existing bridge would be delivered under the same integrated contract arrangement and by the same Developer as the remainder of the Project but would be handed over to Kentucky at Substantial Completion. The procurement options for the work to the existing bridge are shown on **Exhibit 4-1**.

Options 2a and 3a are included in **Exhibit 4-1** for completeness and show procurement and delivery of the rehabilitation work via separate contracts rather than bundled with the P3. Separate procurement of the rehabilitation work, either as a DB (Option 2a) or a DBB (Option 3a) offers no significant advantages over bundling with the P3 contract and has the disadvantage of introducing additional interfaces. For example, if the rehabilitation work is separately procured, any delay in completion of that work could affect Substantial Completion and toll service commencement of the entire Project. In order to allow for separate procurement of the rehabilitation work it would be necessary to impose constraints into the P3 contract to allow access for the separately appointed rehabilitation work contractor. For this reason Options 2a and 3a are not considered further in this paper and it is assumed that all rehabilitation work would be bundled into the P3.

Exhibit 4-1 addresses key issues in the context of the three procurement options for the existing bridge.

Exhibit 4-1: Summary of Procurement Options for Existing Bridge

Option	General Description	Detailed Design Responsibility	O&M and Life Cycle Responsibility
1	Bundle with the P3 Contract as a DBFOM and transfer O&M / life cycle responsibility to Developer	Developer	Developer
2	Bundle with the P3 Contract as a DB, Kentucky retains O&M / life cycle responsibility	Developer	Kentucky
2a	Procure separately as a DB, Kentucky retains O&M / life cycle responsibility	Developer	Kentucky
3	Bundle with the P3 Contract as DBB, Kentucky retains detailed design and O&M / life cycle responsibility	Kentucky	Kentucky
3a	Procure separately as a DBB, Kentucky retains design and O&M / life cycle responsibility	Kentucky	Kentucky

Option 3 as shown in Exhibit 4-1 is based on KYTC performing rehabilitation design in order to clearly identify the expected risk level anticipated by proposers. Typical repairs such as gusset plate rehabilitation, floorbeam repairs, drainage modifications, etc. may be clearly detailed in the RFP Documents and quantified for "unit price" bids in order to establish a baseline cost for each repair type anticipated. An escalation

allowance of perhaps 10-15% additional quantity may be added to the anticipated scope to be assumed by proposers when preparing the schedule. Further consideration would need to be given to the way in which Substantial Completion of the entire Project would be linked to completion of the work to rehabilitate the existing bridge, taking into consideration permitted sequencing of the work.

Exhibit 4-2 is an example bid form demonstrating how bid items and quantities may be requested from proposers. Plans would be prepared by the States identifying the various types of rehabilitation required. These may be supplemented by photographs included on the drawings to clearly indicate the condition of the elements to be repaired or replaced and elevations and sections of the truss indicating where each type of rehabilitation is expected to occur. Actual bidding quantities and anticipated overrun allowance would be based on an inspection of the bridge. We do not believe that this inspection would be an in-depth inspection, but would be thorough enough to identify current immediate rehabilitation needs and deteriorating conditions which need attention. The entire package could include extensive photo documentation of the floor system, floorbeam connections and truss lower panel points. It is assumed that the upper gusset plates will not require extensive rehabilitation as they are not subject to exposure to deicing chemicals.

Exhibit 4-2: Example of Bid Items and Quantities

Item	Units	Estimated Quantity[1]	Overrun Allowance	Comment[2]
Rivet Replacement	Each	1000	500	This item is probably the least easily quantifiable, but of all the repairs proposed, this is the least cost and shortest duration.
Gusset Plate Rehabilitation, Type A[3]	Each	16	2	Details will be provided on the plans with quantities and materials requirements
Gusset Plate Rehabilitation, Type B[3]	Each	8	1	
Gusset Plate Rehabilitation, Type C[3]	Each	1	0	
Scupper and Downspout Replacement	Each			This is a well-defined quantity
Drainage Pipe Replacement	LF	400	60	
Floorbeam Rehabilitation, Type A[3]	Each	7	1	Details will be provided on the plans with quantities and materials requirements
Floorbeam Rehabilitation, Type B[3]	Each	1	1	
Floorbeam Replacement	Each	2	0	This quantity would be very specific
Deck Replacement	SF		0	This is a well-defined quantity
Expansion Joint Replacement	LF	192	0	This is a well-defined quantity
Navigation Lighting Replacement	LS	1	0	This is a well-defined quantity
Obstruction Lighting Replacement	LS	1	0	This is a well-defined quantity
Roadway Lighting Replacement	LS	1	0	This is a well-defined quantity
Bridge Painting	LS	1	0	This is a well-defined quantity

[1] Quantities shown are provided as an example of what a bid form may look like. Actual quantities would be determined during rehabilitation design

[2] These comments are descriptive of what the work may entail but would not be on the bid form

[3] The number and type of repairs would be determined during rehabilitation design. The details would include materials quantities and types.

The engineering for the rehabilitation of the existing truss may occur concurrently with the procurement process for the DBFOM. The contract structure may be identified early in the procurement process while the repair plans are being produced by the States, with the more detailed scope and plans provided with the issue of the Final RFP. Field work for an inspection and documentation of this nature could be completed within 30 days via snooper truck located on the lower deck and rehabilitation plans completed within an additional 120 days plus review periods.

5. CONCLUSION

It is recommended that the rehabilitation work to the existing bridge is bundled into the P3 procurement package. Because of the way in which P3 Developers would perceive and price the risks associated with fatigue life it would not be good value for money to require a long-term operation and maintenance and handback component for the existing bridge under a P3. The maintenance responsibility for the existing bridge after Substantial Completion of the rehabilitation work should therefore remain with Kentucky.

Based on the complexity of the work, the difficulty of specifying the Final Design requirements in advance of the work and the likelihood of on-site changes being needed to suit circumstances, it is recommended that Kentucky would prepare a detailed design and Proposers would be required to bid prices based on Kentucky-provided quantities, rather than have each Proposer prepare a rehabilitation design. An example of the way bid items and prices may be presented to Proposers (including an estimated quantity and an overrun allowance for schedule purposes) is provided in this report for consideration of the procurement approach.

When work of this nature is bundled into a P3 that is otherwise based on lump sum fixed prices via availability payments, attention needs to be given to the way in which prices for the rehabilitation work are requested in the RFP Documents and evaluated alongside the other Project elements.

Exhibit 5-1: Procurement Options for the Existing Bridge

	1. Bundle with the P3 Contract as a DBFOM and transfer O&M / life cycle responsibility to Developer	2. Bundle with the P3 Contract as a DB, Kentucky retains O&M / life cycle responsibility	3. Bundle with the P3 Contract as DBB, Kentucky retains detailed design and O&M / life cycle responsibility
Final Design responsibilities	Developer	Developer	Kentucky
O&M and Handback Responsibilities	Developer retains O&M / life cycle and handback	Kentucky retains O&M / life cycle – the work is effectively performed as DB	Kentucky retains O&M
Scope of Rehabilitation Work	Under this option a Developer may consider excessive O&M risk associated with retention of existing truss structure. DBFOM proposers would probably prefer to replace the structure and although this approach would provide a cleaner risk allocation it may not be the most cost effective solution overall.	Proposers would bid a lump sum DB for this work, but would need to add a risk premium for unknowns.	Kentucky can develop a scope that matches best assessment of condition, and can plan for some additions during the course of the work if needed.
Commercial Issues	Latent Defect risk is not generally transferred effectively for a structure with so many unknowns. Either Developer will add high risk premium or there may be reluctance to bid on stated terms. Note potential loss to Developer due to latent defects forcing early closures may be extremely high due to Unavailability Adjustments. There may be issues associated with Developer-provided insurances for Probable Maximum Loss and business interruption.	Under this form of contract (effectively a DB) each Proposer is required to assess risks, produce a design based on available information and bid a fixed price lump sum. For this kind of work there is a significant effort in producing a fixed price bid and the cost to each Proposer of doing so may be out of proportion to the value of the work.	Benefit of a separate DBB is that a complex Final Design based on available condition information and Kentucky's life cycle objectives is prepared only once.

	1. Bundle with the P3 Contract as a DBFOM and transfer O&M / life cycle responsibility to Developer	2. Bundle with the P3 Contract as a DB, Kentucky retains O&M / life cycle responsibility	3. Bundle with the P3 Contract as DBB, Kentucky retains detailed design and O&M / life cycle responsibility
On-site Changes	On-site changes are very costly under DBFOM. Rehabilitation work to existing bridge is likely to involve significant unknowns that can only be planned once deck is removed and paint stripped to expose defects.	On-site changes are often costly under DB. Proposers will require Relief and Compensation Events for changes necessitated by unknown condition of structural members.	Under DBB Kentucky retains maximum flexibility to make scope changes as issues are uncovered.