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BRENT SPENCE BRIDGE PROJECT

PRACTICAL DESIGN/ VALUE ENGINEERING WORKSHOP REPORT

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STATE OF OHIO DEPARTMENT OF TRANSPORTATION

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HNTB

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1. INTRODUCTION

1.1. OVERVIEW OF PRACTICAL DESIGN/ VALUE ENGINEERING WORKSHOP

The Brent Spence Bridge (BSB) Project must be right-sized before the Ohio Department of Transportation (ODOT) can determine its optimal delivery approach, including the best funding and financing strategy. A reference concept and technical provisions must meet ODOT's technical and performance requirements while encouraging private sector innovation and value.

Owners, contractors and concessionaires are interested in creating a job that they can build faster and more economically while managing risk. For example, a less complex project can be built more quickly and for less money.

To these ends, HNTB facilitated a Practical Design/ Value Engineering Workshop (PD/VEW) – a variation on traditional value engineering exercises. The primary objectives of the PD/VEW were to:

- Provide a high-level evaluation by select HNTB experts to generate technical ideas for delivering the BSB Project quickly, economically and safely.
- Conduct a field visit and have discussions with representatives from ODOT, the Kentucky Transportation Cabinet (KYTC) and the Federal Highway Administration (FHWA) to better understand the existing BSB corridor, and the opportunities and constraints from the information gathered during the Preliminary Engineering (PE)/ National Environmental Policy Act of 1969 (NEPA) phase of the Project Development Process (PDP).
- Generate technical ideas, particularly those of "high value," which will be evaluated further for use in the *Quantitative Value for Money* analyses and report.

The workshop activities can be categorized in three parts: pre-workshop activities, workshop activities and post-workshop activities.

1.2. PRE-WORKSHOP ACTIVITIES

HNTB's PD/VEW leadership created a project "Fish

Finder" (**Appendix A, Page A6**), named for the device fishermen use to locate the largest concentrations of fish so their efforts can be most productive. HNTB's Fish Finder helps identify the BSB Project's biggest costs, schedule-drivers and areas of risk, allowing subject matter experts to focus their reviews on the areas of maximum opportunity.

For the BSB Project, the "Fish Finder" shows that structures and roadways components comprise a significant portion of the overall project cost, while other items such as right of way (ROW) and utilities comprise a relatively small portion of the overall project cost. Therefore, PD/VEW participants focused on structure and roadway elements.

Among the biggest "fish" identified for the BSB Project are the River Bridge; approach and interchange bridges; and roadway (with associated pavement, embankment, walls and maintenance of traffic (MOT)). Several of HNTB's top bridge, road, traffic, geotechnical, construction and tolling experts were brought together at the PD/VEW and focused primarily on these project components, which presented the greatest opportunities to complete the project cheaper, faster and better.

Before the workshop, the participants were given available project information, including a wide variety of studies; information about the current state of the project; current site conditions; projected traffic data; and related environmental or political commitments.

A HIGH-VALUE IDEA MAY BE ONE THAT COULD EASILY BE IMPLEMENTED AND POTENTIALLY PROVIDE SIGNIFICANT SAVINGS IN PROJECT COSTS OR DELIVERY, WITH MINIMAL RISK OR ADDITIONAL NEGATIVE IMPACTS.

1.3. WORKSHOP ACTIVITIES

The PD/VEW took place over three days in HNTB's Cincinnati office (see **Appendix A, Pages A1-A6** for the list of attendees, agenda and workshop handouts).

Day 1 included a project overview by workshop leaders and representatives from FHWA, ODOT and KYTC; a review of the Fish Finder process; and a visit to the project site. Day 2 included breakout sessions with the HNTB technical experts to generate ideas for making project design and construction more efficient and effective. Day 3 was spent presenting, categorizing and assigning preliminary values to the ideas generated during Day 2.

The preliminary value designations – high, medium and low – helped determine which ideas would be selected for further study.

1.3.1. VALUE DESIGNATIONS

The value designations were assigned based on an idea's potential benefit to the project combined with the difficulty and/or likelihood of its implementation.

A high-value idea may be one that could easily be implemented and potentially provide significant savings in project costs or delivery, with minimal risk or additional negative impacts. Conversely, a low-value idea is one that, although it could provide a significant cost reduction, may also require the acquisition of more Section 4(f) property; may be difficult to implement; may negatively impact the project schedule; and, as a result, would be unlikely to advance beyond the conceptual level.

The team was encouraged to come up with as many ideas as they could. The goal of the PD/VEW was to unearth as many high-value ideas as possible; however, even a low-value idea could serve as inspiration for another stronger idea.

During the breakout sessions, participants generated ideas utilizing two different approaches:

- Clean-sheet ideas
- Practical design improvements

1.3.1.1. Clean-Sheet Ideas

The clean-sheet ideas approach is intended to provide a fresh look at the project. Essentially "wipe the slate clean," and reimagine the project without any constraints. Often, projects pick up different elements over the years from different influencers – consultants, owners or third parties. A clean-sheet approach is unencumbered by these elements and therefore can provide concepts that address only the project purpose and need.

1.3.1.2. Practical Design Improvements

The practical design improvement approach acknowledges that the project has reached its present scope and design for a variety of reasons, but it focuses on making improvements to the project through design alterations, modifications to the owner's standards, or incorporating other design and construction modifications.

1.3.2. ALTERNATIVES CONSIDERED

The HNTB team considered many alternatives from both the clean-sheet ideas and practical design improvements approaches, including:

- Typical section modifications.
- Alignment (horizontal or vertical) modifications.
- Alternate layouts (interchange, structures, etc.) or material types.
- Alternate structure types and methodologies.
- Shoring methods or foundation types.
- Retaining and reusing existing components such as bridges, pavement or drainage structures.

- Schedule-saving construction methods, operational modifications or materials acquisition.
- Reducing contractor risk through engineering design, or owner/third-party relationships.
- Increased owner value such as reduced future maintenance, or improved safety for users during and after construction.

1.4. POST-WORKSHOP ACTIVITIES

After the workshop, each idea generated by the HNTB team was reviewed. The preliminary low-, medium- and high-value idea designations assigned during the workshop were reevaluated to ensure that the team was advancing the most highly valued concepts. To complete the post-workshop activities, the high-value ideas will be evaluated further to help determine their technical feasibility and level of positive and negative impacts each may have on the schedule, performance, and delivery of the overall project.

2. WORKSHOP OUTCOMES

2.1. CONDITIONS AND CONSTRAINTS

HNTB, ODOT, KYTC, and FHWA PD/VEW participants conducted a field review to observe the configuration and conditions of the existing BSB corridor. Additionally, during the workshop and in the field, participants discussed the constraints outlined in the various studies and technical documents that were developed during the PE/NEPA phase of the PDP. The following conditions and constraints were noted and discussed:

2.1.1. ROADWAY

- The Interstate pavement and shoulders on the Kentucky side appear to be in good condition.
- The Interstate pavement and shoulders on the Ohio side appear to be in fair to poor condition.
- Any changed impacts to Section 4(f), Section 6(f) and/or historic resources would require additional coordination with agencies and stakeholders. Any such changes could lead to modifications to the existing Memoranda of Agreement (MOAs), updated coordination documents and reevaluation of the environmental document. Up to 12 months may be needed to complete changes to the MOAs for Section 4(f), Section 6(f) and historic resources.
- The 5% grade south of the BSB slows trucks, which in turn slows overall traffic flow.
- The I-71 and I-75 mainlines are posted at 55 mph. A design speed of 60 mph was used for mainline during the PE/NEPA phase of the PDP.
- The desirable vertical underclearance for an overpass structure is 17′-0″ in Ohio. The minimum vertical underclearance for most locations is 15′-6″ and can be less than this over some local streets.
- Other vehicular bridges crossing the Ohio River, such as the Clay Wade Bailey Bridge, may have unused capacity for local traffic.
- The signage for drivers northbound into Cincinnati is difficult to read because it is mounted on the underside of the existing BSB top deck.
- The 4th Street-to-northbound on-ramp in Kentucky is very steep and immediately puts vehicles in a weave situation with I-71 northbound.
- The proposed project has an approved Finding of No Significant Impact (FONSI). Alternatives that require an Environmental Impact Statement (EIS) will significantly delay the schedule.
- ODOT and KYTC need to determine the number of lanes that a contractor would be required to maintain during construction on the various routes.
- The preferred Alternative I requires the removal of a portion of the east end of Longworth Hall.
- The city of Cincinnati was opposed to reducing east-west connectivity and the Queensgate alternative, which proposed to shift I-75 to the west of its current location.
- UPS in Ohio requested the preferred alternative not have a detrimental impact on the company's property, particularly parking.

See **Appendix E, Pages E1-E8** for the design exceptions for preferred Alternative I that are specified in the Preferred Alternative Verification Report (PAVR).

2.1.2. BRIDGE

- The existing BSB is in need of extensive rehabilitation including full painting, deck improvements and structural steel repairs. The bridge is currently considered functionally obsolete due to substandard deck geometry and underclearances.
- The existing overpass bridges on the Kentucky side are generally in fair to good condition, with numerous locations of substandard underclearance. Live load-carrying capacity appears to meet the current requirement of an HL-93 vehicle.
- The existing overpass bridges on the Ohio side are generally in satisfactory to very good condition with scattered locations of substandard underclearances and deck geometry. Live load-carrying capacity generally meets previous design vehicle HS-20, but would not meet the current requirement of a HL-93 vehicle.

- The existing approach bridges on the Kentucky side are generally in fair condition and are functionally obsolete due to deck geometry and underclearances.
- The existing approach bridges on the Ohio side are generally in fair condition and are functionally obsolete due to deck geometry and underclearances.
- The BSB main span shall provide sufficient length to ensure that substructure units are outside of the main span piers of the existing BSB. More specifically, a navigation opening of 800′ by 92′ height at Normal Pool Elevation must be maintained.*
- Trusses have already been dismissed through the public process and will not be allowed. The FONSI states that the only valid structure types are tied arch or symmetrical cable-stay structures.
- The highest point of the bridge shall be at least 300′ +/- above the Normal Pool Elevation of the Ohio River (EL. 456.36′)*. This elevation is flexible, especially if the existing bridge is removed.
- The highest point of the bridge shall be less than 420′ +/- above the Normal Pool Elevation of the Ohio River (EL. 456.36′)* If this elevation is exceeded, a reevaluation of Section 106 of the MOA would be required, which could take as long as 12 months.
- The minimum provided underclearance shall be no lower than that provided by the existing BSB.*
- If a double deck design is provided, a minimum 25′ vertical clearance above the bottom deck roadway surface is required.*
- Select existing truss members have been strengthened.
- A fatigue evaluation performed on the existing southbound structure determined that it has infinite fatigue life; however, the fatigue evaluation considered only the standard American Association of State Highway and Transportation Officials (AASHTO) specification study of one-truck and in-plane stresses. Generally, fatigue issues stem from out-of-plane stresses. This study warrants revisiting because a less-than-infinite life would require fatigue retrofits to extend the bridge life.
- There are 2″-12″ diameter gas mains crossing the Ohio River parallel to and approximately 60′ east of the existing BSB.
- Numerous parking lots are under the bridges, especially on the Ohio side, for which vendors have acquired lease agreements from ODOT.
- The preferred Alternative I requires relocating the Duke Energy substation that is now just west of the existing BSB.

2.2. PRACTICAL DESIGN IDEAS

Low-cost and low-impact ideas were identified as part of the development of value-based ideas to reduce cost while achieving the fundamental project goals and objectives. These practical design ideas may not have significant benefits when considered individually, but if combined they could produce a higher value to the overall project.

The ideas identified that represent value opportunities include the following:

- **Add Truck Climbing Lanes** – Due to steep grades in some locations such as the I-75/I-71 southbound lanes south of the river, the addition of truck climbing lanes could improve levels of service (LOSs) and allow a reduction in the basic number of lanes. One disadvantage of this opportunity is the potential for additional impacts to Section 4(f), 6(f) and historic resources on the Kentucky side.
- **Reduce Number of Lanes over River** – The current number of lanes shown in the recommended plan is 16 lanes (8 in each direction). It appears that 13 to 14 lanes would achieve an acceptable LOS, depending on the ultimate allocation of lanes by bridge and route.
- **Reduce Number of Lanes in Kentucky** – There are 12 lanes between 12th Street and Kyles Lane. Six lanes may be needed southbound due to the steep grade, but 5 lanes northbound may be acceptable.

** Information from the FONSI for the Brent Spence Bridge Rehabilitation Project dated 8/09/12.*

- **Widen Existing Pavement in Kentucky (No Full-Depth Reconstruction)** – Cost savings and MOT benefits could result from reusing existing pavement wherever possible.

- **Use Posted Speed as Design Speed** – Using the posted speed as the design speed could reduce earthwork quantities, bridge lengths, retaining wall lengths and ROW impacts due to optimum profile and horizontal curve adjustments.

- **Take Advantage of Criteria Reduction with Switch from Interstate Traffic to Local Traffic** – Segregating Interstate traffic from local traffic could reduce design criteria for some roadways and reduce construction costs.

- **Flip Shoulders on Ramps to Improve Horizontal Stopping Sight Distance** – Wherever a left-side shoulder has to be widened to provide adequate sight distance and the left-side shoulder width is less than the right-side shoulder width, consider using the wider shoulder on the left side to minimize bridge widths.

- **Tie Barrier Size/Type to Design Speed** – Rather than using a tall barrier appropriate for high-speed roadways, match the barrier height to the design speed to reduce barrier costs.

- **Reduce Pavement Thickness Based on Actual Utilization** – Analyze truck volumes by lane and design pavements accordingly.

- **Use Minimum Required Vertical Underclearance** – Particularly in the multilevel system interchange areas, slightly reducing the required vertical underclearance can lower the elevation of crossing roadways with valuable construction cost savings. In Ohio, the minimum vertical underclearance for most locations is 15′ 6″, and can be even less over some local streets.

The above practical design ideas and others from the workshop are denoted with a "P" in the "Ideas and Innovations Matrix" in **Appendix B**.

2.3. HIGH-VALUE IDEAS: ROADWAY

The ideas categorized as "Roadway" were generally ideas unrelated to structures, such as the river crossing, dry bridges and walls. The roadway ideas instead were focused on geometry, alignment, interchange configuration, traffic operations and MOT. Particular focus was on the mainline and interchanges, which are considered major schedule and cost-drivers.

Workshop participants reviewed and referred to Alternative I, which currently is the preferred alternative, and they also reviewed previous concepts considered during Step 5 of the ODOT PDP that were not carried forward. This gave the team a framework of what had been considered in the past and illustrated the project's progression to where it is today.

Two basic roadway cost-saving concepts were prevalent during the workshop and categorized as high-value concepts, including:

1. Reduce reconstruction of overhead crossings on the Ohio side.

2. Separate Interstate traffic from local traffic.

Variations on these two concepts are discussed below.

2.3.1. REDUCE RECONSTRUCTION OF OVERHEAD CROSSINGS ON THE OHIO SIDE

The existing overhead structures provide connections to nearly every local street in the Cincinnati street grid. During the planning phase, city of Cincinnati officials said the Interstate is detrimental to east-west connectivity within the city, and they have requested improvements in this area. The current preferred Alternative I provides the same connections but at a great cost and a significant increase in construction time.

Alternative I maintains all local street east-west connections over I-75 at 5th, 6th, 7th, 9th and Linn streets, and Ezzard Charles Drive in Cincinnati. Workshop participants identified this area as having opportunities for innovation (see **Innovation Nos. 12, 47, 88, 120** and **124** in the "Ideas and Innovations Matrix," **Appendix B**). In addition to improving the operations of the roadway system, reducing the number of connections could significantly reduce the $100 million in associated capital costs specified in the PAVR document and the future maintenance costs.

Innovation No. 124 suggests that reconstructing overpasses (bridges, walls, etc.) is a major cost-driver

SIGNIFICANT COST SAVINGS COULD BE ACHIEVED BY REUSING THE EXISTING RAMPS AND INTERCHANGE BRIDGES. SEVERAL INNOVATIONS PROPOSE SOME TYPE OF REUSE.

on the Ohio side of the project area. Eliminating the number of overpasses by designing a frontage road system (**Figure 1, Page 8**) that fits into the existing city of Cincinnati grid system will save money and time.

The east-west overpass at 6th Street would be a two-way street, and it would connect US 50 to downtown. Likewise, Linn Street and Ezzard Charles Drive (farther north) would retain overpasses. This would eliminate three overpass structures and related construction costs and time.

The concept is not unfamiliar to Cincinnati because it creates a system similar to the one used at Ft. Washington Way. Advantages of the concept include significant cost and time savings; disadvantages include potential opposition from the city of Cincinnati and the amount of time it could take to garner stakeholder acceptance.

Other advantages and disadvantages for **Innovation No. 124** are shown in the "Ideas and Innovations Matrix" in **Appendix B, Page B8**. Further policy discussions will be needed before advancing this idea beyond the preliminary concept stage.

2.3.2. SEPARATE INTERSTATE TRAFFIC FROM LOCAL TRAFFIC

The existing interchanges near the Ohio River bridges currently include most of the desired local street connections. The proposed configuration of the roadways across the river requires significant reconstruction of the ramps and bridges, particularly on the Ohio side.

Significant cost savings could be achieved by reusing the existing ramps and interchange bridges. **Innovation Nos. 6, 16, 22, 104** and **123** propose some type of reuse by using the existing bridge for all local connections, whereas a new bridge, or bridges, would be constructed to serve only I-75/I-71 traffic. Conversely, if I-75 and I-71 use the existing bridges, many of the system ramps could possibly be reused.

Although the concept of separating local traffic from the Interstate or express traffic is included in the current plan, the plan combines Interstate and local traffic on double-stack bridges. The resulting combination of roadways creates the need to reconstruct many of the interchange ramps and associated bridges.

The following is a brief overview of some of the concepts to separate local and Interstate traffic:

- **Innovation No. 22** would build the new bridge to the east of the existing for I-75/71 traffic reusing the ramps and existing infrastructure where possible. The Interstate mainline bridge would be a flat bridge (see section **2.4. HIGH-VALUE IDEAS: BRIDGE** and **Appendix C, Page C1** for a preliminary sketch of this concept) lining up I-75 northbound and southbound to the existing alignment sooner in Ohio than currently proposed. The advantage of this alternative is that it preserves much of the existing overpasses at 5th, 6th, 7th and 9th streets. It also avoids the Duke Energy substation and Longworth Hall to the west. One of the disadvantages of this alternative is the need to relocate the existing 2"-12" diameter gas mains located just east of the existing BSB.

- **Innovation No. 85** shifts the mainline I-75 west, which would allow for an interchange with US 50 along Freeman Avenue (see **Appendix C, Pages C5-C6** for a preliminary sketch of this concept). Inspired by the Queensgate alternative considered several years ago for its removal of I-75 through-traffic from the corridor, this alternative appears to offer less significant impacts to existing businesses, ROW or environmentally sensitive areas than the Queensgate alternative impacted. Following existing Freeman Avenue, the new I-75 through movements would snake through the west side of downtown Cincinnati. I-71 would be maintained in place on the existing bridge, thereby simplifying the interchange north of the BSB or tieing into the new I-75 and US 50 interchange. Several opportunities exist with this alternative to rehabilitate and reuse the existing infrastructure, which could result in significant cost and time savings. Moving I-75 and possibly I-71 through traffic out of the congested downtown Cincinnati CBD would improve the geometry and safety of this heavily traveled Interstate corridor, and it would help simplify wayfinding signage

Figure 1: Frontage Road Concept in Cincinnati

approaching and leaving the bridge from both sides of the river. The construction phasing of the I-75 and 71 corridors would also be advantageous, since much of the new I-75 alignment could be built offline. In addition, the new river crossing, carrying I-75 alone, could be smaller and more affordable than the currently proposed alternative. Some of the disadvantages with this option include the potential for resistance from the local stakeholders who opposed the Queensgate alternative, additional impacts to section 4(f), 6(f), and historic resources, and having the new bridge cross the river on a skew. Up to 12 months may be needed to complete changes to the MOAs for the Section 4(f), Section 6(f) and historic resources.

- **Innovation No. 123** proposes to isolate local traffic to the existing bridge and connecting roadways. Interstate movements would be accommodated by simple (flat) bridges with separate northbound and southbound roadways located east and west of the existing bridge (see **Appendix C, Pages C7–C8** for a preliminary sketch of this concept). The separate roadways would connect to system ramps for I-75 and I-71 separate from the existing ramps. The objective would be to preserve as many of the existing ramps and bridges as possible for the local connections. There may be advantages to locating the bridges differently while still maintaining the basic concept. **Innovation No. 123** would not increase the ROW impacts west of the existing bridge; however, the northbound roadway east of the existing bridge would probably require relocating the existing 2"-12" diameter gas mains. Also, the best transition for the Interstate roadways south of the river would be to provide grade separations (braided roads) with the local roadways to place the Interstate roadways on the inside of the corridor. The higher truck volumes associated with the Interstate highways then would not conflict with the local ramp connections at the interchanges in Kentucky north of 12th Street. Further study is needed to determine to what extent the Interstate lanes are physically separated from the local lanes at this location.

2.3.3. LANE REQUIREMENT CONSIDERATIONS

Several key movements will determine overall system delay for traffic moving through the project area on I-75 and I-71. These areas present the greatest opportunity to right-size the project in terms of reduced/reconfigured lane requirements. The areas identified as the highest potential for lane reduction/reconfiguration were:

- The bridges across the Ohio River and the merges and diverges between I-75 and I-71.
- The 5% grade through the "Cut in the Hill."
- The configuration of Dixie Highway and Kyles Lane Interchanges.

2.3.3.1. Bridges across the Ohio River

Any traffic analysis for the river bridge will be influenced by ramp connections at interchanges immediately north and south of the river. Our evaluation of the 2035 forecasted travel demand for the I-75 mainline and I-71 southbound ramps north of the river shows a required 3 lanes and 2 lanes, respectively. The Interstate traffic southbound would likely require a 5-lane section with a drop to 4 lanes occurring as quickly as possible before the bridge main span to minimize river bridge cost. A traffic microsimulation analysis is recommended by the Highway Capacity Manual (HCM) for these types of lane drop situations. Four lanes is required for both southbound and northbound I-75/I-71 express lanes across the Ohio River, and that will provide a LOS D operation for 2035 design peak-hour traffic.

Major system ramp diverges on the north side of the river should typically be 4 lanes to 3 lanes for I-75, and continuous 2 lanes for I-71, for both southbound and northbound movements.

Three lanes in each direction for the local only roadways across the Ohio River will provide a LOS D operation for 2035 design peak-hour traffic.

2.3.3.2. Five Percent Grade through the "Cut in the Hill"

The existing traffic analysis used a planning methodology based on "level terrain" to achieve the identified LOS E for the proposed 6 lanes. When the 5% up-grade south of the existing bridge is considered, it would appear that 7 lanes southbound may be needed to provide LOS E. If the I-75/I-71 southbound traffic (express lanes) is separated from the local traffic south of 12th Street, the express lanes would require 4 lanes to maintain LOS E operation. The local southbound traffic would require 3 lanes to maintain a minimum LOS E operation, but would actually achieve a LOS D during the PM peak hour. A total 6 lanes would be adequate to accommodate Interstate and local traffic in the northbound direction.

2.3.3.3. Dixie Highway/Kyles Lane Interchange Alternatives

The preferred alternative for the Dixie Highway-Kyles Lane interchange configurations shows a collector-distributor (C-D) system with full pavement replacement for mainline and ramps, and the replacement and widening of the Dixie Highway and Kyles Lane bridges. As part of the development of value-based ideas to reduce cost while achieving the fundamental project goals and objectives, the identification of low cost and low impact ideas that would contribute to savings were identified.

Innovation No. 81 was identified that represents value opportunities at the above interchanges through a variety of options including the following:

- Replace with a braided ramp system to eliminate the northbound and southbound weave. For northbound, maintain the existing exit ramp to Dixie Highway and braid the C-D road with the entrance ramp (with short, simple span bridge), then potentially use a slip ramp before Kyles Lane and maintain the existing entrance ramp from Kyles Lane. Similarly, for southbound, maintain the existing exit ramp to Kyles Lane and braid the C-D road with the entrance ramp, then potentially use a slip ramp before Dixie Highway and maintain the existing entrance ramp from Dixie Highway. Like the other options above, the primary goal of this option is to preserve as much of the existing infrastructure as possible, which helps reduce construction costs. See **Appendix C, Page C2** for a preliminary sketch of this concept.

- Maintain the proposed C-D system design but shifts the C-D roads to the outside either over (with short, simple span bridges) or under (with box culverts) Dixie Highway and Kyles Lane. This option would reduce construction costs by preserving most, if not all, of the existing infrastructure at these two locations which was observed to be in a state of good repair. See **Appendix C, Page C3** for a preliminary sketch of this concept).

- Replace with a split diamond interchange configuration involving the northbound exit to Dixie Highway and entrance from Kyles Lane, and southbound exit to Kyles Lane and entrance from Dixie Highway, and no access between the crossroads. This option would also reduce construction costs by preserving most, if not all, of the existing crossroad bridges, crossroads and ramps. See **Appendix C, Page C4** for a preliminary sketch of this concept.

For each of these interchange options, as well as the river bridge lanes and the number of lanes through the "Cut in the Hill," traffic capacity would need to be confirmed for adequacy of lanes on the mainline, ramps and C-D roads. However, continued evaluation of these alternatives, including an in-depth traffic analyses, will only be conducted after an initial screening of the alternative concepts is completed.

2.4. HIGH-VALUE IDEAS: BRIDGE

2.4.1. USE NETWORK TIED ARCHES FOR NAVIGATION SPAN ONLY

The idea of using network tied arches stems from the general philosophy that the bridge type needs to fit the site, and that form should meet function. In this span range (830') the network tied arch generally would be the most economical structure solution. At this span range, a tied arch is going to be comparable to a cable-supported structure in dollars per square foot; however a tied arch would reduce the length of complex bridge by 50% when compared to a cable-stayed option. Assuming the cable- or arch-supported section is about $800 per square foot of deck area, and the shorter approach spans are $250 per square foot, a savings of about $120 million (present-day dollars) would be realized by using the tied arch-supported structure instead of the cable-supported structure. These costs need to be studied further to determine an actual projected total project cost for planning purposes.

2.4.2. USE SINGLE-LEVEL BRIDGES INSTEAD OF DOUBLE-DECKER BRIDGES

The idea of using single-level bridges instead of double-decker bridges has several advantages. Single-level bridges will generally reduce the number of shoulders required. Therefore, the square footage of the deck is greatly reduced. If the proposed double-decker was 12 lanes on one level instead of two, it would save about 58′ of deck width, or 22% of the deck. This change alone would save between $50 million to $75 million (present-day dollars, range stated as it depends on bridge type) for the river portion of the bridge.

Single-level bridges would simplify the connection to the interchanges on each side of the river and will generally shorten the length of those bridges, thereby reducing project cost. This needs to be studied further to determine project savings, but initial estimates indicate that it could reduce the project cost by $50 million to $150 million (present-day dollars). A bridge on a single level provides the ability to sign the movements clearly, thereby providing a safer venue for the travelling public.

Lastly, it would provide a more visually pleasing river structure as the longitudinal trusses necessary for a double-decker bridge are eliminated.

2.4.2.1. Bridge Types for the Single-Level Bridges

2.4.2.1.1. Network Tied Arch

Several advances have been made in the design of tied arches in the past decade. The introduction of network cables has added redundancy as well as structural efficiency, allowing the rib sections to be reduced. Depending on span length and width of bridge, an I-shaped section could be considered, further reducing costs. The construction methods employed to build arches also facilitates rapid replacement (float-ins) and provides for safer construction methods as the workers are constructing the structure closer to the ground. For a float in, the arches will need to be built in the adjacent pools, as their height will not allow them to be floated underneath the existing bridges even at low pool.

2.4.2.1.2. Flat Slab Cable-Stayed

For an 830′ span length and a bridge that is in the 60′ wide range, a flat slab cable-stayed bridge should be considered. The omission of floor beams and stringers greatly simplifies construction and can reduce construction costs. The ability to cast the backspans in place and simplified connections of the cable anchorages has several advantages. This system is still expected to cost somewhere between the costs of an arch and a traditional cable-stayed structure. But, if it is important to the stakeholders of the project to have the aesthetics associated with cables, this option could be considered or incentivized in the RFP.

2.4.2.1.3. Traditional Cable-Stayed Bridge

If a traditional cable-stayed bridge is considered, the following technologies should be allowed and encouraged: a semi-fan cable arrangement; vertical hollow pylons; and longitudinal post-tensioning only in areas where it is required. Other techniques that have been used widely in the recent past include the use of drilled shafts; multicolumn bents for the rest piers; using the next approach span for "ballast"; vertical saddles; and matching the edge girder depth to the floor beam depth to simplify detailing.

2.4.3. GENERAL ARRANGEMENT OF RIVER BRIDGES

See **Appendix D, Pages D1-D5** for general arrangements of river bridges and general suggestions of how to widen the substructure of the existing river piers. The drawings include:

- New Single-Level Bridge in addition to the existing double-decker bridge. The advantages to this option are discussed above (less shoulders, shorter approach bridges and safety).
- Two Single-Level Bridges (replace existing superstructure): This option has the same advantages as the above, but with all lanes at the same level. In addition, it may have significant advantages when considering lifecycle costs for the next 50 years. This needs to be investigated more thoroughly.
- Three Single-Level Bridges (new superstructure): Same advantages as above, with the additional benefit of having significant capacity to decommission the existing bridge and build the new superstructure without reducing the existing through traffic capacity.

Rough Expected Lifecycle Cost Savings when putting a new superstructure on the existing substructure is a total approximate savings of $115 million (in 2012 dollars), not including the opportunity for enhanced revenue from tolling. This rough estimate warrants further study to determine the actual value of replacement to the owner.

3. NEXT STEPS

The PD/VE workshop introduced more than 100 technical ideas that conceptually appear to make the BSB project design even better, faster, cheaper and safer than the current preferred Alternative I.

Based on discussions among workshop participants and ODOT and KYTC representatives, as an initial phase of the post-workshop analysis, the HNTB team subject matter experts grouped these ideas according to one of three value designations: high, medium and low. The value designations were assigned based on an idea's potential benefit to the project combined with the difficulty and/or likelihood of its implementation.

Based upon the information reviewed and findings discovered during the workshop, the HNTB team will study in more detail the high-value ideas to achieve the following outcomes from the post-workshop activities:

- Additional detailed analysis of each high-value idea to verify technical feasibility and level of positive and negative impacts on the schedule, performance, financing and delivery of the overall project.

- More detailed cost breakdowns for each high-value idea, including a comparison of increased and decreased costs to implement the proposed idea instead of the preferred alternative.

- Collaboration with traffic and revenue modelers to verify and further develop tolling model scenarios based on high-value ideas that would positively impact potential toll revenues compared to the preferred alternative.

- Additional conceptual analysis of each medium-value idea to verify technical feasibility and how/whether to accommodate the ideas into a procurement process.

These post-workshop activities are expected to be substantially complete by January 2013.

BRENT SPENCE BRIDGE PROJECT

Practical Design/Value Engineering WORKSHOP REPORT

APPENDIX A:
WORKSHOP MATERIALS

Workshop Materials: Sign-In Sheet

Brent Spence Bridge - Practical Design Workshop
October 17 -19, 2012
Sign In Sheet

Attendee	Company/Focus	17-Oct	18-Oct	19-Oct
Paul Huston	HNTB/PM	X	X	X
Scott Campbell	HNTB/Management	X	X	X
Kurt Codutti	HNTB/Management	X	X	X
Rob Turton	HNTB/Bridge	X	X	X
John Brestin	HNTB/Bridge	X	X	X
Marco Rosignoli	HNTB/Bridge	X	X	X
Ted Zoli	HNTB/Bridge		X	
Finn Hubbard	HNTB/Bridge	X	X	X
Rich Bloch	HNTB/Bridge	X	X	X
Ken Ishmael	HNTB/Construction	X	X	X
Bob Fisher	HNTB/Construction	X	X	X
John Anderson	HNTB/Geotech	X	X	X
Matt Riegel	HNTB/Geotech	X	X	X
John Siwula	HNTB/Geotech	X	X	X
Matt Simon	HNTB/MOT	X	X	X
Jason Rhoades	HNTB/MOT/Road		X	X
Charlie Dodge	HNTB/Road	X	X	
Dale McGregor	HNTB/Road	X	X	X
Jake Stremmel	HNTB/Road	X	X	X
Jeff Dailey	HNTB/Tolls	X	X	
Brad Guilmino	HNTB/Tolls		X	X
Bill Wiedelman	HNTB/Traffic	X	X	X
Amit Thomas	HNTB/Traffic	X	X	X
Mike Wawszkiewicz	ODOT/Central Office Innovative	X	—	X
Stefan Spinosa	ODOT/District 8 PM	X	—	X
Steve Mary	ODOT/District 8 Dist Dep Director	[initials]	—	[initials]
Rob Hans	KYTC\Chief District Engineer		—	X
Stacee Hans	KYTC\PM	X	—	X
Dave McDougall	HNTB	X	X	X
Andy Thompson	FHWA	X	—	
Joe Vogel	ODOT D8	X		X

Workshop Materials: Agenda (Page 1 of 2)

AGENDA

BRENT SPENCE BRIDGE

Practical Design/Value Engineering Workshop

October 17 -19, 2012 – Cincinnati, OH

DAY 1 – Field Visit (12:00 pm to 5:00 pm)

Introductions	30 minutes
Review of Project Goals and Ground Rules	30 minutes
Project Overview	30 minutes
Review of Fish Finder	30 minutes
Field Visit	2½ hours
Reconvene to discuss Field Observations	30 minutes

DAY 2 – Innovation Sessions

Morning Breakout Session (8:00 am to 12:00 pm) 4 hours

Name	Core Discipline	Name	Core Discipline	Name	Core Discipline
Session 1 - Thursday AM		***Focus on Innovative Ideas (Clean Sheet Approach)***			
Rob Turton *	Bridge	Charlie Dodge *	Road	Matt Simon *	Road
John Brestin	Bridge	Dale McGregor	Road	Jason Rhoades	Road
Marco Rosignoli	Bridge	John Anderson	Geotech	Matt Riegel	Geotech
Ted Zoli	Bridge	Bill Wiedelman	Traffic	John Siwula	Geotech
Finn Hubbard	Bridge	Jeff Dailey	Tolls	Amit Thomas	Traffic
Rich Bloch	Bridge	Jake Stremmel	Project	Kurt Codutti	Project
Scott Campbell	Project	Bob Fisher	Construction	Paul Huston	Project
Ken Ishmael	Construction			Brad Guilmino	Tolls

* Indicates breakout session spokesperson

Lunch (12:00 pm to 12:30 pm) ½ hour

Present morning ideas (12:30 pm to 1:00 pm) ½ hour

Workshop Materials: Agenda (Page 2 of 2)

Afternoon Breakout Session (1:00 pm to 5:00 pm) 4 hours

Session 2 - Thursday PM ***Focus on Innovative Ideas and Practical Design***

Name	Core Discipline	Name	Core Discipline	Name	Core Discipline
John Brestin *	Bridge	Jason Rhoades*	Road	Bill Wiedelman*	Traffic
Rob Turton	Bridge	Matt Simon	Road	Paul Huston	Project
Marco Rosignoli	Bridge	Charlie Dodge	Road	Scott Campbell	Project
Ted Zoli	Bridge	Dale McGregor	Road	Jake Stremmel	Project
John Anderson	Geotech	Ken Ishmael	Construction	Amit Thomas	Traffic
Matt Riegel	Geotech	Bob Fisher	Construction	Jeff Dailey	Tolls
John Siwula	Geotech	Finn Hubbard	Bridge	Kurt Codutti	Project
		Rich Bloch	Bridge	Brad Guilmino	Tolls

* Indicates breakout session spokesperson

Present Afternoon ideas (5:00 pm to 5:30 pm) ½ hour

DAY 3 – Innovation Sessions

Morning Breakout Session (8:00 am to 10:00 am) 2 hours

Session 3 – Friday AM ***Focus on Innovative Ideas along with ODOT Practices***

Name	Core Discipline	Name	Core Discipline	Name	Core Discipline
Scott Campbell*	Project	Jake Stremmel*	Project	Paul Huston *	Project
Rob Turton	Bridge	John Brestin	Bridge	Matt Simon	Road
Dale McGregor	Road	Jason Rhoades	Road	Charlie Dodge	Road
Matt Riegel	Geotech	John Siwula	Geotech	John Anderson	Geotech
Kurt Codutti	Project	Bob Fisher	Construction	Ken Ishmael	Construction
Finn Hubbard	Bridge	Rich Bloch	Bridge	Marco Rosignoli	Bridge
Jeff Dailey	Tolls	Bill Wiedelman	Traffic	Amit Thomas	Traffic
		Brad Guilmino	Tolls		

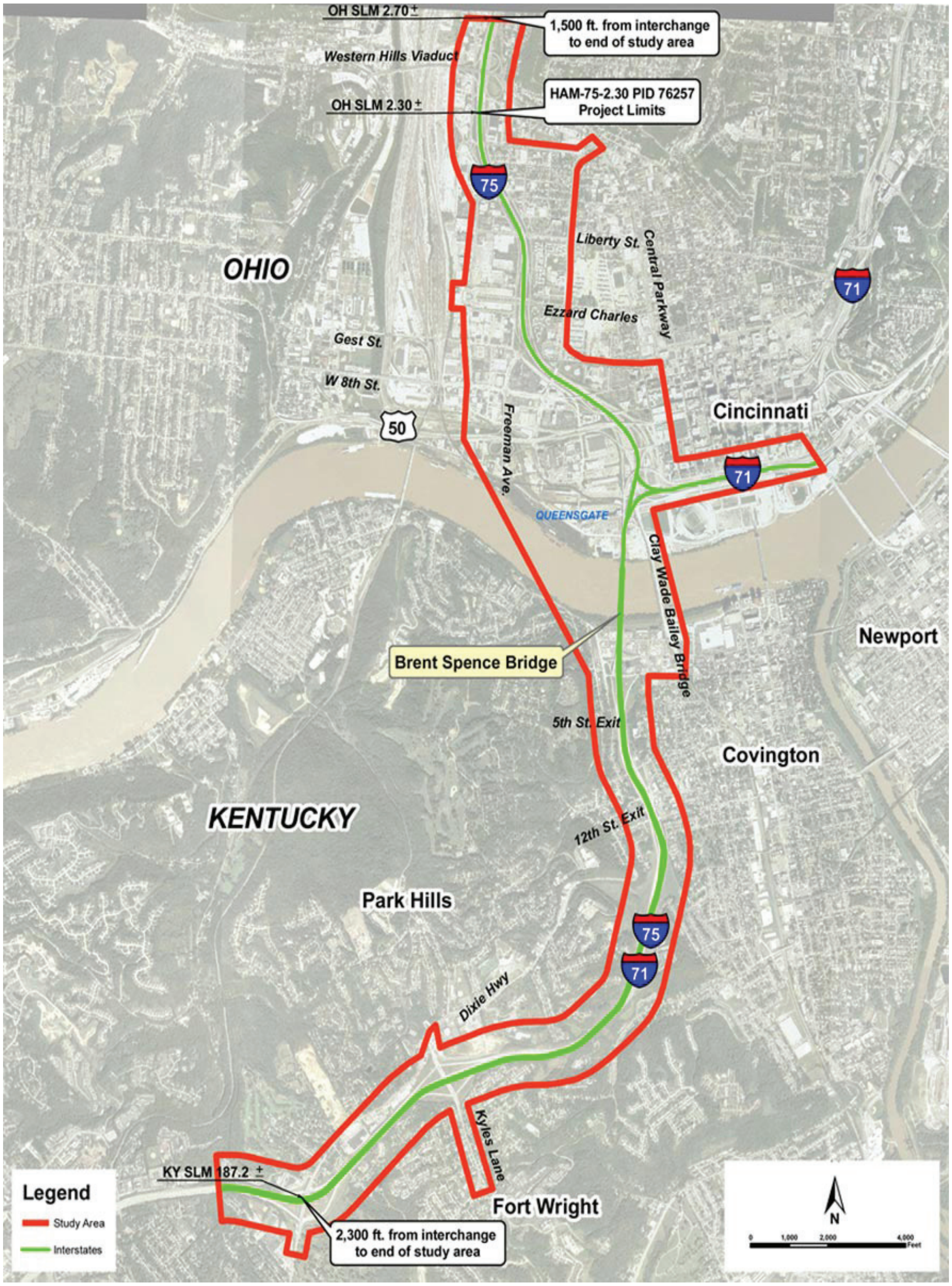
* Indicates breakout session spokesperson

Review morning ideas (10:00 am to 10:30 am) ½ hour

Collate ideas and follow-up tasks (10:30 am to 12:00 pm) 1½ hours

Workshop Materials: Handout 1 – Study Area

Brent Spence Bridge Study Area



Workshop Materials: Handout 2 – Preferred Alternative 1

Workshop Materials: Handout 3 – "Fish Finder"

THE "FISH FINDER"

Preliminary Cost / Schedule / Risk Analysis

Project: Brent Spence Bridge Project

Estimated Construction Cost = $ 1,391,800,000

Updated: 17-Oct-12

Project Component	Estimated Percent of Component Cost		Potential Cost/ Schedule/ Risk Saving Innovation Opportunity or Strategy	Est. Max. Cost Saving Potential Reduction Percentage (0-100%) (from Component)	VE Revised Component Cost Percentage	Estimated Owner's Cost (rounded)	Estimated Maximum Cost Savings (rounded)	Estimated VE Cost (Owner's less VE) (rounded)	Schedule Driver (Y/N)?	Construction Risk Driver (Y/N)?
Structures		**73%**								
River Bridge	34%				34%	$345,600,000	$0	$345,600,000		
Rehab existing	3%				3%	$31,800,000	$0	$31,800,000		
Approach bridges	52%				52%	$528,800,000	$0	$528,800,000		
Walls	10%				10%	$104,300,000	$0	$104,300,000		
Noise Barriers	1%				1%	$8,800,000	$0	$8,800,000		
					0%	$0	$0	$0		
Major Component Subtotals	*100%*			*0.0%*	*100.0%*	*$1,019,300,000*	*$0*	*$1,019,300,000*		
Roadway		**17%**								
Pavement	28%				28%	$64,500,000	$0	$64,500,000		
Drainage	10%				10%	$22,400,000	$0	$22,400,000		
Earthwork	27%				27%	$63,400,000	$0	$63,400,000		
Traffic control	9%				9%	$20,000,000	$0	$20,000,000		
MOT	3%				3%	$6,900,000	$0	$6,900,000		
Lighting	5%				5%	$11,500,000	$0	$11,500,000		
Incidentals (incl addt'l MOT)	19%				19%	$43,200,000	$0	$43,200,000		
					0%	$0	$0	$0		
Major Component Subtotals	*100%*			*0.0%*	*100.0%*	*$231,900,000*	*$0*	*$231,900,000*		
Other		**10%**								
ROW	40%				40%	$56,600,000	$0	$56,600,000		
Utilities	59%				59%	$83,400,000	$0	$83,400,000		
non-highway demo	0%				0%	$600,000	$0	$600,000		
					0%	$0	$0	$0		
					0%	$0	$0	$0		
					0%	$0	$0	$0		
Major Component Subtotals	*100%*			*0.0%*	*100.0%*	*$140,600,000*	*$0*	*$140,600,000*		
Project Totals		**100%**		***0.0%***		***$1,391,800,000***	***$0***	***$1,391,800,000***		

Other Non-Cost Schedule / Risk Drivers:

Non-Cost Project Component		Potential Schedule/ Risk Saving Innovation Opportunity or Strategy	Schedule Driver (Y/N)?	Construction Risk Driver (Y/N)?
Coast Guard Coordination / Approvals				
City of Cincinnati Coordination / Approvals				
FAA Approvals				
USACE Permit Approvals				
City of Covington Coordination / Approvals				

BRENT SPENCE BRIDGE PROJECT

Practical Design/Value Engineering WORKSHOP REPORT

APPENDIX B:
IDEAS AND INNOVATIONS MATRIX

Ideas and Innovations Matrix: Page 1 of 8

Practical Design Workshop - Ideas and Innovations

Project: **Brent Spence Bridge** **11/16/2012**

Innovation Number	Discipline / Major Cost Element	Proposed Design Innovation	Advantages	Disadvantages	Priority (High=H, Medium=M, Low=L, Practical Design = P)
1	Roadway	Truck Climbing Lanes on SB in KY	Increases safety and traffic flow on SB by keeping trucks in their own lane	Requires geometric and signing modifications to implement effectively; likely to increase cost. May have additional impacts to section 4(f), 6(f), and historic resources that would require more time to for coordination to revise the MOAs and re-evaluation of the environmental document	P
2	Systems	Reduce Number of Lanes over River	Reduces construction costs and long term bridge maintenance.	Potentially reduces level of service	P
3	Systems	Reduce Number of Lanes in KY	Reduces construction costs and ROW impacts	Potentially reduces level of service	P
4	Procurement	Phased Implementation	Under a P3 concession procurement, this allows improvements to be phased in based on need, not predetermined scope and schedule.	Extends implementation over a longer period.	P
5	Procurement	MAP 21 - Reconfirgure so maximimum number of lanes are tollable	Most revenue potential; potential of new BSB; adding shoulders back in could reestablish the amount of free lanes	Political acceptance	
6	Roadway	Existing Bridge Service Local / New Bridge serve thru Traffic or vise versa	Earlier decision point for drivers (thru versus local) improves traffic flow. Easier to sign. Allows for dynamic tolling on thru facility. Reduces cost of direct ramp connections on Ohio side with I-75/I-71.	Elimination of direct connections may require improvements on local intersections to handle capacity.	H
7	Systems	Consider Managed Lanes (Reversible, HOT, HOV)	Increases level of service on general purpose lanes by removing thru traffic. Allows for dynamic tolling.	Likely will not be effective without a wider range managed lane system	L
8	Procurement	Toll Local Lanes @ reduced cost	Additional revenue; political compromise; minimize evasion and impacts to existing system	MAP-21 authority; political acceptance; implementation plan	H
9	Procurement	(Toll Local Zip codes) Toll All Lanes, including locals	Revenue maximization; ease of implementation; eliminates connectivity of partially tolled plans	Political acceptance; diversion potential affecting existing network	H
10	Procurement	Toll all bridges in town	Can maximize revenue; can create most efficient traffic flows; can minimize diversion (traffic and cost benefits); can result in lowest BSB toll rates; enhances social justice by tolling all; creates a network; mitigates	MAP 21; political acceptance; increases toll technology capital and ops costs	H
11	Structures	Salvage more exist structures on OH side	Saves cost by reusing existing bridges that are in good condition.	Will require design exceptions due to clearances and geometrics;	M

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Ideas and Innovations Matrix: Page 2 of 8

Practical Design Workshop - Ideas and Innovations

Project: **Brent Spence Bridge** **11/16/2012**

Innovation Number	Discipline / Major Cost Element	Proposed Design Innovation	Advantages	Disadvantages	Priority (High=H, Medium=M, Low=L, Practical Design = P)
12	Systems	Reduce / Consolidate X-St Bridges in OH	Reduces construction impacts to traffic on mainline. Reduces number of bridges and retaining walls and future maintenance costs. Increases ROW for development opportunities.	Reduces east-west connectivity. May require improvements on local intersections to handle capacity. Potential for oppostion from city of Cincinatti and increase in time to get stakeholder acceptance.	H -->L
13	Roadway	Move 75 Thru lanes/bridge further west (similar to Queensgate option)	See #85	See #85	H -->L
14	Procurement	Use "Other" River Bridges to equalize movements and reduce some ramp movements in interchange	Could reduce the needed capacity of BSB, thereby reducing cost; reduces cost of ramps;	Capital costs to modify connectivity of "other" bridges; other bridges have limited connectivity and access	L
15	Systems	Remove some system to system interstate moves @ core of I/C - Force them to use C/Ds to make moves	Reduces cost by eliminating approach structures and pavement while simplifying MOT	Eliminates movements.	M
16	Systems	Keep existing system entirely intact for local connections, only add new req'd thru lanes	Reduces number of thru lanes. Conducive for tolling options as it separates thru from local.	Design exceptions for existing infrastructure	H
17	Roadway	Tear down Dunn-Humby building to optimize Interchange geometrics and reduce cost	Optimizes geometrics. Helps minimize design exceptions. Increases safety.	Loss of valuable property.	M
18	Structures	One new bridge on each side of Brent Spence to optimize connectors in Interchange and reduce cost	Built in the clear	Cost, Gas line, Geometrics	M
19	Roadway	Create Truck Only Lanes and toll them	See #6	See #6	P
20	Roadway	Move SB merge points further south in KY past the Cut in the Hill		Adds scope, changes project limits	L
21	Roadway	Regrade Cut in the Hill for flatter grades and make Express	Increases safety	Cost	M
22	Roadway	Put new Bridge East of Brent Spence in line with I-75 to salvage existing local street	Saves existing infrastructure on OH side. Avoids Duke Energy substation. Avoids Longworth Hall.	Need to verify geometry will work. Potential design exceptions. ROW impacts. Potential new environmental impacts	M
23	Structures	Remove Existing BSB Superstructures truss and build new bridge on exist foundations	See #29	See #29	H
24	Procurement	Developer control assests that generate revunue. If BSB is not replaced and is non-tolled, exclude from the P3	P3 bidders will add significant O&M or replacement costs for existing BSB; allows bidders to only be responsible for the facilities it is operating; cleanest for P3 arrangement; allows for the continued use of BSB; allows for free local tolling on existing	Public owners retain risk of existing BSB;	
25	Procurement	Reassess traffic projections & assignment, optimize the number of lanes for each movement and consider phasing and tolling	Saves near-term capital costs by only constructing required lanes	Requires additional buildout in future; phased approach could complicate P3 construct	H

Ideas and Innovations Matrix: Page 3 of 8

Practical Design Workshop - Ideas and Innovations

Project: **Brent Spence Bridge** — **11/16/2012**

Innovation Number	Discipline / Major Cost Element	Proposed Design Innovation	Advantages	Disadvantages	Priority (High=H, Medium=M, Low=L, Practical Design = P)
26	Procurement	Evaluate cost benefit of reconstructing/replacing the BSB (additinional revenue potential of tolling all lanes and O&M savings)	Maximizes revenue potential; could save costs of O&M; minimizes risk of existing BSB condemnation	Replaces BSB while some life is left on bridge	H
27	Structures	Build New River Crossing Bridge near Airport @ Mineola - Connect to US 50 for alternate route downtown	Everything is offline - significant reduction in congestion at spaghetti bowl	Re-opens FONSI	L
28	Structures	Replace the lower level deck/floorbeams with shallower sections (seated lower on the truss chords)	Greatly improves driver visibility for NB traffic on existing bridge.	Greatly increases cost for existing bridge rehabilitation.	L
29	Structures	Replace Existing Super Structure Only (verify fdns ok maybe widening)	Reduced Life Cycle Cost - likely reduction in bid in P3 environment	Higher First Cost	H
30	Structures	Replace Existing in entirety (1 or 2 new)	Everything is built in the clear, no question about condition of substructure	Substructure is in good condition	L
31	Structures	Build new Bridge offline and close exist for rehab (detour 71). The conceptual MOT plan already investigated this idea.	MOT - very little disruption to traffic	expense of cross-overs	H
32	Structures	New Bridge type - tied arch: Build offline and float in. Minimize length of "complex bridge" (no backspans). Existing bridge is 830' mainspan for 800 nav channel. No sidechannel requirements. Ht of arch restricts offline to adjacent pools (new & exist)	Saves significant dollars, aesthetically pleasing. Form meets function		H
33	Structures	Triple decker on exist foundations (elim fdns in river?)	Eliminates need to build new substructure in river, tighter footprint	All the disadvantages of a double decker intesified: Longer approach bridges, signage is complicated. Poor Aesthetics.	L
34	Structures	Twin new arch supers (830' spans): 8 lanes each - facilitates cost and schedule considerations (verify capacity/condition of exist fdns)	Saves significant dollars, aesthetically pleasing. Form meets function		H
35	Structures	Triple deck on new alignment with demo of existing			L
36	Structures	Approach bridge - PC or Stl Girders			P
37	Structures	Approach Bridge - Stretch spans toelim piers			P
38	Structures	Approach bridge - Rehab vs replace (stack alt)			P
39	Structures	Keep CS on lower level of exist & decommission top level, put I-71 NB on new single level bridge…toll new bridge w "free" CDs on exist br…w/ new CD bridge in future			L
40	Procurement	Keep CD & Interstate on separate facilities/separate procurements	Cleaner to have a smaller P3 procurement for just tolled facility; allows public flexibility to allow free or higher connectivity	Smaller transaction	H
41	Procurement	Procurement issue that takes adavantage of "best value" vs "lowest cost" (CJV can get credit for valuable alt)			P
42	Procurement	Tolling policy ---> differential rates to control leakage	Charging non-transponder customers a higher rate encourages transponder penetration thereby reducing transaction costs and leakage		
43	Roadway	Queensgate alt looks best from bridge perspective / ops---> FONSI issue?			L
44	Structures	Dbl deck Alts to consider castellated trusses for longitudinal frames	great idea, but there is not much benefit to studying it		L
45	Structures	Land bridges: Segmental Plate girdgers, PC girders, Stl tubs (tight radius curves)	Cost - when worked in conjunction with roadway geometry		H
46	Structures	Reconfig required if reuse mainspan from Alt I			

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Ideas and Innovations Matrix: Page 4 of 8

Practical Design Workshop - Ideas and Innovations

Project: **Brent Spence Bridge** **11/16/2012**

Innovation Number	Discipline / Major Cost Element	Proposed Design Innovation	Advantages	Disadvantages	Priority (High=H, Medium=M, Low=L, Practical Design = P)
47	Roadway	Reduce connectivity at spaghetti bowl	Reduces construction impacts to traffic on mainline. Reduces number of bridges and retaining walls and future maintenance costs	Reduces east-west connectivity. Eliminates direct connections from mainline to local. May require improvements on local intersections to handle capacity. Potential for local opposition. May take additional time to gain stakeholder acceptance.	H -->L
48	Systems	Westernhillls viaduct access ramp: Eliminate or Develop alts			L
49	Roadway	Run CD thru end spans rather than replace (both Dixie & Kyles)	Saves initial cost by maintaining bridge in place.	May increase future maintenance costs by keeping older bridge in service.	M
51	Structures	Use Single level bridge vs. double deck	single level options have the benefit of reducing number of shoulders, length of approach bridges, a safer system and improved aesthetics	Larger footprint, potential for additional ROW	H
52	Structures	less wide shoulders, less pavement, less sq ft bridge, less ret walls. Need further policy discussion with ODOT prior to advancing this idea.	This is practical design - best value, MoDOT has had significant success in stretching their budgets with this approach	violates standards	M
53	Structures	Piles instead of shafts	good idea …. Not worth studying		L
54	Roadway	Relocate the gas line (2x12")			L
55	Structures	Widen Exist pier (see sketch)	works in conjunction with replacing the superstructure - need to study to get cost		H
56	Structures	Arches: Use Networked cables, I-shaped Rib, Use lifiting towers on barges, float in low, FB and stringers, strings (framed in) / Composite tie, Basket handles (Aesthetoics +10%), 2-60' wide arches + Existing, 3x75' arches -> 15 lanes	works in conjunction with replacing the superstructure - need to study to get cost		H
57	Structures	Arches: Grid Deck, Lt Wt Concrete, HPC, Weathering Steel, Knuckle Detailing, (Blennerhassett, Champlain), Arch Rib (Conc Filled Pipe)	good idea …. Not worth studying		L
58	Structures	Flat Slab Cable Stayed: 3 x 70 Bridges, CIP on Backspan, Traveller main span, semi fan cables, hollow towers, stress from deck, no saddles in tower	Should study to get a cost		H
59	Structures	Cable Stay - Semi Fan, Match E.G Depth to F.B., long. PT only in Tension Regions, Saddles/Keep Cables Vert., Vertical Pylons, Avoid Ballast by "pushing in" end piers - Use approach spans, Hollow Pylons, Drilled Shafts (Cap) - River Pier Fntn, Multi Column Bent @ Rest Pier	good idea …. Not worth studying		L
60	Structures	Segmental - Uniformity of X-section-->clean up geomoetry, Gantry - Mainline, Beam/Winch--> Flyovers/Ramps, Overlay the segments	worth moderate study to price		M
61	Structures	Pier spacing on Approaches w/ Tied Arch	works in conjunction with replacing the superstructure - need to study to get cost		H
62	Structures	Gentle Curveys-->P/C & Steel work	works in conjunction with spaghetti bowls improvements - should study		M
63	Structures	Twin - One Level Arches--$800/ft--> CS or Arch, Dbl Deck=200 ft, single deck = 160 ft, $250 Approachs COST SAVINGS: $320 - $170 = $150M	Need to Determine more accurate cost		H
64	Structures	New Super on Existin Sub (Main River Unit)	covered above		H
65	Structures	Rehab Aproaches vs Replace Approaches w DBL Decks = Saves $40M	works in conjunction with replacing the superstructure - need to study to get cost		H

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Ideas and Innovations Matrix: Page 5 of 8

Practical Design Workshop - Ideas and Innovations

Project: Brent Spence Bridge — 11/16/2012

Innovation Number	Discipline / Major Cost Element	Proposed Design Innovation	Advantages	Disadvantages	Priority (High=H, Medium=M, Low=L, Practical Design = P)
66	Procurement	P3: Legislation to Toll: - KY - Ability and Enforcement (leakage)	Tolling legislation necessary for procurement; enforcement critical to maintain revenue and bankability; allows for procurement acceleration; reduces public subsidy	Political acceptance	H
67	Procurement	P3: Prefer the entire project - Has to be large	Larger project is the most attractive to bidders	Makes phasing difficult; larger cost so larger public subsidy	
68	Procurement	Leave open so more options for existing BSB; points for replacement of existing	Replacement of BSB might increase value; cost savings can be outweigh original scope	Limits control of public agencies	H
69	Procurement	P3: Duration of 50 years+	50 years is the sweet spot for concessions	Present valuce calculation doesn't provide much value over 50 years	
70	Procurement	P3: Tolling--> Meters for local/thru traffic		KY doesn't want it	
71	Procurement	DB: Non - Prescriptive Perfomance Spec = $$$	Flexibility increases value; cost savings can be outweigh original scope	Limits control of public agencies	H
72	Procurement	DB: Give Credit for Deleting BSB ($100M)			H
73	Procurement	DB: Reward Aeisthetics --> Advisory Committee (KCIcon)			H
74	Procurement	DB: Fixed Price/Flexible Scope			H
75	Procurement	DB: One on One Meetings			H
76	Procurement	DB with more Control Ideas: Dynamic DB (70% dwgs), ATCS, DBB w/ATCs, One Step, Reward for removing Dbl Deck (Safety)			
77	Procurement	DBB: Segment Project: KY - OH - River Bridge (Separate River Bridges)			
78	Procurement	DBB: DBB w/ATCs			
79	Procurement	DBB: Lane Rentals			
80	Procurement	DBB: Tolls ---> Work through a segment that is "Tollable"			
81	Roadway	Modify C/D system @ Dixie & Kyles (Save Existing Bridges) - move CD ramps outside and either over/under, Frontage Road/Split Diamond, Braided Ramps (see onion skin)	Reduces construction impacts to traffic on mainline and crossroads. Utilizes the life of the existing bridges. Level of Service on mainline will not be impacted. Depending on the option, can save construction cost and time.	Depending on option, may require modifications to the IJR, less direct access, and additional bridges to maintain.	H
82	Roadway	Widen Existing Pavement in KY (no full depth reconstruction)	Reduces construction costs by salvaging existing pavement.		H
83	Systems	Eliminate Lanes north of Kyles to 12th St based on Traffic Volumes			M
84	Roadway	Reduce 5% grade on KY side with Profile Adjustment and/or split grades (truck impact)(repeat)	Increases safety	Cost	M

Ideas and Innovations Matrix: Page 6 of 8

Practical Design Workshop - Ideas and Innovations

Project: **Brent Spence Bridge** **11/16/2012**

Innovation Number	Discipline / Major Cost Element	Proposed Design Innovation	Advantages	Disadvantages	Priority (High=H, Medium=M, Low=L, Practical Design = P)
85	Roadway	Shift new Alignment west for I-75 traffic, maintain I-71 traffic in place - Shift I/C North, West and use existing road corridor. Reconstruct I/C with 50, tie system connection between 75 and 71 using 50 corridor.	Signficant cost savings could be achieved along with significant economic development opportunities for the city of Cincinatti. Although on a skew, using a flat tied arch bridge maybe cheaper than the double-decker proposed in the preferred alternative due to the reduction in total number of lanes, shoulder widths, and having a single deck versus a double deck. Many existing I-71 interchange elements can be rehabilitated instead of replaced. Significantly reduces new infastructure within congested construction area immediately downtown - reduces construction cost as a result. Improved geometrics, improved safety. Potential phased construction opportunity with I-71 and I-75 corridors developed separately. Separates complicated/confusing system movements - will be easier for drivers to navigate. I-75 corridor and bridge crossing would be constructed offline, lessening the construction impact to drivers, businesses, civic events. The N/S corridor on the OH side of the river would carry fewer lanes, making it a less divisive element of the downtown infastructure. The cross connection structures would be shorter and less expensive.	Skewed river crossing increases the length. Potential impacts to businesses along I-75 corridor. This alignment is an improved variation of an alignment that was previously studied and rejected by the City. Potential for local opposition, difficulty acquiring stakeholder acceptance, and additional impacts to section 4(f), 6(f), and historic resources	H -->M
86	Roadway	Flip I-75 and I-71 alignments			M
87	Systems	Utilitize the CWB Bridge as the C/D Bridge, widen and shirft new alignment to the east (repeat)			L
88	Roadway	Reduce/Eliminate low-volume connections on Ohio side - Combine bridges, eliminate 4th to NB ramp (see onion skin)	Reduces construction impacts to traffic on mainline. Reduces number of bridges and retaining walls and future maintenance costs. Increases ROW for development opportunities.	Reduces east-west connectivity. Eliminates direct connections from 4th to NB. May require improvements on local intersections to handle capacity.	H -->L
89	Structures	use fill plugs to eliminate bridge spans			M
90	Roadway	Western Hills Viaduct - Roundabout - CD System (see onion skin)			L
91	Structures	Build one new bridge, tear down old, consider life cycle costs			M
92	Structures	Build river crossing new airport, connect to US 50 to reduce truck volumes			L
93	Procurement	Break out Kyles lane I/C and south as DBB ($200M)			M

Ideas and Innovations Matrix: Page 7 of 8

Practical Design Workshop - Ideas and Innovations

Project: **Brent Spence Bridge** **11/16/2012**

Innovation Number	Discipline / Major Cost Element	Proposed Design Innovation	Advantages	Disadvantages	Priority (High=H, Medium=M, Low=L, Practical Design = P)
94	Procurement	Add Tolled E/W Connections (existing connection to west side of city currently only served by Western Hills Viaduct, 8th Street Viaduct, Hopple Street Viaduct, & US 50)	Look for additional revenue options, if additive to the system of tolling new movements. May help city of Cincinatti fund replacement of Western Hills Viaduct.	new revenue must outweigh the cost; political ability of new tolling; connectivity abilities	H
95	Procurement	Retro Actively introduce managed lanes farther north (say to I-275)	Ability to generate additional revenue; tolling for new interstate capacity is allowed	Requires additional tolling approval; additional tolling along the corridor in additional to the bridge	H
96	Procurement	Utilize toll credits for Federal Match	Allows states to meet local match if this is a problem		
97	Procurement	Phase Implimentation of modified queensgate option to allow completion of ES w/o delaying start			L
98	Procurement	Defer from Linn St to the north ($170M)	Saves initial construction cost	Complete project need not being met.	L
99	Roadway	Use Design Speed = Posted Speed			P
100	Roadway	Take Advantage of Criteria reduction w/switch from interstate to local			P
101	Roadway	Flip shoulders on ramps to reduce width/improve HSSD			P
102	Roadway	Tie Barrier Size/Type to design speed			P
103	Roadway	Reduce Pavement thickness based on actual utilization			P
104	Roadway	Keep local traffic on existing bridge w/ thru traffic on new	Earlier decision point for drivers (thru versus local) improves traffic flow. Easier to sign. Allows for dynamic tolling on thru facility. Reduces cost of direct ramp connections on Ohio side with I-75/I-71.	Elimination of direct connections may require improvements on local intersections to handle capacity.	H
105	Procurement	Optimize construction phasing for revenue/lower construction cost	Full funding not required upfront; build additional bridge/lanes as needed; test tolling elasticity and revenue potential on a smaller scale; allows time to pursue other enviro approvals	Difficult to include future build scenarios in one P3; large bundled project is attractive to bidders;potentially lose economies of scale;	H
106	Roadway	Utilize other state standards			P
107	Roadway	Use minimum vertical underclearance. In Ohio, the minimum vertical underclearance for most locations is 15' 6" and can be less than this over some local streets.			P
108	Procurement	Forget tolling existing bridge --> Garner public support for the "New" tolled bridge, maybe managed lane, Bus Lanes	Could potentially allow KY legislature to approve faster this February if some local tolling is free	Reduces revenue; reduces ultimate control over project	
109	Roadway	Design Speed = Post Speed			P
110	Procurement	Performance Based - Design to LOS not # of lanes	Saves near-term capital costs by only constructing required lanes	Requires additional buildout in future; phased approach could complicate P3 construct	H
111	Procurement	Staged pavement construction, Bid Alt Pavement Designs, Bid years of Life			H
112	Procurement	Include Maintenance Plan in Evaluation Criteria			
113	Procurement	Design /Build to Budget (phased per funding) (include min perf rqmts)			
114	Procurement	Order of Events --> Segmented Contracts, Who do you toll first?, Commuters=Biggest Bang $$$			
115	Roadway	Bus on Shoulder, other transit options			L
116	Systems	HOV/Managed Lanes			M

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Ideas and Innovations Matrix: Page 8 of 8

Practical Design Workshop - Ideas and Innovations

Project: Brent Spence Bridge — 11/16/2012

Innovation Number	Discipline / Major Cost Element	Proposed Design Innovation	Advantages	Disadvantages	Priority (High=H, Medium=M, Low=L, Practical Design = P)
117	Procurement	Commuters get a break if they car pool	Could reduce the number of lanes required; allows some free movements for carpools; discount only for registered carpoolers can help overall revenue collection if everyone else is tolled	Reduces a small amount of revenue	H
118	Systems	Think in terms of moving people not cars, more modern approach			M
119	Systems	Consolidate the crossings - local streets (repeat)	Reduces construction impacts to traffic on mainline. Reduces number of bridges and retaining walls and future maintenance costs	Reduces east-west connectivity. May require improvements on local intersections to handle capacity. Potential for oppostion from city of Cincinatti and increase in time to get stakeholder acceptance.	H --> L
120	Roadway	Eliminate the C-D system and use Frontage Concept (repeat)	Consolidates access points to/from downtown from the corridor. Simplifies the local access points, making the I/C easier to navigate. Similar to Ft Washington Way concept - familiar facility.	Reduces east-west connectivity. Many local intersection required. Potential for oppostion from city of Cincinatti and increase in time to get stakeholder acceptance.	H --> L
121	Procurement	Allow Concession to include Land rights for "Freed" property. Most of the L/A R/W is under easement from the city of Cincinatti.			L
122					
123	Roadway	Express lanes: Build new 4 lane bridge on west side, build new 3 lane bridge east side, Rehab Exist to be 3 top/3 bottom for locals (Bill & Dales' idea) see onion skin	Allows for utilization of existing connections in Ohio or other innovations to reduce cosntruction impacts and cost. Allows for effective implementation of truck climbing lanes on inside lane of SB on Kentucky side for improved safety and traffic flow. Allows for reduction of lanes over the River for reduced construction cost and long term bridge maintenance. Allows for utilizing existing bridge substructure to build new bridge in place.	Need to verify geometry on Kentucky side will work. East side bridge may result in additional ROW and new environmental impacts. Elimination of direct connections may require improvements on local intersections to handle capacity.	H
124	Roadway	Frontage road system on OH spaghetti bowl rather than C-D. Fits into City grid. Eliminates numerous overpass crossing structures. (see onion skin)	Reduces construction impacts to traffic on mainline. Reduces number of bridges and retaining walls and future maintenance costs	Reduces east-west connectivity. Eliminates direct connections from mainline to local. May require improvements on local intersections to handle capacity. Potential for opposition from city of Cincinatti and increase in time to get stakeholder acceptance.	H --> L

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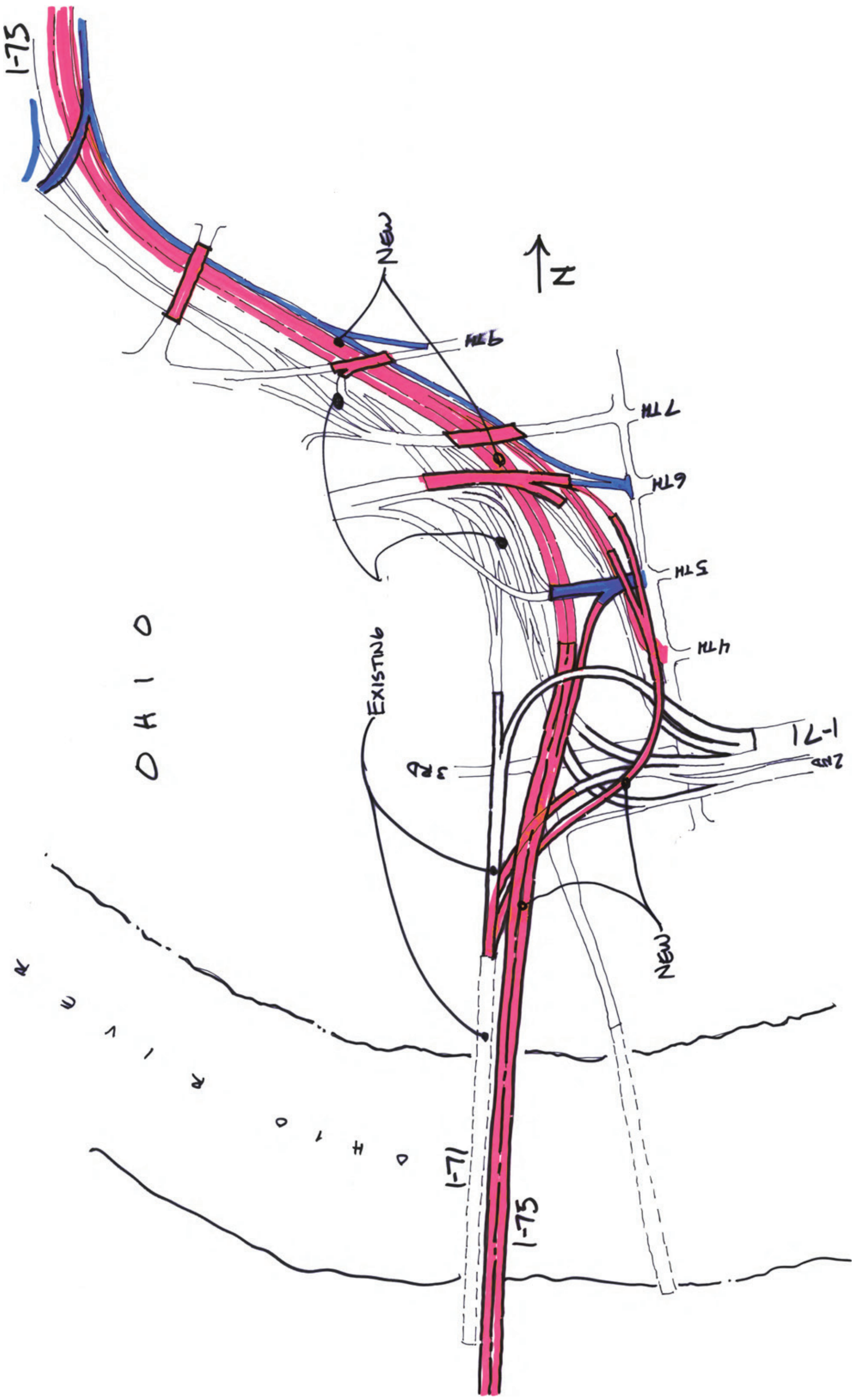
BRENT SPENCE BRIDGE PROJECT

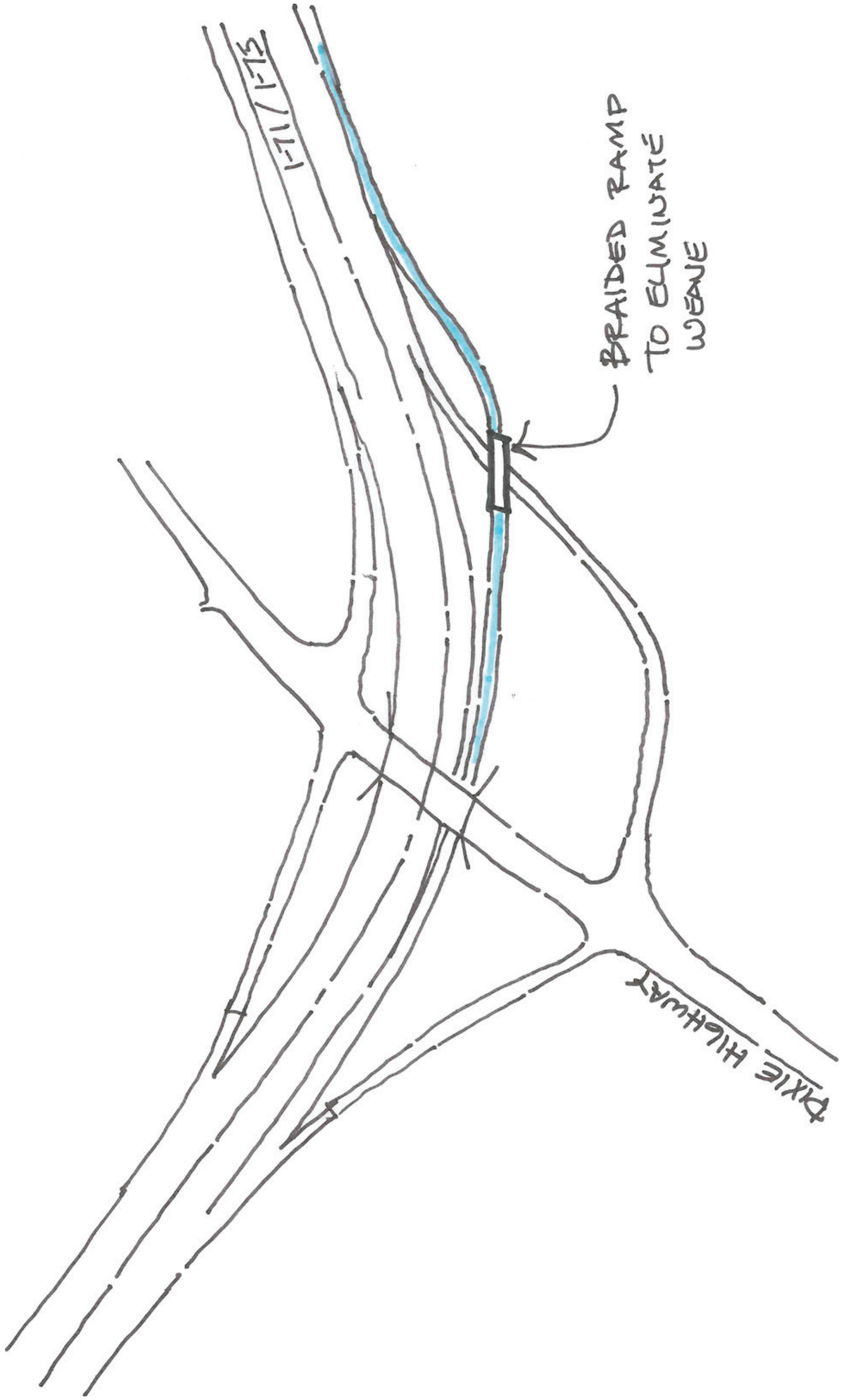
Practical Design/Value Engineering WORKSHOP REPORT

APPENDIX C: INNOVATION CONCEPTS

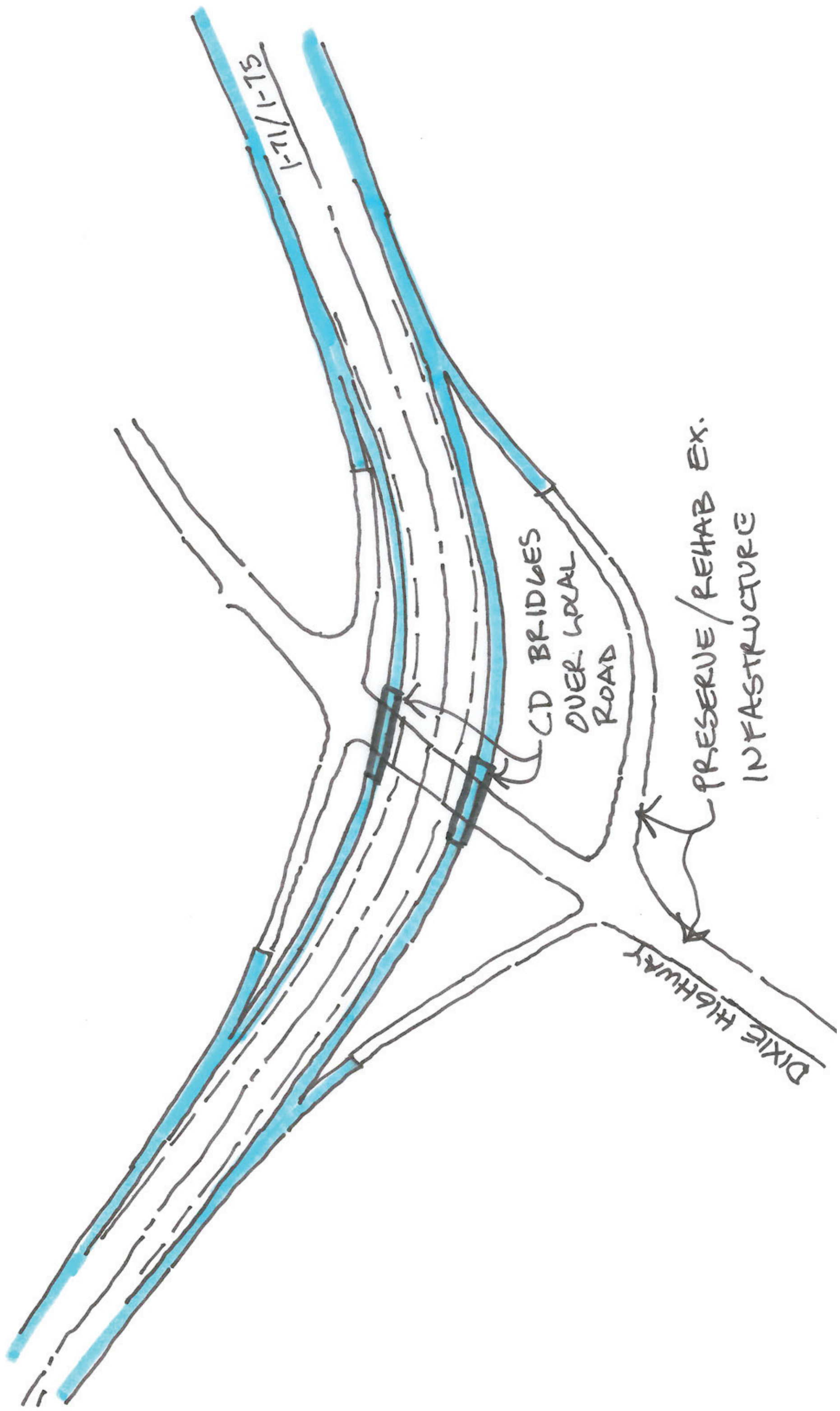
Innovation No. 22 East Concept



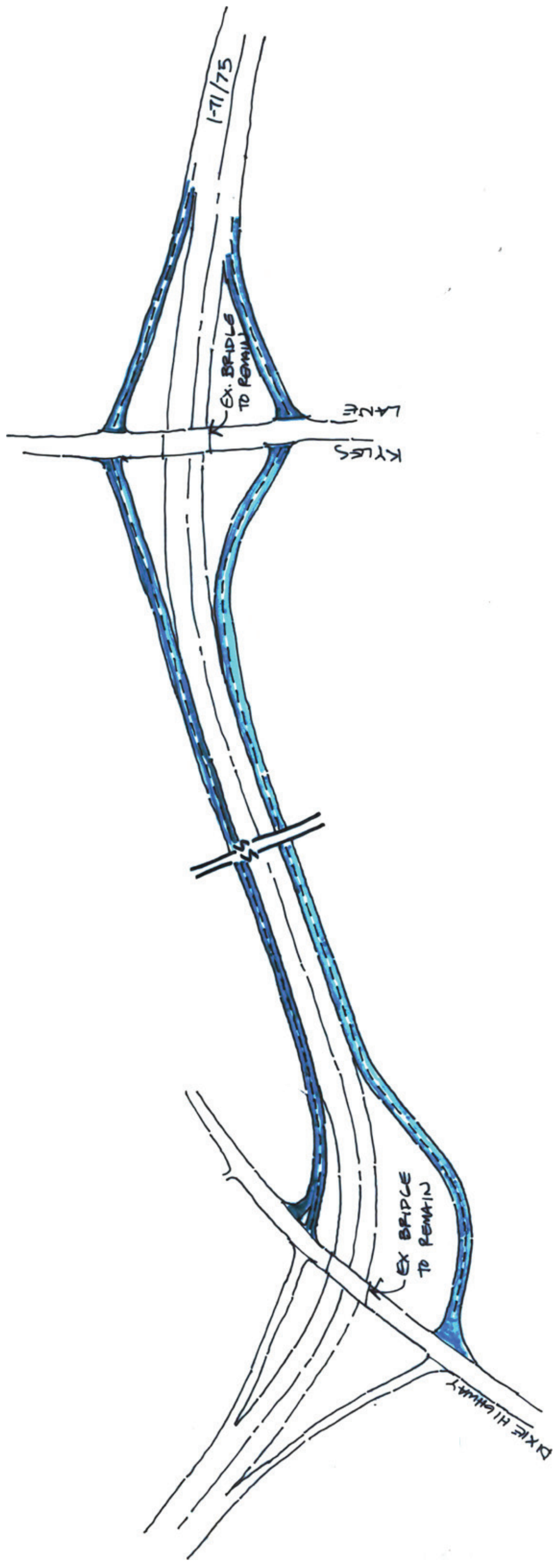
Innovation No. 81 Braid Concept



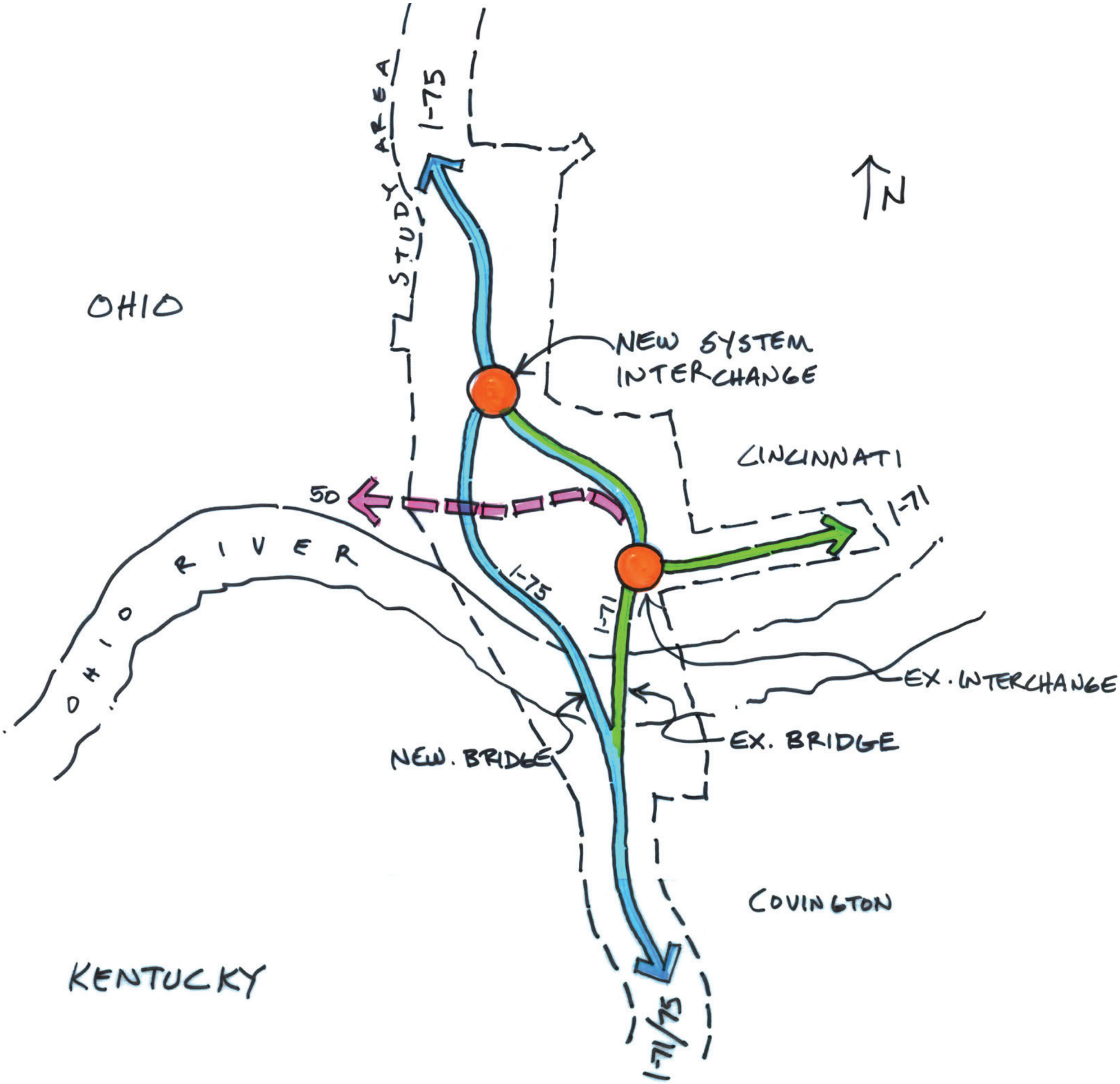
Innovation No. 81 C-D Bridges Over Concept



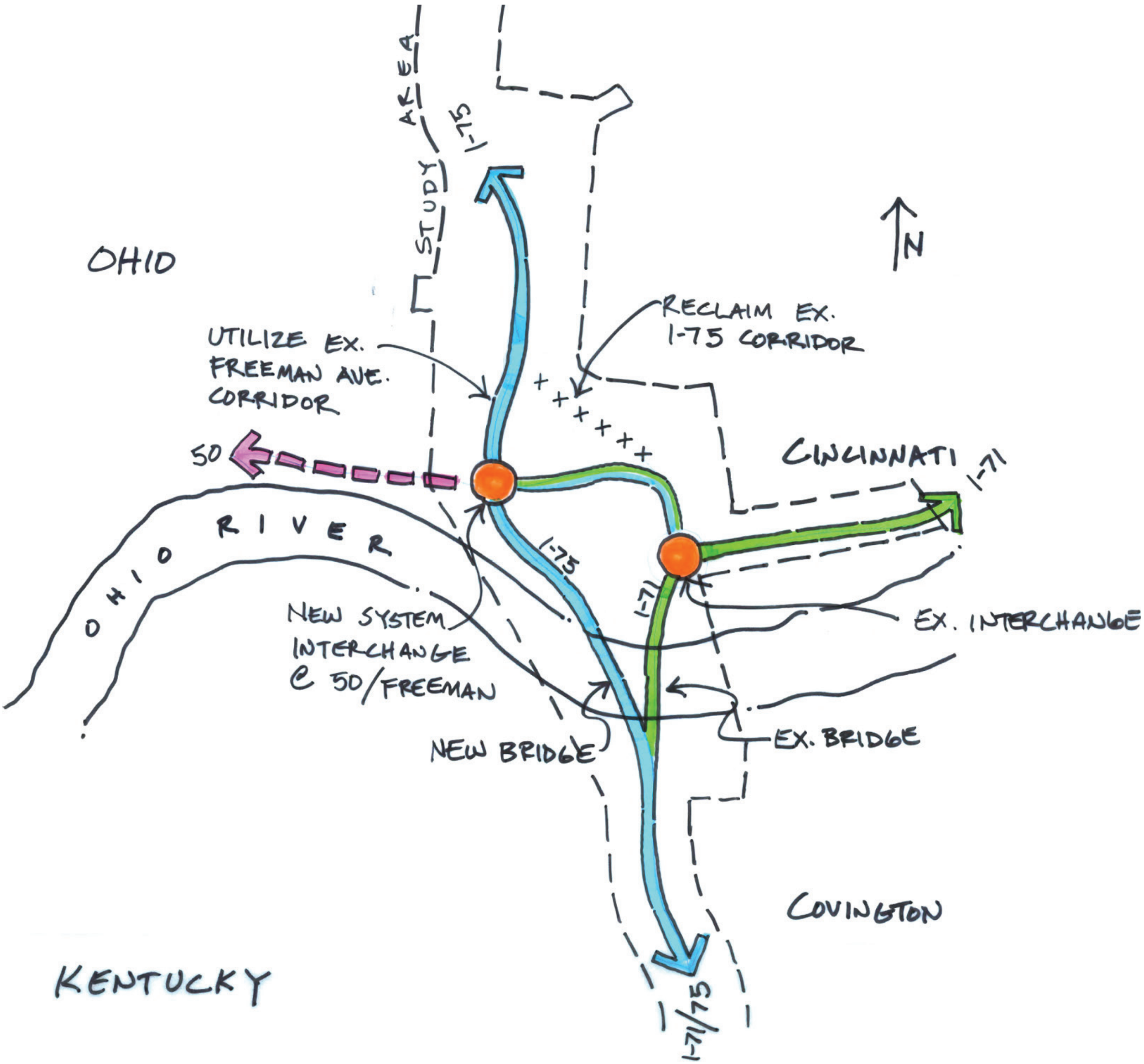
Innovation No. 81 Split Diamond Concept



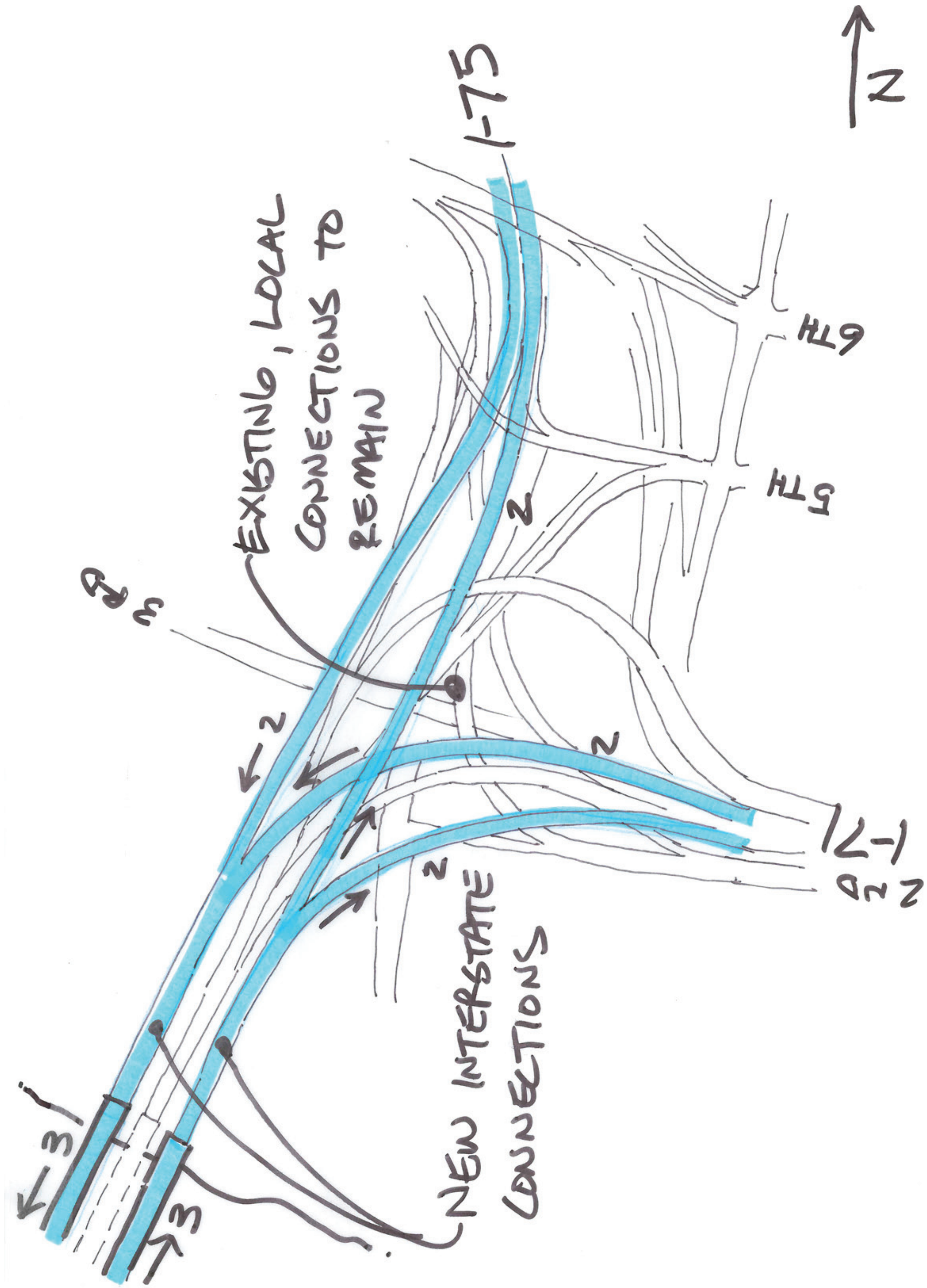
Innovation No. 85 Move Interchange North Concept



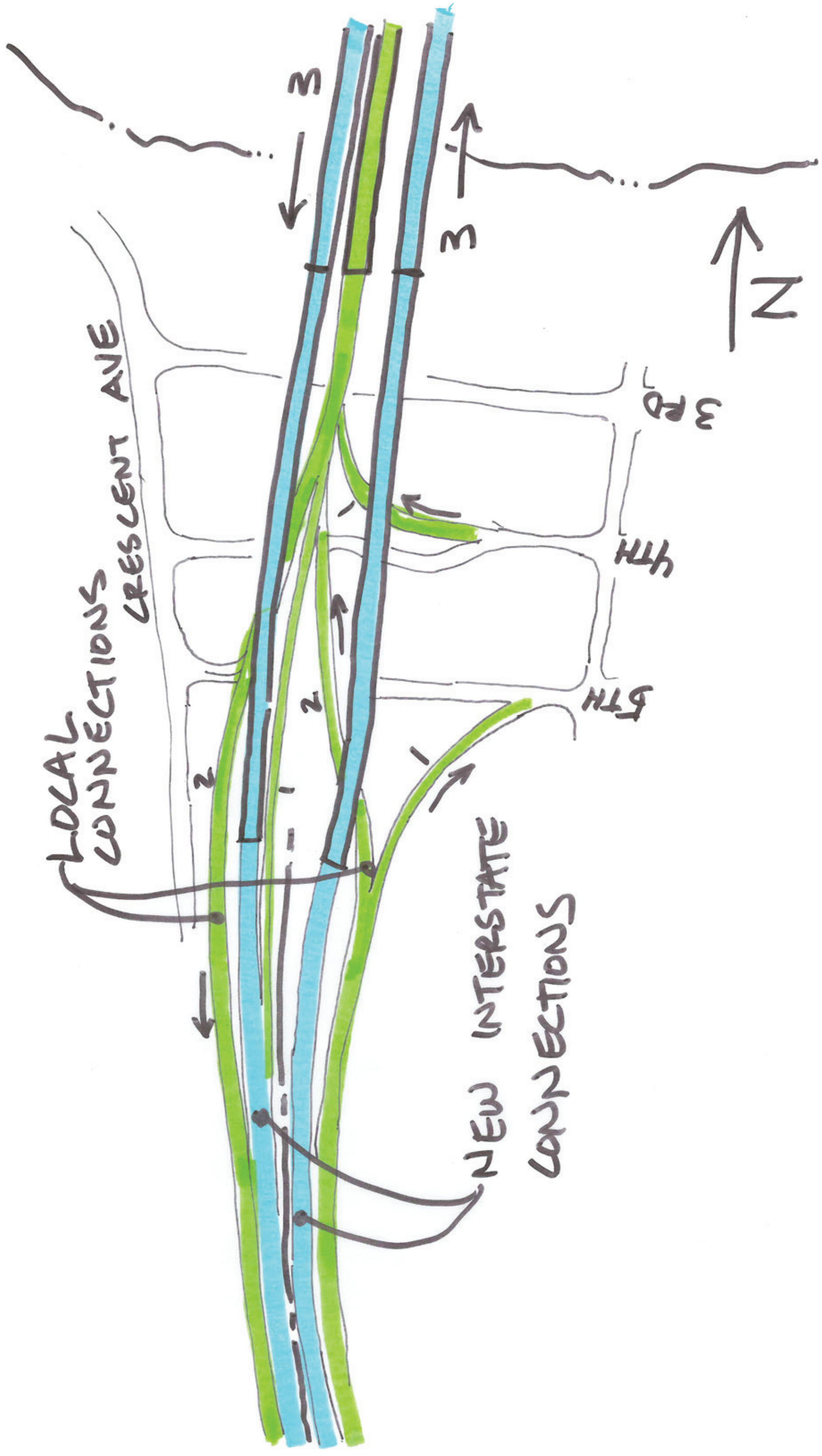
Innovation No. 85 Move Interchange West Concept



Innovation No. 123 Express Lanes Concept – Part 1



Innovation No. 123 Express Lanes Concept – Part 2

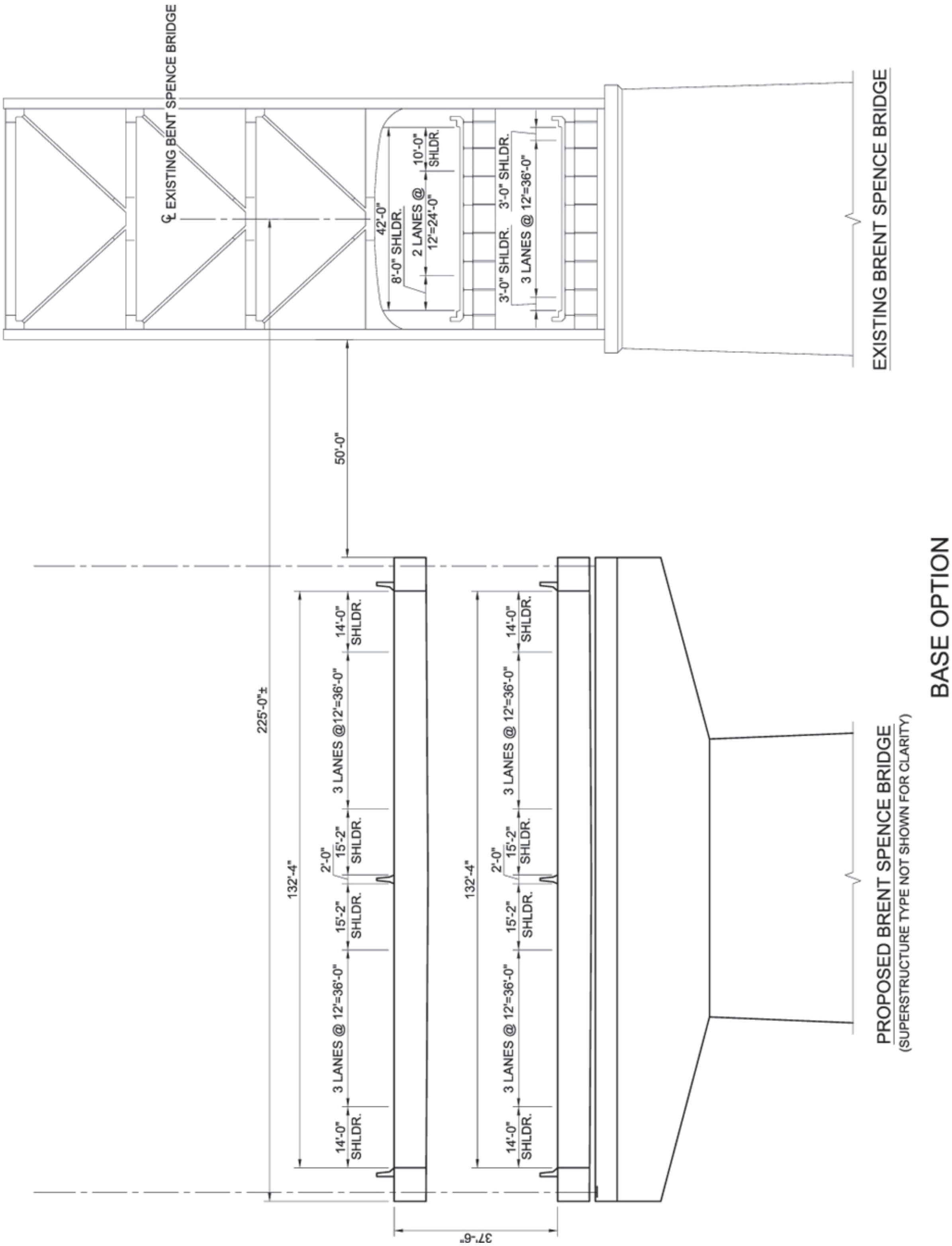


BRENT SPENCE BRIDGE PROJECT

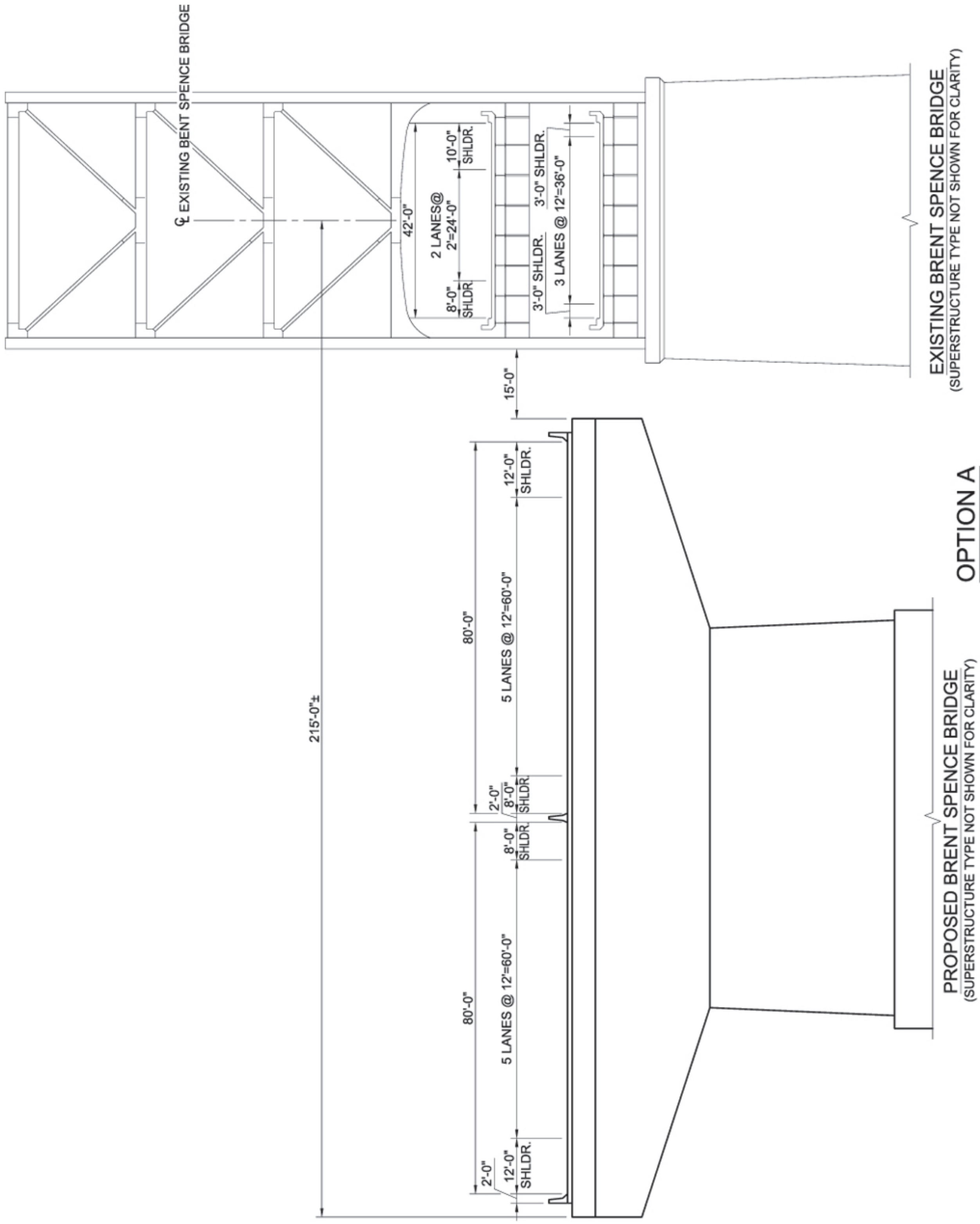
Practical Design/Value Engineering WORKSHOP REPORT

APPENDIX D:
BRENT SPENCE BRIDGE OPTIONS

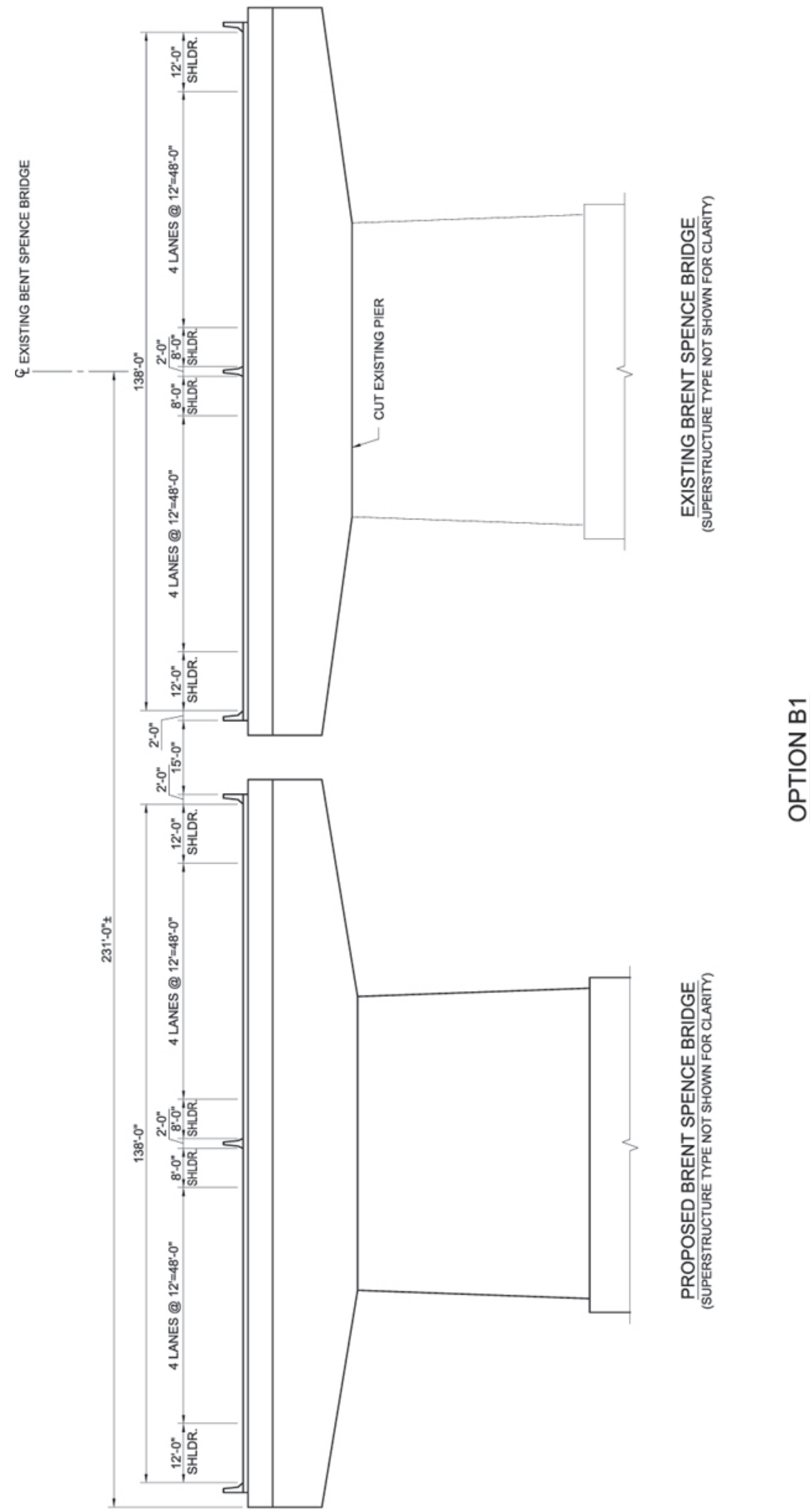
Brent Spence Bridge – Base Option



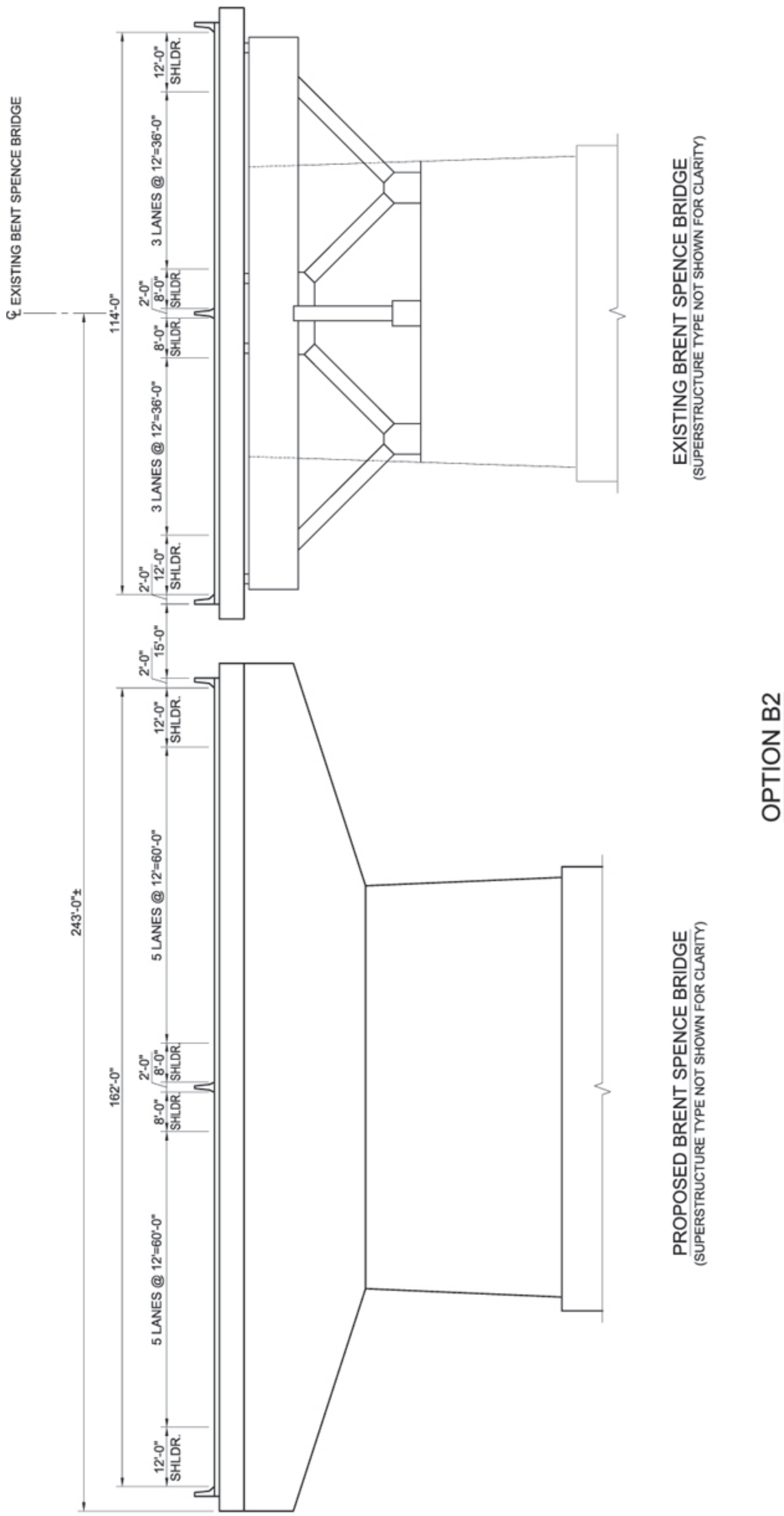
Brent Spence Bridge – Option A



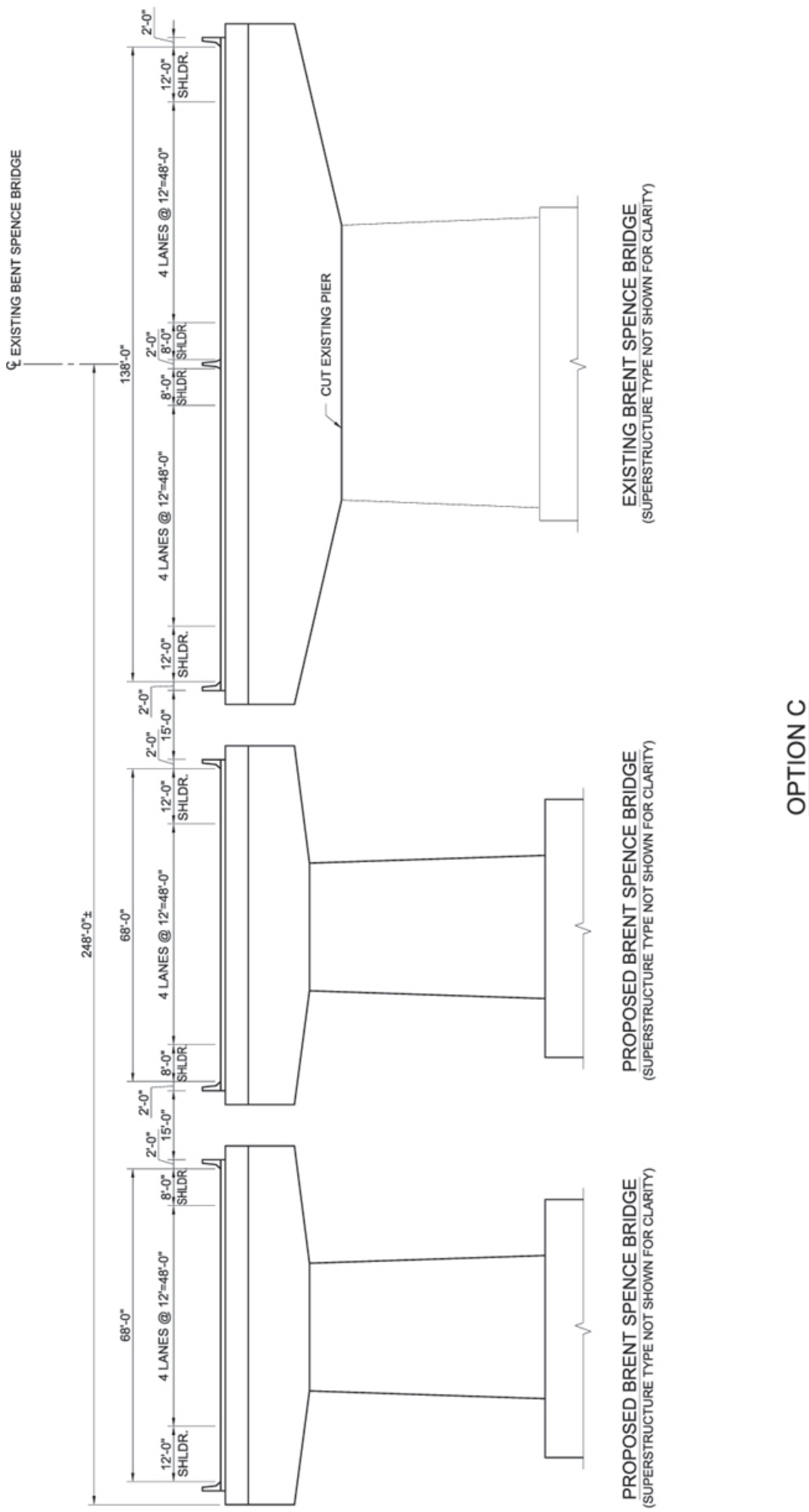
Brent Spence Bridge – Option B1



Brent Spence Bridge – Option B2



Brent Spence Bridge – Option C



BRENT SPENCE BRIDGE PROJECT

Practical Design/Value Engineering **WORKSHOP REPORT**

APPENDIX E:

BRENT SPENCE BRIDGE DESIGN EXCEPTIONS – ALTERNATIVE I

Brent Spence Bridge Design Exceptions – Alternative I: Page 1 of 8

Brent Spence Bridge
Design Exceptions - Alternative I

I-71/I-75/US 50 INTERCHANGE	Station	Design Exception	D.E. Number	Design Speed Met (Required)	Horizontal Dc (Maximum)	Horizontal SSD (Minimum)	Vertical Curvature - K (Minimum)	Other	Design Speed Existing	Reason(s) For Design Exception	Potential Impact(s) to Eliminate Design Exceptions	Potential Mitigation Solutions
Interstate 75 (OH)	CURVE NO. 5 PI Sta. 24+98.87 (Horiz.)	Y	1	57 mph (60)		526' (570')			44 mph	• The line of sight for the northbound inside lane is impeded by the median barrier and the southbound outside lane a the bridge parapet. • The proposed 12' median shoulder (minimum) needs to be widened to 20' to meet the needed sight distance. • The median shoulder width was discussed with the Office of Roadway Engineering and a guideline was given to cap the width at 12'. This is due to several factors; expense, excessively wide shoulders can confuse drivers and be used as a passing lane, and collecting debris.	• Widen the inside shoulder for the I-75 NB. This can be accomplished by either linearly transitioning the shoulder or separating the NB and SB horizontal alignments. The two profiles will be different as well and bifurcated barrier will be required. This will impact the potential connection from Clay Wade Bailey Bridge to I-75. • If this potential connection from Clay Wade Bailey Bridge is to be maintained, all NB alignments will need to shift to the East potentially causing vertical clearance issues with US 50 WB and I-71 SB. This would potentially impact the Dunnhumby Building also. • If using a flatter curve, 5 structures (businesses) could potentially be impacted and additional impacts to Longworth Hall would be needed. • A design speed of 55 MPH would also fix this design exception.	• Add Signage/ Lighting
	Sta. 23+00 to Sta. 27+00 (Southbound Only)	Y	2					6.0% (Downgrade)		• A grade of 6.0% (5.0 % max) needed to achieve clearance over the existing railroad/I-71 SB to SB CD Road and under I-71 SB to SB CD Road to maintain a 60 mph design speed. The 6.0 % grade has a tangent length of 150'.	• Shift SB CD Road alignment further West so that the lower deck does not cross under the upper deck until after the existing railroad. This would increase the impact to Longworth Hall and could potentially impact 4 additional buildings and parking.	
	CURVE NO. 6 PI Sta. 33+88.15 (Horiz.)	Y	3	51 mph (60)		443' (570)			50 mph	• The line of sight for the inside lane is impeded by the median barrier. • The proposed 12' median shoulder needs to be widened to 25' to meet the needed sight distance. • The median shoulder width was discussed with the Office of Roadway Engineering and a guideline was given to cap the width at 12'. This is due to several factors; expense, excessively wide shoulders can confuse drivers and be used as a passing lane, and collecting debris. • 55 mph would require a 17' minimum shoulder.	• Widen the inside shoulder for the I-75 NB. This can be accomplished by either linearly transitioning the shoulder or separating the NB and SB horizontal alignments. The two profiles will be different as well and bifurcated barrier will be required. This will impact the potential connection from Clay Wade Bailey Bridge to I-75. • If this potential connection from Clay Wade Bailey Bridge is to be maintained, all NB alignments will need to shift to the East potentially causing vertical clearance issues with US 50 WB and I-71 SB. This would potentially impact the Dunnhumby Building also. • If using a flatter curve, 5 structures (businesses) could potentially be impacted and additional impacts to Longworth Hall would be needed.	• Add Signage/ Lighting
	CURVE NO. 9 PI Sta. 65+12.82 (Horiz.)	Y	4	52 mph (60)		463' (570)			40 mph	• The line of sight for the outside lane is impeded by the roadside barrier. • The proposed 12' outside shoulder needs to be widened to 20' to meet the needed sight distance. • 55 mph would require a 15' shoulder (standard minimum shoulder is 12').	• The ramp from Freeman Ave to I-75 NB and Winchell Ave would have to shift to the East. This would impact the property on the SE corner of Ezzard Charles Drive and Winchell Ave. • There is also a potential impact to a 60" combined sewer under Winchell Ave. • The Freeman Ave to Winchell Ave bridge and the Ezzard Charles Drive bridges would need to be lengthened to span the additional pavement width. • If using a flatter curve, this could potentially impact 8 structures, relocate 3 local roads (Ezzard Charles Drive EB and WB, Winchell Ave.), cut off 2 local roads (West Court Street and Freeman Ave to I-75 NB).	• Add Signage/ Lighting
I-75 SB Baseline at Ezzard Charles	CURVE NO. 16 PI Sta. 65+22.36 (Horiz.)	Y	5	54 mph (60)		488' (570)			40 mph	• The line of sight for the inside lane is impeded by the median barrier. • The proposed 12' median shoulder needs to be widened to 20' to meet the needed sight distance. • The median shoulder width was discussed with the Office of Roadway Engineering and a guideline was given to cap the width at 12'. This is due to several factors; expense, excessively wide shoulders can confuse drivers and be used as a passing lane, and collecting debris. • 55 mph would require a 13' shoulder (standard minimum shoulder is 12').	• Widen the inside shoulder of the I-75 SB. This can be accomplished by either linearly transitioning the shoulder or separating the NB and SB horizontal alignments The Northbound lanes would remain the same. This location will have a bi-furcated barrier section. • By changing the SB baseline, the Southbound CD Road would need to move further to the SW which would change three other alignments (I-75 SB to Freeman Ave, Western Ave. to SB CD Road and Gest Street). Gest Street was already narrowed down to 3 lanes and this will narrow it even further. • If using a flatter curve, this could potentially impact 8 structures and 3 local roads (Western Ave, Gest St., and part of Freeman Ave.).	• Add Signage/ Lighting

N/A = Not Applicable
D.E. = Design Exception
Design Speed for Interstate is 60 mph and ramps per 503-1

Alt I D.E. Summary - MAINLINE

Brent Spence Bridge Design Exceptions – Alternative I: Page 2 of 8

Brent Spence Bridge
Design Exceptions - Alternative I

I-71/I-75/US 50 INTERCHANGE	Station	Design Exception	D.E. Number	Design Speed Met (Required)	Horizontal Dc (Maximum)	Horizontal SSD (Minimum)	Vertical Curvature - K (Minimum)	Other	Design Speed Existing	Reason(s) For Design Exception	Potential Impact(s) to Eliminate Design Exceptions	Potential Mitigation Solutions
I-71 Southbound (OH)	CURVE NO. 24 PI Sta. 16+31.45 (Horiz.)	Y	6	50 mph (60)	6° 30' 00" (4° 15' 00")				35 mph	• Curve needed to tie into existing Fort Washington Way footprint, avoid Dunnhumby building, and to tie into proposed new bridge before bridge abutment.	• Using Fort Washington Way (I-71 SB) as a fixed tie in point, a 4 degree curve will require the new Ohio River Bridge crossing the river to move about 250' to the West. • Additional potential impacts from this alignment change would include going through the Duke Energy substation. In addition, the I-75 centerline would also need to shift West possibly impacting half of the Longworth Hall and an additional 5 structures just to the west of I-75 between 3rd Street and 9th Street which include two Duke Energy buildings, two UPS buildings, and the former Harriet Beecher Stowe Elementary School (Fox 19) building. • The curves (super transitions) from these alignment changes may also extend onto the new Ohio River Bridge.	• Add Signage/Traffic Control Devices
	CURVE NO. 24 PI Sta. 16+31.45 (Horiz.)	Y	7	42 mph (60)		339' (570)			35 mph	• The line of sight for the inside lane is impeded by the bridge parapet. • The proposed shoulder needs to be widened to meet the needed sight distance therefore increasing the structure width. • 50 mph would require a 20' shoulder (standard minimum shoulder is 12').	• Widen inside shoulder to match the proposed bridge width (3 lanes and 14' shoulder). • A flatter curve is not possible without introducing a curve starting around Plum Street and extending onto the new bridge which would also need to move west as described above. Some connections may potentially become a problem doing this (i.e. US 50) and using the existing bridge would be very difficult.	• Add Signage/ Lighting
		Y	8					Shoulder Width		• Allows for a deceleration lane to be added to exit from I-71 SB to SB CD Road within the existing footprint of Fort Washington Way (4' left shoulder, 6.5' right shoulder for about 700').	• Widen pavement width on outside of I-71 SB (Fort Washington Way) from Elm Street to Central Ave. This will impact the Elm Street bridge and reduce the 3rd Street on ramp to SB CD Road to 1 lane from 2 lanes.	• Add Signage/ Lighting
	Sta. 20+00 to Sta. 32+00	Y	9					5.9 % (Upgrade)		• A grade of 6.0% (5.0 % max) needed to achieve clearance over the existing railroad/I-71 SB to SB CD Road and under I-71 SB to SB CD Road to maintain a 60 mph design speed. • This grade matches the existing profile set during the Fort Washington Way project. It allows for clearance over Plum Street, flood wall, future rail lines.	• A flatter grade of 5.0 % would create a clearance problem over the NB CD Road to 5th Street resulting in the potential of this connection being cut off.	
I-71 Northbound (OH)	CURVE NO. 20 PI Sta. 14+44.56 (Horiz.)	Y	10	50 mph (60)	6° 30' 00" (4° 15' 00")				45 mph	• Curve needed to tie into existing bridge abutment and still tie in with US 50 EB before entering Fort Washington Way.	• Using Fort Washington Way (I-71 NB) as a fixed tie in point and trying to tie into the existing bridge, several connections would be lost. Connections off of the NB CD Road from Kentucky to I-71 NB and to 2nd Street would be lost. Clearance over the existing railroad may also be an issue coming off of the bridge if the existing profile is to be maintained. • Another option using Fort Washington Way (I-71 NB) as a fixed tie in point and trying to tie into the new Ohio River Bridge, a 4 degree curve will require the new Ohio River Bridge crossing the river to move about 250' to the West if we were to maintain all connections. Other connections including I-75 NB and SB, and NB CD Road would need to be investigated on whether their connections could be maintained.	• Add Signage/Traffic Control Devices
	CURVE NO. 20 PI Sta. 14+44.56 (Horiz.)	Y	11	44 mph (60)		358' (570)			41 mph	• The line of sight for the inside lane is impeded by the bridge parapet. • The proposed shoulder needs to be widened to meet the needed sight distance therefore increasing the structure width. • 50 mph would require a 20' shoulder (standard minimum shoulder is 12').	• Widen inside shoulder with a pavement taper on the bridge. • A flatter curve tying into the existing bridge is not possible without introducing a curve starting around Plum Street and extending onto the existing bridge. Second Street would need to be relocated along with the flood wall. Connections off of the NB CD Road from Kentucky to I-71 NB and to 2nd Street would be lost.	• Add Signage/ Lighting
	Sta. 25+00 to Sta. 29+00	Y	12					6.0 % (Downgrade)		• A grade of 6.0% (5.0 % max) needed to achieve clearance over Plum Street for pedestrians. The 6.0 % grade has a tangent length of about 300'. • This grade matches the existing profile set during the Fort Washington Way project. It allows for clearance over Plum Street, flood wall, future rail lines.	• A flatter grade of 5.0 % could potentially create a clearance problem over US 50 WB and 3rd Street.	
US 50 EB	CURVE NO. 47 PI Sta. 109+73.97 (Horiz.)	Y	13	40 mph (50)	10° 30' 00" (6° 45' 00")				30 mph	• Curve needed to achieve clearance over SB CD Road and under US 50 to 5th Street	• See US 50 WB impacts.	• Add Signage/Traffic Control Devices
	CURVE NO. 47 PI Sta. 109+73.97 (Horiz.)	Y	14	36 mph (50)		261' (425)			30 mph	• The line of sight for the inside lane is impeded by the bridge parapet. • The proposed shoulder needs to be widened to meet the needed sight distance therefore increasing the structure width. This potentially could reduce clearances over SB CD Road to 2nd Street to below minimum.		• Add Signage/ Lighting

N/A = Not Applicable
D.E. = Design Exception
Design Speed for Interstate is 60 mph and ramps per 503-1

Alt I D.E. Summary - MAINLINE

Brent Spence Bridge Design Exceptions – Alternative I: Page 3 of 8

Brent Spence Bridge
Design Exceptions - Alternative I

I-71/I-75/US 50 INTERCHANGE	Station	Design Exception	D.E. Number	Design Speed Met (Required)	Horizontal Dc (Maximum)	Horizontal SSD (Minimum)	Vertical Curvature - K (Minimum)	Other	Design Speed Existing	Reason(s) For Design Exception	Potential Impact(s) to Eliminate Design Exceptions	Potential Mitigation Solutions
US 50 WB	CURVE NO. 53 PI Sta. 114+02.58 (Horiz.)	Y	15	40 mph (50)	10° 30' 00" (6° 45' 00")				35 mph	• Curve needed to achieve clearance over I-75 NB and under US 50 to 5th Street	• Design exceptions 9, 10, 11, 12, and 13 need to be treated as a whole in order to fix. To design an alignment to maintain a 50 mph design speed (existing US 50 posted speed West of I-75), the geometry would follow the proposed alignment shown for US 50 EB/SB CD to 2nd Street. US 50 EB would parallel US 50 WB in order to tie into existing US 50 lanes through Fort Washington Way to the East causing some connections to be lost. • Connections that could potentially be lost would include: 1) US 50 EB to 5th Street, 2) I-75 SB to I-71 NB from I-75 mainline lanes, 3) SB CD Road to potential Clay Wade Bailey Bridge, 4) US 50 WB to Gest Street, 5) Linn Street to US 50 EB (would be significantly impacted if not cut off) which is beyond our current project limits. • SB CD Road alignment would shift West approximately 200' which would impact the former Harriet Beecher Stowe Elementary School (Fox 19) building in addition to their parking garage and the UPS warehouse would also now be impacted in addition to their parking. In addition, the Duke Energy buildings North of 3rd Street, Longworth Hall, and the Duke Energy substation along the river will have additional impacts. • The new Ohio River Bridge would need to be either moved west or widened to accommodate the taper of the SB CD Road into the I-71 SB to SB CD Road ramp which would not come together soon enough to tie into the current bridge typical section and abutment limits. • The horizontal sight distance can not be fixed with out taking the alignment for US 50 west from Fort Washington Way along 3rd Street.	• Add Signage/Traffic Control Devices
	CURVE NO. 53 PI Sta. 114+02.58 (Horiz.)	Y	16	34 mph (50)		242' (425)			30 mph	• The line of sight for the inside lane is impeded by the bridge parapet. • The proposed shoulder needs to be widened to meet the needed sight distance therefore increasing the structure width. This potentially could reduce clearances over I-75 NB to below minimum.		• Add Signage/ Lighting
	CURVE NO. 56 PI Sta. 128+38.49 (Horiz.)	Y	17	40 mph (50)	10° 30' 00" (6° 45' 00")				35 mph	• Curve needed to avoid Dunnhumby building and achieve clearance under I-71 SB		• Add Signage/Traffic Control Devices

N/A = Not Applicable
D.E. = Design Exception
Design Speed for Interstate is 60 mph and ramps per 503-1

Alt I D.E. Summary - MAINLINE

Brent Spence Bridge Design Exceptions – Alternative I: Page 4 of 8

Brent Spence Bridge
Design Exceptions - Alternative I

I-71/I-75/US 50 INTERCHANGE	Station	Design Exception	D.E. Number	Design Speed Met (Required)	Horizontal Dc (Maximum)	Horizontal SSD (Minimum)	Vertical Curvature - K (Minimum)	Other	Design Speed Existing	Reason(s) For Design Exception	Potential Impact(s) to Eliminate Design Exceptions	Potential Mitigation Solutions
Interstate 75 (OH)	CURVE NO. 5 PI Sta. 24+98.87 (Horiz.)	Y	1	57 mph (60)		526' (570')			44 mph	• The line of sight for the northbound inside lane is impeded by the median barrier and the southbound outside lane a the bridge parapet. • The proposed 12' median shoulder (minimum) needs to be widened to 20' to meet the needed sight distance. • The median shoulder width was discussed with the Office of Roadway Engineering and a guideline was given to cap the width at 12'. This is due to several factors; expense, excessively wide shoulders can confuse drivers and be used as a passing lane, and collecting debris.	• Widen the inside shoulder for the I-75 NB. This can be accomplished by either linearly transitioning the shoulder or separating the NB and SB horizontal alignments. The two profiles will be different as well and bifurcated barrier will be required. This will impact the potential connection from Clay Wade Bailey Bridge to I-75. • If this potential connection from Clay Wade Bailey Bridge is to be maintained, all NB alignments will need to shift to the East potentially causing vertical clearance issues with US 50 WB and I-71 SB. This would potentially impact the Dunnhumby Building also. • If using a flatter curve, 5 structures (businesses) could potentially be impacted and additional impacts to Longworth Hall would be needed. • A design speed of 55 MPH would also fix this design exception.	• Add Signage/ Lighting
	Sta. 23+00 to Sta. 27+00 (Southbound Only)	Y	2					6.0% (Downgrade)		• A grade of 6.0% (5.0 % max) needed to achieve clearance over the existing railroad/I-71 SB to SB CD Road and under I-71 SB to SB CD Road to maintain a 60 mph design speed. The 6.0 % grade has a tangent length of 150'.	• Shift SB CD Road alignment further West so that the lower deck does not cross under the upper deck until after the existing railroad. This would increase the impact to Longworth Hall and could potentially impact 4 additional buildings and parking.	
	CURVE NO. 6 PI Sta. 33+88.15 (Horiz.)	Y	3	51 mph (60)		443' (570)			50 mph	• The line of sight for the inside lane is impeded by the median barrier. • The proposed 12' median shoulder needs to be widened to 25' to meet the needed sight distance. • The median shoulder width was discussed with the Office of Roadway Engineering and a guideline was given to cap the width at 12'. This is due to several factors; expense, excessively wide shoulders can confuse drivers and be used as a passing lane, and collecting debris. • 55 mph would require a 17' minimum shoulder.	• Widen the inside shoulder for the I-75 NB. This can be accomplished by either linearly transitioning the shoulder or separating the NB and SB horizontal alignments. The two profiles will be different as well and bifurcated barrier will be required. This will impact the potential connection from Clay Wade Bailey Bridge to I-75. • If this potential connection from Clay Wade Bailey Bridge is to be maintained, all NB alignments will need to shift to the East potentially causing vertical clearance issues with US 50 WB and I-71 SB. This would potentially impact the Dunnhumby Building also. • If using a flatter curve, 5 structures (businesses) could potentially be impacted and additional impacts to Longworth Hall would be needed.	• Add Signage/ Lighting
	CURVE NO. 9 PI Sta. 65+12.82 (Horiz.)	Y	4	52 mph (60)		463' (570)			40 mph	• The line of sight for the outside lane is impeded by the roadside barrier. • The proposed 12' outside shoulder needs to be widened to 20' to meet the needed sight distance. • 55 mph would require a 15' shoulder (standard minimum shoulder is 12').	• The ramp from Freeman Ave to I-75 NB and Winchell Ave would have to shift to the East. This would impact the property on the SE corner of Ezzard Charles Drive and Winchell Ave. • There is also a potential impact to a 60" combined sewer under Winchell Ave. • The Freeman Ave to Winchell Ave bridge and the Ezzard Charles Drive bridges would need to be lengthened to span the additional pavement width. • If using a flatter curve, this could potentially impact 8 structures, relocate 3 local roads (Ezzard Charles Drive EB and WB, Winchell Ave.), cut off 2 local roads (West Court Street and Freeman Ave to I-75 NB).	• Add Signage/ Lighting
I-75 SB Baseline at Ezzard Charles	CURVE NO. 16 PI Sta. 65+22.36 (Horiz.)	Y	5	54 mph (60)		488' (570)			40 mph	• The line of sight for the inside lane is impeded by the median barrier. • The proposed 12' median shoulder needs to be widened to 20' to meet the needed sight distance. • The median shoulder width was discussed with the Office of Roadway Engineering and a guideline was given to cap the width at 12'. This is due to several factors; expense, excessively wide shoulders can confuse drivers and be used as a passing lane, and collecting debris. • 55 mph would require a 13' shoulder (standard minimum shoulder is 12').	• Widen the inside shoulder of the I-75 SB. This can be accomplished by either linearly transitioning the shoulder or separating the NB and SB horizontal alignments The Northbound lanes would remain the same. This location will have a bi-furcated barrier section. • By changing the SB baseline, the Southbound CD Road would need to move further to the SW which would change three other alignments (I-75 SB to Freeman Ave, Western Ave. to SB CD Road and Gest Street). Gest Street was already narrowed down to 3 lanes and this will narrow it even further. • If using a flatter curve, this could potentially impact 8 structures and 3 local roads (Western Ave, Gest St., and part of Freeman Ave.).	• Add Signage/ Lighting

N/A = Not Applicable
D.E. = Design Exception
Design Speed for Interstate is 60 mph and ramps per 503-1

Alt I D.E. Summary - MAINLINE

Brent Spence Bridge Design Exceptions – Alternative I: Page 5 of 8

Brent Spence Bridge
Design Exceptions - Alternative I

I-71/I-75/US 50 INTERCHANGE	Station	Design Exception	D.E. Number	Design Speed Met (Required)	Horizontal Dc (Maximum)	Horizontal SSD (Minimum)	Vertical Curvature - K (Minimum)	Other	Design Speed Existing	Reason(s) For Design Exception	Potential Impact(s) to Eliminate Design Exceptions	Potential Mitigation Solutions
3rd Street WB (OH) to SB CD ROAD		N										
3rd Street/Clay Wade Bailey to I-75 NB		N										
US 50 WB to GEST ST.		N										
6th Street WB (OH) to US 50 WB		N										
4th Street WB (OH) to NB CD ROAD		N										
NB CD ROAD to US 50 WB (Directional Ramp)	CURVE NO. 63 PI Sta. 22+70.83 (Horiz.) (NB CD Road)	Y	29	44 mph (50)		354' (425)			N/A	• The line of sight for the inside lane is impeded by the bridge parapet. • The proposed shoulder needs to be widened to meet the needed sight distance therefore increasing the structure width. • 50 mph would require a 17' shoulder (standard minimum shoulder is 10').	• Widen the inside shoulder. This may impact the clearance over 4th Street to NB CD Road ramp.	• Add Signage/ Lighting
	CURVE NO. 66 PI Sta. 33+69.33 (Horiz.) (Directional Ramp)	Y	30	40 mph (45)	11° 45' 00" (9° 00' 00")				35 mph	• Curve needed to tie into 6th Street to US 50 WB and clear 4th Street to NB CD Road.	• A flatter curve could require the 4th Street NB on ramp to be relocated from its current alignment creating weaving on the NB CD Road. The ramp from US 50 WB to Gest Street potentially could be cut off also if US 50 WB would also need to be flattened.	• Add Signage/Traffic Control Devices
	CURVE NO. 66 PI Sta. 33+69.33 (Horiz.) (Directional Ramp)	Y	31	33 mph (45)		236' (360)			32 mph	• The line of sight for the inside lane is impeded by the bridge parapet. • The proposed shoulder needs to be widened to meet the needed sight distance therefore increasing the structure width. • 45 mph would require a 26' shoulder (standard minimum shoulder is 4', a 6' shoulder is used).	• Widen the inside shoulder. • A flatter curve could require the 4th Street NB on ramp to be relocated from its current alignment creating weaving on the NB CD Road. The ramp from US 50 WB to Gest Street potentially could be cut off also if US 50 WB would also need to be flattened.	• Add Signage/ Lighting
NB CD ROAD to 5th Street EB (OH)		N										
NB CD ROAD to I-71 NB (Directional Ramp)	Sta. 27+80 Rt (I-71 NB)	Y	32					Shoulder Width	N/A	• < 8' min due to flood wall. • A 39:1/acceleration lane taper Sta. 14+75 to Sta. 30+00 (I-71 NB) is needed to minimize the impact to the flood wall/I-71 (FWW) and maintain a 4' minimum shy line from the roadside barrier.	• If a 50:1 taper is used I-71 in the trench will need to be widened just to maintain a 4 foot shoulder.	
	Sta. 9+50	Y	33					6.69 % (Upgrade)		• A grade of 6.69% (5.0 % max) needed to achieve clearance under I-71 NB (upper deck) and yet tie into I-71 NB before entering the Fort Washington Way trench and to clear the existing railroad. The 6.69% grade does not have a tangent length, the vertical curves are reverse curves.	• A flatter grade would violate railroad clearance if existing vertical curve on the existing bridge is to be maintained.	
NB CD ROAD to 2nd Street EB (OH)		N										
6th Street WB (OH) to WINCHELL AVE		N										
9th street to 6th connector to Winchell		N										
Gest St/Freeman Ave to Winchell Ave		N										
Gest St/Freeman Ave (OH) to I-75 NB		N										
SB CD ROAD to 7th Street (OH)		N										

N/A = Not Applicable
D.E. = Design Exception
Design Speed for Interstate is 60 mph and ramps per 503-1

Alt I D.E. Summary - RAMPS

Brent Spence Bridge Design Exceptions – Alternative I: Page 6 of 8

Brent Spence Bridge
Design Exceptions - Alternative I

I-71/I-75/US 50 INTERCHANGE	Station	Design Exception	D.E. Number	Design Speed Met (Required)	Horizontal Dc (Maximum)	Horizontal SSD (Minimum)	Vertical Curvature - K (Minimum)	Other	Design Speed Existing	Reason(s) For Design Exception	Potential Impact(s) to Eliminate Design Exceptions	Potential Mitigation Solutions
SB CD RD to Gest St/Freeman Ave		N										
Western Ave (OH) to SB CD ROAD		N										
SB CD ROAD to 5th Street (OH)		Y	34					7.5% upgrade		• Sta. 26+10 to Sta. 32+60 (Vertical, 7.0% max) a grade of 7.5% is needed to achieve clearance under US 50 WB and over I-75 SB to I-71 NB.	• Flattening the vertical curve will impact the clearance over I-75 SB to I-71 NB. Either the SB CD Road to 5th Street or I-75 SB to I-71 NB alignment will potentially be cut of and traffic will need to be directed another way. • If the connections are to be maintained, raising the US 50 WB profile would be an alternate but there may be a potential that US 50 WB to Gest Street may be cut off due to the higher profile. Changing the profiles for NB CD Road to US 50 WB and 6th Street to US 50 WB will also need to be investigated.	• Add Signage/Traffic Control Devices
SB CD ROAD to 2nd ST. (OH)		N										
SB CD ROAD to 3rd ST. (OH)		N										
9th Street (OH) to SB CD ROAD		N										
US 50 EB to SB CD ROAD	CURVE NO. 85 PI Sta. 108+02.34 (Horiz.)	Y	35	40 mph (45)	10° 45' 00" (9° 00' 00")				N/A	• Diverging curvature per table 505-2a is not met.	• Flattening the curve in gore area could increase impacts to the UPS warehouse, cut off on ramp from Linn Street, and create a pavement taper on the new Ohio River Bridge.	• PI Sta. 29+81.48 (Horiz.) Exit Geometry
	CURVE NO. 85 PI Sta. 108+02.34 (Horiz.)	Y	36	34 mph (45)		246' (360)			N/A	• The line of sight for the inside lane is impeded by the bridge parapet. • The proposed shoulder needs to be widened to meet the needed sight distance therefore increasing the structure width.	• Widen shoulder which could potentially increase impact to the UPS Building and increase retaining wall heights.	• Add Signage/Traffic Control Devices
US 50 EB to 2ND ST (OH)		N										
US 50 EB to 5TH ST (OH)		N										

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D.E. = Design Exception
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Alt I D.E. Summary - RAMPS

Brent Spence Bridge Design Exceptions – Alternative I: Page 7 of 8

Brent Spence Bridge
Design Exceptions - Alternative I

I-71/I-75/US 50 INTERCHANGE	Curve PI	Design Exception	D.E. Number	Design Speed Met (Required)	Horizontal SSD (Minimum)	Horizontal Dc (Maximum)	Vertical Curvature - K (Minimum)	Other	Design Speed Existing	Reason For Design Exception	Potential Impact(s) to Eliminate Design Exceptions	Potential Mitigation Solutions
Third Street (OH)		N										
Central Avenue (OH)		N										
Seventh Street (OH)		N										
Ninth Street (OH)		N										
Linn Street (OH)		N										
NB CD ROAD to Winchell Ave (Local)	PI Sta. 65+75.00 (Vertical)	Y	37	31 mph (40)			39 (44) - crest		N/A	• Curve needed to be able to tie profile in from NB CD Road to Winchell Ave.	• To fix, the horizontal alignment would need to be adjusted for three connections (NB CD Road to Winchell Ave., 6th Street to Winchell Ave., and W. Court Street.). • Moving these alignments could potentially impact 7 structures along Winchell Ave. and W. Court Street.	• Add Signage/ Lighting • Vertical Curve 2.0 times the minimum length needed.
	PI Sta. 69+20.00 (Vertical)	Y	38	31 mph (40)			39 (64) - sag		N/A	• Vertical curve used to match existing profile.	• Fill in the sag point which may impact neihboring apartment building.	• Add Signage/ Lighting • Vertical Curve 2.0 times the minimum length needed.
					Existing posted speed limit on Winchell Ave. is 40 mph							
Gest Street (OH)	CURVE NO. 192 PI Sta. 14+34.53 (Horiz.)	Y	39	30 mph (40)	207' (305)				33 mph	• The line of sight is impeded by a roadside barrier and retaining wall. • The proposed shoulder needs to be widened to meet the needed sight distance therefore increasing the structure length of 7th and 9th streets.	• Widen shoulder using a pvement taper. • Flattening the curve could potentially impact a hotel parking garage. • Extend overhead bridges to set abutments outside of the clear zone so that ne barrier is needed.	• Add Signage/ Lighting
John St.		N										
West Court St.		N										
Ezzard Charles WB		N										
Ezzard Charles EB		N										

N/A = Not Applicable
D.E. = Design Exception
Design Speed for Interstate is 60 mph and ramps per 503-1

Alt I D.E. Summary - SIDEROADS

Brent Spence Bridge Design Exceptions – Alternative I: Page 8 of 8

Brent Spence Bridge
Design Exceptions - Alternative I

I-75/I-71	Station	Design Exception	D.E. Number	Design Speed Met (Required)	Horizontal SSD (Minimum)	Horizontal Dc (Maximum)	Vertical Curvature - K (Minimum)	Other	Design Speed Existing	Reason For Design Exception	Potential Impact(s) to Eliminate Design Exceptions	Potential Mitigation Solutions
SB I-75 to Kyles Lane	Sta. 445+00	Y	40					Grade		• Proposed ramp grade is 8.1 percent due to right of way considerations.	• Extending the beginning of ramp futher south and thus widening the right of way limits required for the connection to the existing elevtion at the ramp terminal.	• This steep slope is less than 500 feet long and provides an exit ramp to Kyles Lane on which traffic has to decelerate.
NB CD Road	Existing Bridge (Lower Deck)	Y	41					Lane Width		• 11' lanes needed to utilize the existing bridge width.	• Replace the existing bridge and rebuild structure to accommodate a wider section.	• Will be maintaining one 12' lane on the lower bridge deck.
	Existing Bridge (Lower Deck)	Y	42					Shoulder Width		• A minimum 4' left shoulder and an 8' right shoulder are needed to maintain 3 through lanes and utilize the existing bridge width.	• Replace the existing bridge and rebuild structure to accommodate a wider section.	

N/A = Not Applicable
D.E. = Design Exception
Design Speed for Interstate is 60 mph and ramps per 503-1

Alt I D.E. Summary - Kentucky