APPENDIX O-1

US 41 Existing Bridges Evaluation Report

Clarification Note: This document was completed before the development of Central Alternative 1B Modified (Selected); therefore, the alternative is not included in the document. Applicable information regarding Central Alternative 1B Modified (Selected) is provided in the FEIS.

FEBRUARY 21, 2018

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US 41 EXISTING BRIDGES EVALUATION REPORT

I-69 Ohio River Crossing Project

Evansville, IN and Henderson, KY

US 41 Existing Bridges Evaluation Report

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Final
February 21, 2017

Prepared by:
Parsons in cooperation with Stantec

SCOPE & ASSUMPTIONS

This report has been developed by the Bridge Structures discipline, to assist in the development of Alternatives in the NEPA documentation concerning the existing US 41 bridges over the Ohio River. It is based on and summarizes the in-depth US 41 Existing Bridges Rehabilitation Engineering Report.

The locations of the bridges considered are shown in Figure 1. They include the main bridges carrying US 41 northbound and southbound over the Ohio River, as well as 9 smaller bridges on US 41 and associated ramps north of the river (the "overflow" bridges).

A partial view of both river bridges is given in Figure 2. The northbound river bridge was constructed in 1932 and is of riveted steel construction on cast-in-place concrete substructures. In 2025, the bridge will be 93 years old, and in 2060 the bridge will be 128 years old. The southbound bridge was constructed in 1965 and is of welded and bolted steel construction on cast-in-place concrete substructures. In 2025 the bridge will be 60 years old, and in 2060 the bridge will be 95 years old.

The overflow bridges are a mix of conventional concrete and steel girder superstructures on cast-in-place concrete substructures, and are of varying age and rehabilitation history. A representative view of one overflow bridge is given in Figure 3.

As of this writing, all bridges are rated as adequate for their respective legal load requirements. The main river bridges are identified as "posted, not substandard", based on their prohibition of a 10% legal load exceedance normally allowed by Kentucky statute for agricultural and forest product loads.

Estimates of the operation and maintenance costs of the northbound and southbound US 41 river bridges between 2018 and 2060, exclusive of current contracts, have been evaluated under three traffic scenarios:

Scenario 1 – continued service of the existing US 41 bridges, in the case where a new I-69 river crossing is not constructed.

Scenario 2 – continued service of the existing US 41 bridges, in the case where a new I-69 river crossing is constructed with an attendant 50% decrease in traffic demand on US 41.

Scenario 3 – continued limited service of the existing US 41 bridges, in the case where a new I-69 river crossing is constructed, vehicular demand decreases on US 41, and all truck traffic is precluded from using the US 41 bridges.

These assumed scenarios were selected for analysis in advance of and independently from the screening process, to cover the full range of possible bridge and tolling scenarios, and to evaluate the potential influence of traffic forecasts on long-term maintenance costs for the bridges. The alternative screening process considered many different bridge operation and tolling scenarios, each of which would have different effects on traffic forecasts for these bridges but would be within the range of the estimates presented in this report.

The operation and maintenance costs for the overflow bridges on US 41 and associated ramps have been evaluated under Scenario 1 conditions only.

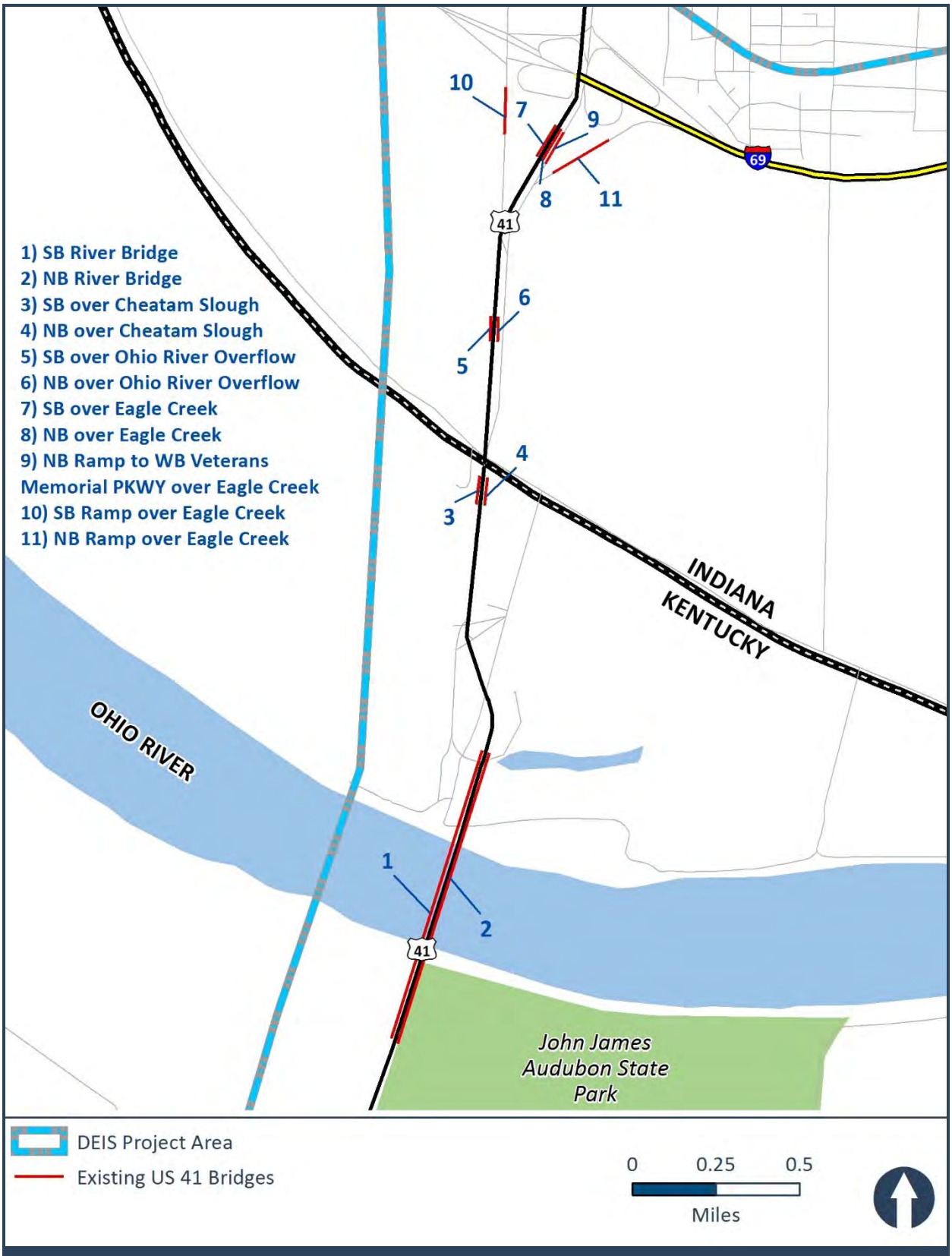


Figure 1. Key Map Showing US 41 Bridges under Consideration

Figure 2. View South of the Through Truss River Span Units of the Ohio River Bridges (1932 Northbound Bridge at Left, 1965 Southbound Bridge at Right)

Figure 3. View North of Representative Overflow Bridge (NB 41 over Ohio River Overflow)

These cost evaluations are based on:

- Review of past bridge inspection reports.
- Review of record plans from original construction through recent repair and rehabilitation work.
- Consultation with KYTC and INDOT maintenance staff, for understanding of experience and typical practices.
- Review of bid tab data and independent cost estimate work for similar recent works in Kentucky and Indiana.
- Opinion and judgement of study team engineers with experience in bridge design, construction and maintenance.

These sources have been factored together to arrive at a proposed sequence of routine maintenance and specific rehabilitation works. Separate sequences are constructed for each of the northbound and southbound river bridges, and for each of Scenario 1, 2 and 3 (six total). By estimating the routine and the specific intervention costs, a cumulative expenditure prediction is developed, covering the 2018 to 2060 analysis period.

Cost estimates in the full US 41 Existing Bridges Engineering Report were developed in 2017 dollars consistently for all expenditures. This evaluation report factors those estimates to Year of Expenditure dollars assuming construction inflation that averages 4% over the next 10 years, and 2.5% thereafter.

ESTIMATED COSTS – MAIN RIVER BRIDGES

The rolled-up costs, in year of expenditure dollars, for operations and maintenance of the two river bridges, from abutment to abutment, under the three Scenarios is presented in Table 1.

Table 1. Operate and Maintain Costs for Existing US 41 Bridges over Ohio River

	SOUTHBOUND		NORTHBOUND	
Scenario 1: No-Build I-69	Prior to 2025 2025 - 2060 Total	$18.1 M $127.0 M $145.1 M	Prior to 2025 2025 - 2060 Total	$18.9 M $129.1 M $148.0 M
Scenario 2: Build I-69, traffic demand on existing US 41 reduced by half.	Prior to 2025 2025 - 2060 Total	$2.4 M $139.4 M $141.7 M	Prior to 2025 2025 - 2060 Total	$2.7 M $140.1 M $142.8 M
Scenario 3: Build I-69, reduce traffic demand on existing US 41 and eliminate truck traffic.	Prior to 2025 2025 - 2060 Total	$2.4 M $104.0 M $106.4 M	Prior to 2025 2025 - 2060 Total	$2.5 M $137.1 M $139.7 M

Note: Year of Expenditure dollars, including construction & contingency, MOT, and design & construction engineering

As shown in Table 1, the reduction in costs associated with decreased traffic demand under Scenarios 2 and 3 are fairly limited. For the southbound, where conditions favor a new deck in year 2025, there is some differentiation afforded by Scenario 3. In Scenarios 1 and 2, with heavier assumed traffic, a cycle of major deck patching plus rigid overlay is estimated to arise prior to

2060, within the study period. With truck traffic removed under Scenario 3, the amount of deck patching and crack repair anticipated as part of routine annual maintenance would be sufficient to defer the major deck patching and rigid overlay work to sometime beyond 2060. If the bridge remains in service beyond 2060, it is expected that this need will arise eventually outside the study period of this analysis. For northbound, the proposed works align such that no cycles of major work are avoided in Scenarios 2 or 3. The Scenario 3 cost to retain the northbound bridge is more than 90% of the no-build cost for that structure.

For Scenarios 1 and 2 there is also little differentiation between the costs to maintain northbound and southbound. At this point, both are aging steel bridge structures of comparable size, and needing comparable levels of ongoing investment to maintain them in good condition.

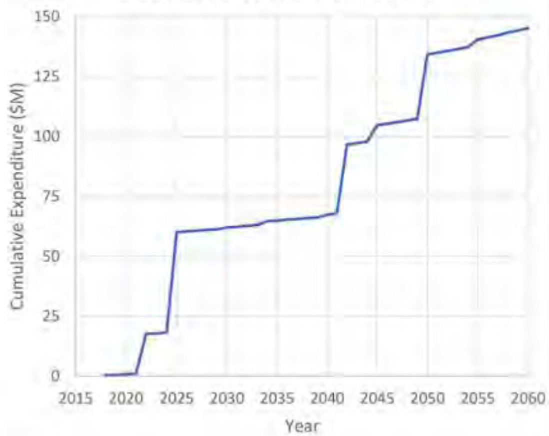
The rolled up costs of Table 1 are broken down in Figures 4 and 5. These describe, in year of expenditure dollars, how the operation and maintenance costs may accumulate between 2018 and 2060. The listing of major expenditure items capture the main cost drivers. In this display we see, for example, how for southbound the major deck patch and overlay work that is required in 2050 for Scenario 1 is extended in Scenario 2 to 2055, and in Scenario 3 to beyond 2060, because of the reduced demand.

The Engineering Report concludes that extending the life of the existing northbound and/or southbound US 41 bridge to 2060 is feasible. The southbound bridge will be 95 years old and the northbound bridge will be 128 years old at that time, but no fatal flaw is identified that would prevent this kind of life extension, assuming the necessary investments in regular maintenance and periodic major rehabilitation are made.

The cost estimates were developed in collaboration with INDOT and KYTC and are based on a detailed review of the as-built drawings, maintenance history, traffic forecasts and relevant experience maintaining and rehabilitating major bridge structures of similar age and construction. While attempts were made to recognize and account for cost risks, forecasts of this duration and for bridges of this age are of course speculative. Table 2 summarizes some of the key cost risk drivers and mitigation actions which could improve the certainty of future costs.

Southbound US 41 over Ohio River

Scenario 1: No I-69 Build

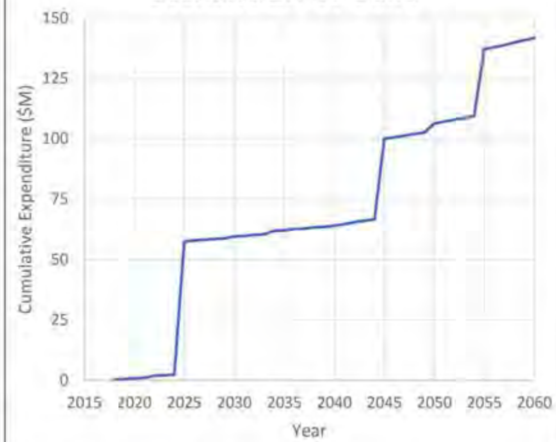


Year of Expenditure Summary	
Total Cost	$145.1 M
$ prior to 2025	$18.1 M
$ in 2025-2060	$127.0 M

Major Expenditure Items

Year	Item
2022	Paint
2025	Deck replacement and major steel rehabilitation
2042	Paint
2045	Major steel repairs and deck joint repairs & replacements
2050	Deck patching & rigid overlay
2055	Minor steel and minor substructure repairs

Scenario 2: I-69 Build

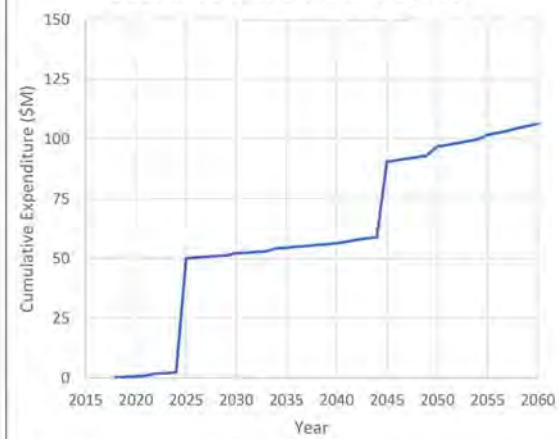


Year of Expenditure Summary	
Total Cost	$141.7 M
$ prior to 2025	$2.4 M
$ in 2025-2060	$139.4 M

Major Expenditure Items

Year	Item
2022	N/A
2025	Paint, deck replacement, and major steel rehabilitation
2042	N/A
2045	Paint and major steel repairs
2050	Deck joint repairs and replacements
2055	Deck patching and rigid overlay, and minor steel repairs

Scenario 3: No Trucks US 41



Year of Expenditure Summary	
Total Cost	$106.4 M
$ prior to 2025	$2.4 M
$ in 2025-2060	$104.0 M

Major Expenditure Items

Year	Item
2022	N/A
2025	Paint, deck replacement, and major steel rehabilitation
2042	N/A
2045	Paint and major steel repairs
2050	Deck joint repairs and replacements
2055	Minor steel repairs

Notes:
1. Major Expenditure Items account for > 80% of the total cost. The remaining 20% is distributed among routine maintenance and inspections (annual or bi-annual), and smaller joint, bearing and substructure patching type works. 2. Costs are in year of expenditure dollars. 3. The Scenario 2 I-69 Build condition assumes a 50% decrease in traffic demand relative to the No-Build scenario. The Scenario 3 I-69 Build condition assumes a 50% decrease in auto traffic and removal of all trucks from US 41.

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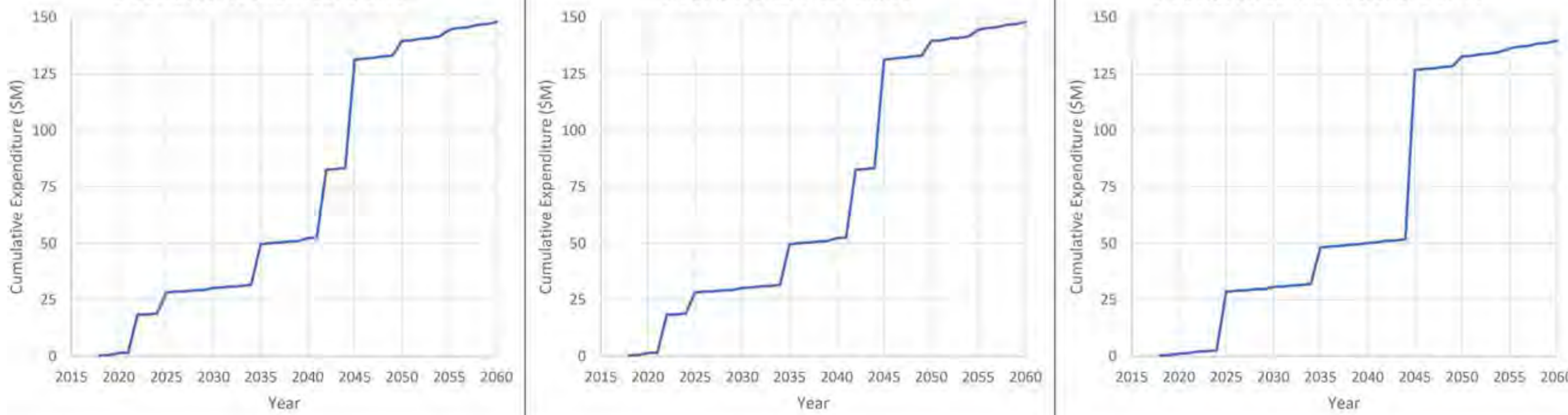
Figure 4. O&M cost profiles for southbound US 41 over Ohio River, Scenarios 1, 2 and 3

Northbound US 41 over Ohio River

Scenario 1: No I-69 Build | Scenario 2: I-69 Build | Scenario 3: No Trucks US 41



Scenario 1: No I-69 Build

Year of Expenditure Summary	
Total Cost	$148.0 M
$ prior to 2025	$18.9 M
$ in 2025-2060	$129.1 M

Major Expenditure Items

Year	Item
2022	Paint
2025	Deck patching & bituminous overlay
2035	Major steel rehabilitation and bituminous resurfacing
2042	Paint
2045	Deck replacement and deck joint repairs & replacements
2050	Major steel repairs
2055	Minor steel repairs

Scenario 2: I-69 Build

Year of Expenditure Summary	
Total Cost	$142.8 M
$ prior to 2025	$2.7 M
$ in 2025-2060	$140.1 M

Major Expenditure Items

Year	Item
2022	N/A
2025	Paint and deck patching & bituminous overlay
2035	Major steel rehabilitation and bituminous resurfacing
2042	N/A
2045	Paint, deck replacement, and deck joint repairs & replacements
2050	Major steel repairs
2055	Minor steel repairs

Scenario 3: No Trucks US 41

Year of Expenditure Summary	
Total Cost	$139.7 M
$ prior to 2025	$2.5 M
$ in 2025-2060	$137.1 M

Major Expenditure Items

Year	Item
2022	N/A
2025	Paint and deck patching & bituminous overlay
2035	Major steel rehabilitation and bituminous resurfacing
2042	N/A
2045	Paint, deck replacement, and deck joint repairs & replacements
2050	Major steel repairs
2055	N/A

Notes:

1. Major Expenditure Items account for > 80% of the total cost. The remaining 20% is distributed among routine maintenance and inspections (annual or bi-annual), and smaller joint, bearing and substructure patching type works. 2. Costs are in year of expenditure dollars. 3. The Scenario 2 I-69 Build condition assumes a 50% decrease in traffic demand relative to the No-Build scenario. The Scenario 3 I-69 Build condition assumes a 50% decrease in auto traffic and removal of all trucks from US 41.

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Figure 5. O&M cost profiles for northbound US 41 over Ohio River, Scenarios 1, 2 and 3

Table 2. Uncertain Cost Items and Mitigation Measures

RISK	MITIGATION
Heat treated high strength steel. The SB river bridge used heat treated high strength steels extensively in fracture critical members. It appears on connection gusset plates, and it appears as butt-welded thickenings at connections. Both of these details have required intervention at considerable expense on other KYTC bridges (gusset plates at Combs-Hehl, member butt welds at Kennedy).	Continued vigilance in bi-annual fracture critical inspection is assumed. An in-depth inspection of HT members and gusset plates with load rating based on as-inspected conditions should be performed, to confirm no proactive intervention is warranted now or at 2025. This study recommends converting from biennial to annual inspection once the bridge reaches 75 years age. This study includes approximately $1M cost (2017 dollars) in anticipation of the need for isolated response to instances of cracking over the 2025 to 2060-time horizon (see 2045 Major Steel Repair).
Aging pins and eyebar tension members. The NB river bridge uses pin-connected multi-eyebar tension members in fracture critical applications. Some of these bars are designated as "heat treated", though the implications (if any) of such treatment on 1930's steel are not known.	The risk of fracture is mitigated somewhat by the parallel nature of the members: eyebars occur in pairs, or in some members as 4 or 6 bars. With regard to the pins, stress demand appears to be fairly low. Continued vigilance in bi-annual fracture critical inspection is assumed. An in-depth inspection of pins, including non-destructive testing, should be performed to confirm no proactive intervention is warranted now or at 2025. This study includes approximately $1M cost (2017 dollars) in anticipation of the need for isolated response to pin and eyebar concerns over the 2025 to 2060-time horizon (see 2045 Major Steel Repair).
Gusset plates. Gusset plate connections are obviously crucial elements of any fracture critical bridge. Fracture critical gusset plates appear in the NB and SB through truss spans, and in NB deck truss spans. Recent FC inspections have been inventorying gusset plate conditions, but to date their as-inspected condition has not been reflected into load rating calculations.	An in-depth inspection of gusset plates with load rating based on as-inspected conditions should be performed to establish specific scopes of work related to gusset rehabilitation.
Rating based on as-inspected condition. The NB & SB bridges exhibit measurable section loss in some members. To date, load ratings have been performed based on as-built plan conditions. Rating based on as-inspected member conditions could result in a load posting requirement.	A full load rating based on as-inspected member conditions should be performed following an in-depth inspection, to establish specific scopes of work related to member condition.
NB Through Truss Rocker Bearing. Recent inspections have noted inconsistent extension of the up and downstream rocker bearings for the through truss at Pier A. This could be inducing unintended loads on the structure which could affect its load rating.	In-depth inspection targeted toward tracing the manifestations of mis-aligned bearings should be performed. Determine if a member or members have slipped, or a substructure has shifted, or what other source is responsible, and determine if member forces or stability could be affected, and if corrective action is warranted.

ESTIMATED COSTS – OVERFLOW BRIDGES

The rolled-up costs, in year of expenditure dollars, for operations and maintenance of the 9 overflow bridges under Scenario 1 (only) is presented in Table 3.

Table 3. Operate and Maintain Costs for Existing US 41 Overflow Bridges

	SOUTHBOUND (4 BRIDGES)		NORTHBOUND (5 BRIDGES)	
Scenario 1: No-Build I-69	Prior to 2025	$0.3 M	Prior to 2025	$0.4 M
	2025 - 2060	$40.5 M	2025 - 2060	$51.1 M
	Total	$40.8 M	Total	$51.5 M

Note: Year of Expenditure dollars, including construction & contingency, MOT, and design & construction engineering

EXISTING RIVER BRIDGE EVALUATIONS

The I-69 ORX NEPA process will consider these operation and maintenance costs in determining if one or both or neither of the existing US 41 river bridges will be retained.

If only one of the bridges is to be retained, the modest differences in cost between northbound and southbound for each Scenario make it relevant to consider factors in addition to maintenance costs. The age of the structure is important, with the southbound being 30 years younger. Southbound also offers a higher absolute load rating. It also provides three feet additional cross section width between centerlines of trusses, and there is a greater institutional knowledge base regarding applicable repair and rehabilitation details (e.g. full floor system replacement). Therefore, if only one of the US 41 bridges is retained, the Bridge Structures recommendation is that the newer southbound structure be retained and the older northbound structure be removed from service.