BCA TECHNICAL MEMORANDUM

KAY COUNTY, OKLAHOMA I-35 BRIDGE BUNDLE

Executive Summary

The Benefit Cost Analysis (BCA) was prepared for the Kay County, Oklahoma Interstate 35 (I-35) Bridge Bundle application in accordance with the BCA Guidance for Discretionary Grant Programs dated June 2018. The BCA was prepared for each individual bridge included in the bundle (total of ten bridges), as well as, for the total project. The Kay County I-35 Bridge Bundle (Project) provides a benefit-cost ratio (BCR) of 1.46 (0.54 when discounted at seven percent). For every dollar invested in the project, 146 percent benefit will be received. Consequently, a $15.7 million investment in the project would equal a positive net user benefit of about $15.0 million to the public.

Over the life of the project, the vehicle operating costs due to detours from weight limits and bridge closures is the largest contributor to the positive cash flow projected for this project, providing a positive net present value of $6.3 million. The reduced travel times due to not needing these same detours contributes $5.9 million in positive net present value.

Project Definition and Approach

The proposed Project consists of two bridge replacements and eight bridge raisings. The two I-35 bridge replacements over U.S. 60 would replace existing reinforced concrete slab bridges with new steel plate girder bridges. The bridge replacements will improve the structural condition of the bridges and widen the span to allow additional turn lanes on U.S. 60. The two bridge replacements are bridges I-35 Northbound (NBI 14409) and I-35 Southbound (NBI 14408).

In addition to the two replacements, eight existing reinforced concrete slab bridges over I-35 will be raised and rehabilitated to provide adequate vertical clearances (17’0”). ODOT will use an innovative bridge-raising technique to create the desired 17-foot clearance over I-35. I-35 requires an overlay slated for implementation following the bridge raisings. Lowering I-35’s profile is expensive and would significantly delay and damage freight and traveler operations. The eight bridge raisings include the following bridges: North (NBI 14429), Highland (NBI 14435), Hartford (NBI 14437), Coleman (NBI 15145), Chrysler (NBI 15146), Ferguson (NBI 15147), Adobe (NBI 15149), and Indian (NBI 14155).

The BCA for the project accounts for anticipated capital costs of the project (engineering and design, right-of-way acquisition costs, utility relocation, construction, and contingency), as well as, ongoing maintenance and operations cost of the structures. The BCA compares these costs with the total project benefits over a twenty-year period as advised through the BCA Guidance for Discretionary Grant Programs dated June 2018. While the BCA uses a twenty-year period, the improvements have an anticipated lifecycle of seventy-five years and will extend well past a twenty-year period. These future benefits are not quantified or included in the Project benefits.

Project Costs

The project has a total capital cost of $15,710,932 (2018$) over a two-year construction period from June 2020 to August 2021. Capital costs were deflated to 2017$ for the BCA to provide a uniform base year of 2017 for all cost numbers to be inflated from. These costs are broken down by bridge and shown as a total bundled cost in Table 1.

Table 1: Summary of Probable Estimated Capital Costs

		Construction		Initial Costs	
Bridge Number	Bridge Location	Start (Year)	Completion (Year)	2018$	2017$
Kay County Bridge Raises					
14155 - Indian	Indian Road over I-35	2020	2021	$813,805	$800,685
14429 - North	North Avenue over I-35	2020	2021	$763,773	$751,460
14435 - Highland	Highland Avenue over I-35	2020	2021	$748,933	$736,859
14437 - Hartford	Hartford Avenue over I-35	2020	2021	$753,173	$741,031
15145 - Coleman	Coleman Road over I-35	2020	2021	$755,187	$743,012
15146 - Chrysler	Chrysler Avenue over I-35	2020	2021	$759,427	$747,184
15147 - Ferguson	Ferguson Avenue over I-35	2020	2021	$761,653	$749,374
15149 - Adobe	Adobe Road over I-35	2020	2021	$957,329	$941,896
Subtotal				*$6,313,280*	$6,211,502
Kay County Bridge Reconstructions					
14408 - I-35 SB	I-35 SB over US 60	2020	2021	$4,698,614	$4,622,866
14409 - I-35 NB	I-35 NB over US 60	2020	2021	$4,699,038	$4,623,284
Subtotal				*$9,397,652*	$9,246,150
Total				**$15,710,932**	$15,457,652

Project Benefits

The following project benefits are quantified in the following sections:

- Transportation System User Effects – Implementation of the projects in this bundle will provide substantial benefit by eliminating the need to detour traffic from I-35 due to demolition of the existing bridge or due to structural deficiencies and reduced load ratings and eventual closure. The benefits of traffic detour avoidance include reduced vehicle operating costs, reduced travel time, reduced crash costs, and reduced emissions costs.
- State of Good Repair – Implementation of the projects in this bundle will improve pavement condition on the approach and bridge slab therefore reducing vehicle operating costs.
- Bridge System Impacts – Implementation of the projects in this bundle will improve the condition of the bridges and reduce ongoing operations, maintenance, and inspection costs to ODOT.

Transportation System User Effects

The economic competitiveness category quantifies multiple benefits with its analysis. Each bridge provides benefits to both the roadway on the bridge and the corridor underneath the bridge as all bridges are over other roadways. For the roadways on the bridge there are benefits associated with keeping the bridges open through rehabilitation or replacement rather than closing the bridges and forcing detours. For the roadways under the bridges there are benefits associated with rehabilitation (this applies to eight structures) because under the no-build condition these bridges would be closed and demolished in ten years without the rehabilitation and would require a two-and-a-half-day closure of I-35 for the bridge to be removed. The following sub-sections describe the direct benefits in greater detail.

Reduced Vehicle Operating Costs

Reduced vehicle operating costs were calculated by determining the number of miles saved from detours due to temporary and permanent closures, as well as, weight limits on the bridges. These additional vehicle miles travelled (VMT) were found separately for automobile (11,009,364) and truck traffic (2,281,238). The VMTs were multiplied by the operating costs per mile provided in the BCA guidance ($0.39 per mile for automobiles and $0.90 per mile for trucks) to determine the additional costs to the user and the year in which they would occur. This resulted in a present value of $6,346,765 savings from vehicle operating costs due to detours avoided.

Reduced Travel Time

The benefit from reduced travel time was calculated by determining the increase in travel time for the detour routes due to temporary and permanent closures, as well as weight limits compared to the current route. The additional time (228,934 hours from automobiles and 41,531 hours from trucks) was then multiplied by an occupancy (1.39 persons for automobiles) and then the value of time provided in the BCA guidance ($14.80 per hour for all persons and $28.60 per hour for truck drivers). Calculations resulted in $5,897,420 in present value savings from travel time saved by detours avoided.

Reduced Crash Cost

Reduced crash costs use the same reduction in miles travelled as noted above and applied crash rates for Kay County, Oklahoma to the additional distance to determine the increased cost of crashes resulting from the detours. This uses the FHWA value of a crash per person or vehicle, vehicle occupancy (1.39), and number of vehicles per crash (1.87) data to determine the cost to the public from the increase exposure to crashes. To further address the difference which will be found on the I-35 bridges over U.S. 60, crash modification factors (CMFs) were applied to the reconstructed bridges for replacing the bridge and replacing the guardrail. The benefit of the reduced crashes from the reduction in miles driven by detours avoided is $2,406,689.

Reduced Emissions Damage

The reduction in emission damage from the avoided detours were computed for Volatile Organic Compounds (VOCs), Nitrogen Oxides (NOx) and Particulate Matter ($PM_{2.5}$). Saving these emissions by reducing the miles driven over the 20-year benefit analysis horizon has resulted in emissions damage savings of $332,148.

State of Good Repair

This benefit is about the reduction in operating costs due to the improvement in pavement condition. This is mostly tire, alignment and rough road repair items. The cost of rough roads in Oklahoma is computed to be $457 per vehicle per year by the US PIRG Education Fund in 2010. This was then used by the proportion of pavement being improved through replacement and repair as part of this project and multiplied by the number of vehicles each year to equate the savings. This benefit has a present value of $18,431 to the public.

Bridge System Impacts

The calculation of the savings to the Oklahoma DOT and therefore the public from the reduced need for supplemental inspections associated with rehabbing and replacing these bridges. Oklahoma DOT maintenance staff provided information that it costs the state half as much to inspect a new bridge as the current bridges and 80 percent as much to inspect a rehabilitated bridge as it takes to inspect the current bridges. This benefit equated to a present value when taken over the 20-year analysis life of $20,800.

Summary of Benefits

As summarized in the tables on the following page, the project benefits for the replacement and rehabilitation of the bridges in this bundle over a 20-year period result in approximately $13,425,887 in present value with a 7 percent discount for an investment of $5,871,877.

Table 2: BCA Summary

Bridge Number	Bridge Location	Capital Costs	Residual Value	Benefit 1a Vehicle Operating Cost Savings due to Avoided Detours	Benefit 1b Reduced Travel Time due to Avoided Detours	Benefit 1c Reduced Crash Costs due to Avoided Detours	Benefit 1d Reduced Emissions Damage due to Avoided Detours	Benefit 2a Vehicle Operating Cost Savings from Improved Pavement Conditions	Benefit 3a Reduced Inspection Costs due to New Structures	Total Benefits	B/C Ratio
Kay County Bridge Raises											
14155 - Indian	Indian Road over I-35	$800,685	$63,296	$121,135	$99,787	$86,054	$10,938	$21	$1,600	$319,535	0.48
14429 - North	North Avenue over I-35	$751,460	$67,891	$216,076	$258,905	$153,588	$19,485	$21	$1,600	$649,676	0.95
14435 - Highland	Highland Avenue over I-35	$736,859	$66,572	$668,844	$264,011	$155,982	$19,804	$47	$1,600	$1,110,288	1.60
14437 - Hartford	Hartford Avenue over I-35	$741,031	$66,949	$668,459	$263,663	$155,833	$19,733	$21	$1,600	$1,109,309	1.59
15145 - Coleman	Coleman Road over I-35	$743,012	$75,519	$657,563	$258,575	$152,839	$19,390	$21	$1,600	$1,089,988	1.57
15146 - Chrysler	Chrysler Avenue over I-35	$747,184	$75,943	$658,453	$259,755	$153,500	$19,462	$21	$1,600	$1,092,791	1.56
15147 - Ferguson	Ferguson Avenue over I-35	$749,374	$76,165	$658,741	$260,052	$153,641	$19,506	$47	$1,600	$1,093,587	1.56
15149 - Adobe	Adobe Road over I-35	$941,896	$95,733	$124,949	$179,482	$88,706	$11,299	$21	$1,600	$406,057	0.53
Subtotal		*$6,211,502*	*$588,067*	*$3,774,219*	*$1,844,230*	*$1,100,142*	*$139,617*	*$222*	*$12,800*	*$6,871,230*	*1.20*
Kay County Bridge Reconstructions											
14408 - I-35 SB	I-35 SB over US 60	$4,622,866	$3,445,650	$1,286,273	$2,026,595	$653,273	$96,266	$9,105	$4,000	$4,075,511	1.63
14409 - I-35 NB	I-35 NB over US 60	$4,623,284	$3,445,961	$1,286,273	$2,026,595	$653,273	$96,266	$9,105	$4,000	$4,075,511	1.63
Subtotal		*$9,246,150*	*$6,891,611*	*$2,572,545*	*$4,053,190*	*$1,306,547*	*$192,531*	*$18,209*	*$8,000*	*$8,151,023*	*1.63*
Total		**$15,457,652**	**$7,479,678**	**$6,346,765**	**$5,897,420**	**$2,406,689**	**$332,148**	**$18,431**	**$20,800**	**$15,022,253**	**1.46**

Table 3: BCA Summary (7% Discount)

Bridge Number	Bridge Location	Capital Costs	Residual Value	Benefit 1a Vehicle Operating Cost Savings due to Avoided Detours	Benefit 1b Reduced Travel Time due to Avoided Detours	Benefit 1c Reduced Crash Costs due to Avoided Detours	Benefit 1d Reduced Emissions Damage due to Avoided Detours	Benefit 2a Vehicle Operating Cost Savings from Improved Pavement Conditions	Benefit 3a Reduced Inspection Costs due to New Structures	Total Benefits	B/C Ratio
Kay County Bridge Raises											
14155 - Indian	Indian Road over I-35	$695,443	$11,662	$57,265	$47,036	$40,677	$5,172	$9	$1,181	$151,338	0.23
14429 - North	North Avenue over I-35	$652,688	$12,509	$102,521	$122,821	$72,864	$9,247	$9	$1,181	$308,643	0.49
14435 - Highland	Highland Avenue over I-35	$640,006	$12,266	$317,453	$125,022	$73,878	$9,383	$19	$1,181	$526,937	0.84
14437 - Hartford	Hartford Avenue over I-35	$643,629	$12,335	$317,320	$124,901	$73,826	$9,358	$9	$1,181	$526,594	0.84
15145 - Coleman	Coleman Road over I-35	$645,350	$13,914	$312,268	$122,664	$72,509	$9,202	$9	$1,181	$517,832	0.82
15146 - Chrysler	Chrysler Avenue over I-35	$648,974	$13,992	$312,555	$123,041	$72,719	$9,226	$9	$1,181	$518,731	0.82
15147 - Ferguson	Ferguson Avenue over I-35	$650,876	$14,033	$312,654	$123,141	$72,766	$9,242	$19	$1,181	$519,002	0.82
15149 - Adobe	Adobe Road over I-35	$818,092	$17,639	$59,207	$85,080	$42,041	$5,352	$9	$1,181	$192,869	0.26
Subtotal		*$5,395,058*	*$108,351*	*$1,791,243*	*$873,705*	*$521,280*	*$66,182*	*$90*	*$9,446*	*$3,261,946*	*0.62*
Kay County Bridge Reconstructions											
14408 - I-35 SB	I-35 SB over US 60	$4,015,234	$634,858	$413,609	$645,403	$207,038	$32,274	$3,690	$2,952	$1,304,966	0.48
14409 - I-35 NB	I-35 NB over US 60	$4,015,596	$634,916	$413,609	$645,403	$207,038	$32,274	$3,690	$2,952	$1,304,966	0.48
Subtotal		*$8,030,830*	*$1,269,774*	*$827,219*	*$1,290,806*	*$414,076*	*$64,547*	*$7,381*	*$5,904*	*$2,609,932*	*0.48*
Total		**$13,425,887**	**$1,378,125**	**$2,618,462**	**$2,164,511**	**$935,356**	**$130,729**	**$7,471**	**$15,349**	**$5,871,877**	**0.54**

Table 4: BCA Benefits & Cost Summary

Project Bundle	Kay County I-35 Bridge Bundle
Description	8 Bridge Raises; 2 Bridge Replacements
Total Capital Costs (2017 Dollars)	$15,457,652
Total Capital Costs (7% Discounted) (2017 Dollars)	$13,425,887
Total Net Benefit (2017 Dollars)	$15,022,253
Total Net Benefit (7% Discounted) (2017 Dollars)	$5,871,877
Benefit Cost Ratio (2017)	1.46
Benefit Cost Ratio (7% Discounted)	0.54