Ohio Demonstration Project:

Best-Value Design Build Contracting for Constructio of I-71/I-670 Interchange in Columbus, OH

Final Technical Brief
July 2015

HIGHWAYS FOR LIFE
Accelerating Innovation for the American Driving Experience.

U.S. Department of Transportation
Federal Highway Administration

FOREWORD

The purpose of the Highways for LIFE (HfL) pilot program is to accelerate the use of innovations that improve highway safety and quality while reducing congestion caused by construction. **LIFE** is an acronym for **L**onger-lasting highway infrastructure using **I**nnovations to accomplish the **F**ast construction of **E**fficient and safe highways and bridges.

Specifically, HfL focuses on speeding up the widespread adoption of proven innovations in the highway community. Such “innovations” encompass technologies, materials, tools, equipment, procedures, specifications, methodologies, processes, and practices used to finance, design, or construct highways. HfL is based on the recognition that innovations are available that, if widely and rapidly implemented, would result in significant benefits to road users and highway agencies.

Although innovations themselves are important, HfL is as much about changing the highway community’s culture from one that considers innovation something that only adds to the workload, delays projects, raises costs, or increases risk to one that sees it as an opportunity to provide better highway transportation service. HfL is also an effort to change the way highway community decision makers and participants perceive their jobs and the service they provide.

The HfL pilot program, described in Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) Section 1502, includes funding for demonstration construction projects. By providing incentives for projects, HfL promotes improvements in safety, construction-related congestion, and quality that can be achieved through the use of performance goals and innovations. This report documents one such HfL demonstration project.

Additional information on the HfL program is at www.fhwa.dot.gov/hfl.

NOTICE

1. Report No.	2. Government Accession No	3. Recipient's Catalog No
3. Title and Subtitle Ohio Demonstration Project: Best-Value Design Build Contracting for Construction of I-71/I-670 Interchange in Columbus, OH		5. Report Date July 2015 6. Performing Organization Code
7. Authors Hyung Lee, Ph.D., P.E.		8. Performing Organization Report No.
9. Performing Organization Name and Address Applied Research Associates, Inc. 100 Trade Centre Drive, Suite 200 Champaign, IL 61820		10. Work Unit No. (TRAIS) C6B 11. Contract or Grant No.
12. Sponsoring Agency Name and Address Office of Infrastructure Federal Highway Administration 1200 New Jersey Avenue, SE Washington, DC 20590		13. Type of Report and Period Covered Final Technical Brief 14. Sponsoring Agency Code
15. Supplementary Notes Contracting Officer's Representative: Julie Zirlin Contracting Officer's Task Manager: Ewa Flom		

16. Abstract

As a part of the Federal Highway Administration (FHWA) Highways for LIFE initiative, a Federal grant of $1,000,000 was provided to the Ohio Department of Transportation (ODOT) for this project, which was in addition to FHWA's 80 percent contribution under the Federal-aid highway funding program.

This project is a result of ODOT's I-70/I-71 Split Planning Study, Environmental Impact Statement and Record of Decision, which described a program of construction projects for reconstruction of the existing interstate highways in and around the central business district of Columbus. The project consisted of reconstruction of the I-71/I-670 interchange, including 0.58 miles of I-71 and 1.16 miles of I-670. The project also included construction of connections between the freeways and the local urban corridor street system and a total of 19 bridge structures, including 2 long curved bridges over the interchange area (I-670 eastbound and the connector road from I-670 eastbound to I- 71 northbound).

The key innovation of this project was a two-step best-value based design-build (DB) procurement method of contracting for construction. The DB method is an innovative contracting technique which allows the contractors to develop and propose innovative design methodologies and optimize their capabilities. DB is not a standard practice for ODOT and this type of contracting was expected to cut construction time in half.

17. Key Words	18. Distribution Statement
Highways for LIFE, Design Build, DB, alternate contracting, innovative contracting, best value	No restriction. This document is available to the public through the Highways for LIFE website: http://www.fhwa.dot.gov/hfl/

Security Classif.(of this report)	19. Security Classif. (of this page)	20. No. of Pages	21. Price
Unclassified	Unclassified	21	

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

SI* (MODERN METRIC) CONVERSION FACTORS				
APPROXIMATE CONVERSIONS TO SI UNITS				
Symbol	**When You Know**	**Multiply By**	**To Find**	**Symbol**
		LENGTH		
(none)	mil	25.4	micrometers	μm
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yards	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
		VOLUME		
fl oz	fluid ounces	29.57	millimeters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
		NOTE: volumes greater than 1000 L shall be shown in m^3		
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
		TEMPERATURE (exact degrees)		
°F	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	°C
		ILLUMINATION		
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela per square meter	cd/m^2
		FORCE and PRESSURE or STRESS		
lbf	poundforce	4.45	Newtons	N
lbf/in^2 (psi)	poundforce per square inch	6.89	kiloPascals	kPa
k/in^2 (ksi)	kips per square inch	6.89	megaPascals	MPa
		DENSITY		
lb/ft^3 (pcf)	pounds per cubic foot	16.02	kilograms per cubic meter	kg/m^3
APPROXIMATE CONVERSIONS FROM SI UNITS				
Symbol	**When You Know**	**Multiply By**	**To Find**	**Symbol**
		LENGTH		
μm	micrometers	0.039	mil	(none)
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
		AREA		
mm^2	square millimeters	0.0016	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.195	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	square kilometers	0.386	square miles	mi^2
		VOLUME		
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	cubic meters	35.314	cubic feet	ft^3
m^3	cubic meters	1.307	cubic yards	yd^3
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2000 lb)	T
		TEMPERATURE		
°C	Celsius	1.8C+32	Fahrenheit	°F
		ILLUMINATION		
lx	lux	0.0929	foot-candles	fc
cd/m^2	candela per square meter	0.2919	foot-Lamberts	fl
		FORCE and PRESSURE or STRESS		
N	Newtons	0.225	poundforce	lbf
kPA	kiloPascals	0.145	poundforce per square inch	lbf/in^2 (psi)
MPa	megaPascals	0.145	kips per square inch	k/in^2 (ksi)

*SI is the symbol for the International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380. (Revised March 2003)

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ABBREVIATIONS AND SYMBOLS

ADT	average daily traffic
DB	design-build
DBE	disadvantaged business enterprise
FHWA	Federal Highway Administration
HfL	Highways for LIFE
IRI	International Roughness Index
OBSI	onboard sound intensity
ODOT	Ohio Department of Transportation
OSHA	Occupational Safety & Health Administration
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users
SOQ	statement of qualifications
SRTT	standard reference test tire

INTRODUCTION

HIGHWAYS FOR LIFE DEMONSTRATION PROJECTS

Highways for LIFE (HfL) is the Federal Highway Administration's (FHWA) initiative to advance longer-lasting and promote efficient and safe construction of highways and bridges using innovative technologies and practices. The HfL program provides incentive funding to highway agencies to try proven but little-used innovations on eligible Federal-aid construction projects. The HfL team prioritizes projects that use innovative technologies, manufacturing processes, financing, contracting practices, and performance measures that demonstrate substantial improvements in safety, congestion, quality, and cost-effectiveness. An innovation must be one the applicant State has never or rarely used, even if it is standard practice in other States. Recognizing the challenges associated with deployment of innovations, the HfL program provides incentive funding for up to 15 demonstration construction projects a year. The funding amount typically totals up to 20 percent of the project cost, but not more than $5 million.

The HfL program promotes project performance goals that focus on the expressed needs and wants of highway users. They are set at a level that represents the best of what the highway community can do, not just the average of what has been done. The goals are categorized into the following categories:

1. **Safety**

    a. Work zone safety during construction—Work zone crash rate equal to or less than the preconstruction rate at the project location.

    b. Worker safety during construction—Incident rate for worker injuries of less than 4.0, based on incidents reported on Occupational Safety and Health Administration (OSHA) Form 300.

    c. Facility safety after construction—Twenty percent reduction in fatalities and injuries in 3-year average crash rates, using preconstruction rates as the baseline.

2. **Construction Congestion**

    a. Faster construction —Fifty percent reduction in the time highway users are impacted, compared to traditional methods.

    b. Trip time during construction — Less than 10 percent increase in trip time compared to the average preconstruction speed, using 100 percent sampling.

    c. Queue length during construction—A moving queue length of less than 0.5 miles in a rural area or less than 1.5 miles in an urban area (in both cases at a travel speed 20 percent less than the posted speed).

3. **Quality**

a. Smoothness—International Roughness Index (IRI) measurement of less than 48 inches/mile.

b. Noise—Tire-pavement noise measurement of less than 96.0 A-weighted decibels (dB(A)), using the onboard sound intensity (OBSI) test method.

4. **User Satisfaction**

   a. An assessment of how satisfied users are with the new facility compared to its previous condition and with the approach used to minimize disruption during construction. The goal is a measurement of 4 or more on a 7-point Likert scale.

PROJECT OVERVIEW

As a part of the Federal Highway Administration (FHWA) Highways for LIFE initiative, a Federal grant of $1,000,000 was provided to the Ohio Department of Transportation (ODOT) for this project, which was in addition to FHWA's 80 percent contribution under the Federal-aid highway funding program.

This project is a result of ODOT's I-70/I-71 Split Planning Study, Environmental Impact Statement and Record of Decision, which described a program of construction projects for reconstruction of the existing interstate highways in and around the central business district of Columbus. The project consisted of reconstruction of the I-71/I-670 interchange, including 0.58 miles of I-71 and 1.16 miles of I-670. The project also included construction of connections between the freeways and the local urban corridor street system and a total of 19 bridge structures, including 2 long curved bridges over the interchange area (I-670 eastbound and the connector road from I-670 eastbound to I- 71 northbound).

The key innovation of this project was a two-step best-value based design-build (DB) procurement method of contracting for construction. The DB method is an innovative contracting technique which allows the contractors to develop and propose innovative design methodologies and optimize their capabilities. DB is not a standard practice for ODOT and this type of contracting was expected to cut construction time in half.

PROJECT DETAILS

PROJECT BACKGROUND

This project is a result of the I-70/I-71 Split Planning Study, Environmental Impact Statement and Record of Decision, which described a program of construction projects for reconstruction of the existing interstate highways in and around the central business district of Columbus. This project is the first major project that has been constructed as a consequence of these planning efforts, and it consisted of reconstructing the interchange of I-71 and I-670. This interchange is located within the city limits of Columbus, to the northeast of the downtown area near the Columbus State University campus and the Fort Hayes Support Facility.

PROJECT DESCRIPTION

ODOT's FRA-71-17.76 consisted of reconstruction of the I-71/I-670 interchange, including 0.58 miles of I-71 (approximately from 100 feet south of Long Street to 800 feet north of Old Leonard Avenue/Jack Gibbs Boulevard) and 1.16 miles of I-670 (approximately from 600 feet west of State Route 3/Cleveland Avenue to Joyce Avenue crossing). Figures 1 and 2 show the approximate limits of construction along I-71 and I-670, respectively. The project also included construction of connections between the freeways and the local urban corridor street system and a total of 19 bridge structures, including 2 long curved bridges over the interchange area (I-670 eastbound and the connector road from I-670 eastbound to I- 71 northbound) as well as bridges over Cleveland Avenue, Jack Gibbs Boulevard, and St. Clair Avenue, and under Spring Street and Long Street.

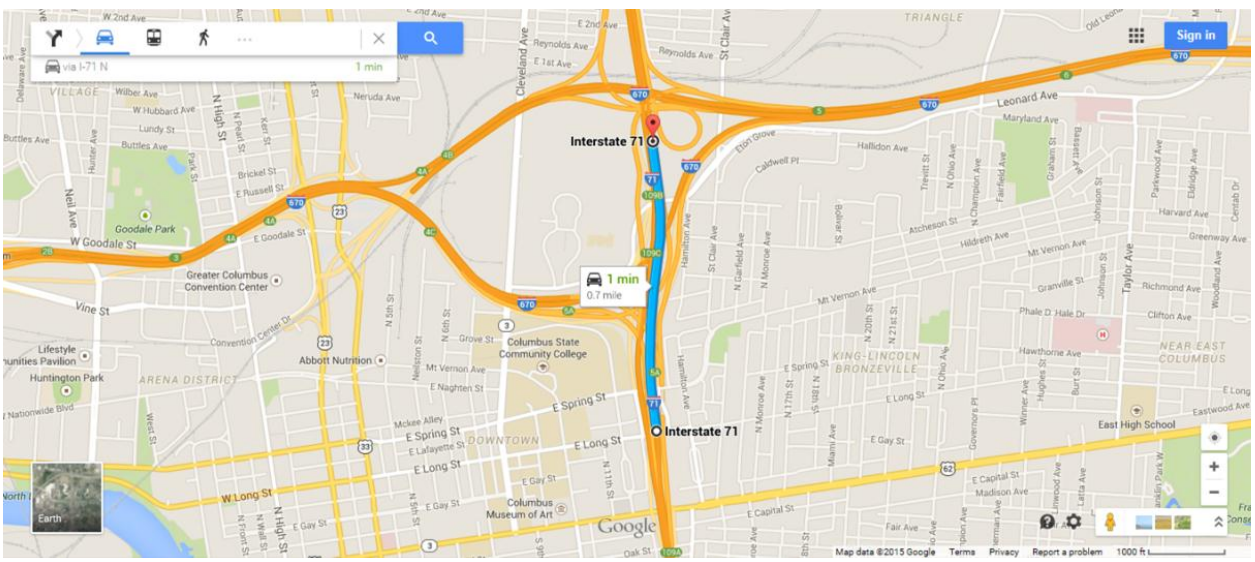


Figure 1. Map. Approximate project limits along I-71.

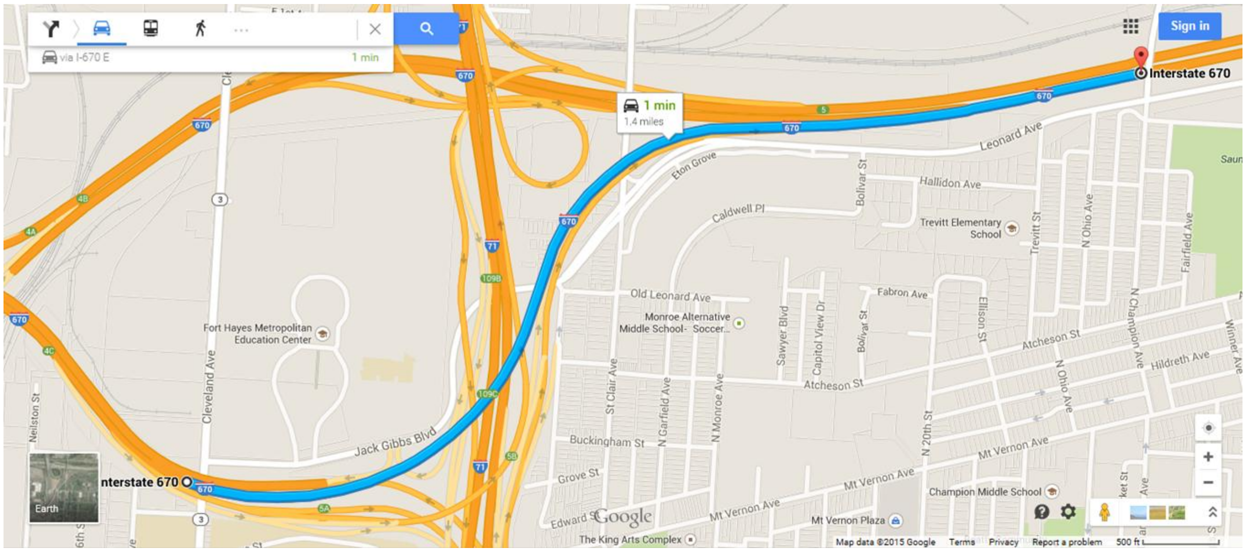


Figure 2. Map. Approximate project limits along I-670.

Both I-71 and I-670 are interstate routes on the Federal Aid System with a legal traveling speed of 55 mph. As of 2005, I-71 had an average daily traffic (ADT) of 145,800 vehicles with 10 percent truck traffic, while I-670 had a two-way ADT of 40,300 vehicles with 7 percent truck traffic at Cleveland Avenue. The eastbound ADT of I-670 was estimated to be 11,900. The purpose of the FRA-71-17.76 project was to replace and relocate the mainline of I-71, the eastbound mainline of I-670, and most of ramps and roadways to better separate movements and improve traffic flow. The design speed for both I-71 and I-670 was 60 mph. The design year (2035) ADT was projected to be 199,700 with 10 percent trucks for I-71 and 43,100 with 7.0 percent trucks for eastbound I-670.

The key innovation of this project was the best-value based DB method of contracting for construction. The DB method is an innovative contracting technique in which the parameters for the desired end result are identified and the minimum design criteria are established by the contracting agency. The contractors then develop and propose design methodologies to meet or exceed the minimum criteria while optimizing their capabilities.

The best-value selection process, in concept, is similar to the traditional low-bid process. The difference is that, during the contractor selection process, the best-value method accounts for the performance (or quality) measures in addition to the proposed cost. The performance criteria are predetermined by the agency to maximize the value of construction, enhance long-term performance, and/or minimize the impact of construction. The performance criteria and the pricing criteria are evaluated and weighted in a manner set forth by the agency to determine the contractor that is deemed to be most advantageous and has offered the greatest value

Figures 3 and 4 show a bird’s eye view of the project interchange before and after construction, respectively.


Figure 3. Photo. I-71/I-670 interchange before construction.


Figure 4. Photo. I-71/I-670 interchange after construction.

ODOT's Best-Value based selection of Design-Build Team

ODOT's best-value based selection of the DB team for the FRA-71-17.76 project was carried out in a two-step process: prequalification and final selection. During the prequalification process, the prospective contractors were required to submit a statement of qualification (SOQ) detailing their qualifications, capabilities, and understanding/approach to the current project. To compete for the final selection, the contractor had to become short-listed based on ODOT's evaluation of the SOQs. The criteria for evaluating the SOQs and the maximum allowable points for each criterion are shown in Table 1.

Table 1. Evaluation criteria for statement of qualification.

Topic	**Evaluation Criteria**	**Maximum Points**
Project Understanding and Approach	How well does the DB team's SOQ demonstrate an in-depth understanding of the design and construction requirements of the project?	30
DB Project Team	How well do the DB team's qualifications, experience, and time availability relate to the requirements of the project?	40
DB Team Capabilities	How well does the DB team's SOQ communicate their design, construction, and project management experience for this project?	30
Total	Statement of Qualification	100

The short-listed, prequalified DB teams were required to submit technical and pricing proposals. The technical proposals were scored (100 points total) based on nine criteria defined by ODOT. These evaluation criteria and the maximum allowable points for each criterion are as follows:

1. Maintenance of traffic and construction access (20 points).
2. Design management (5 points).
3. Proposed design (20 points).
4. Construction management (5 points).
5. Construction (15 points).
6. Quality management (15 points).

7. Outreach to the disadvantaged business enterprise (DBE) community and on-the-job training (5 points).

8. Community relations and aesthetic enhancements (10 points).

9. Sustainability plan (5 points).

Table 2 shows further breakdown of these criteria and the allocated scores. As shown in the table, the bidders were also able to achieve 5 bonus points for “adjacent neighborhood access.” In addition, the proposed duration of construction was included in the technical proposals but was scored separately, as will be explained subsequently.

Table 2. Evaluation criteria for technical proposals.

Part		Evaluation Criteria	Percentage Within Criteria	Maximum Points
A	**Overall**	**Maintenance of Traffic and Construction Access**	**100**	**20**
	A.1	Proposed Phasing and Overall Plan Design	35	7
	A.2	Construction Access Plan	20	4
	A.3	Minimization of Public Inconvenience	35	7
	A.4	MOT Staffing	10	2
B	**Overall**	**Design Management**	**100**	**5**
	B.1	Design Management Staffing	60	3
	B.2	Integration of Management Team (e.g., location, interface with construction, etc.)	20	1
	B.3	Design Checking	20	1
C	**Overall**	**Proposed Design**	**100**	**20**
	C.1	Bridge Designs	35	7
	C.2	Retaining Wall Designs	30	6
	C.3	General Roadway, Roadway Drainage	30	6
	C.4	Other (including Utility Coordination and Relocation)	5	1
D	**Overall**	**Construction Management**	**100**	**5**
	D.1	Construction Management Staffing	50	2.5
	D.2	Construction Management Plan	50	2.5
E	**Overall**	**Construction**	**100**	**15**
	E.1	Construction Integration, Sequencing and Logistics	55	8.25
	E.2	Safety	15	2.25
	E.3	Utility Coordination	10	1.5
	E.4	Micro Tunnel Logistics	20	3
F	**Overall**	**Quality Management**	**100**	**15**
	F.1	Overall Quality Management Approach and Plan	30	4.5
	F.2	Design Quality/Reviews	20	3
	F.3	Construction Quality/Inspection	30	4.5
	F.4	Materials Testing	20	3
G	**Overall**	**Outreach to the Disadvantaged Enterprise Community and On the Job Training**	**100**	**5**
	G.1	Plan to Achieve DBE Goal of 12%	25	1.25
	G.2	Plan to Outreach to the Disadvantaged Communnity	25	1.25
	G.3	Plan to Achieve 30 Trainees	25	1.25
	G.4	Plan for Training, Retention and Tenure of Trainees	25	1.25
H	**Overall**	**Community Relations & Aesthetic Enhancements**	**100**	**10**
	H.1	Public Communication and Community Relations Approach	50	5
	H.2	Aesthetics and Enhancement Management Plan	50	5
I	**Overall**	**Sustainability Plan**	**100**	**5**
J	**Overall**	**Prequalification**	**Not Scored**	
Total		**Technical Proposal**	**N/A**	**100**
K	**Overall**	**Adjacent Neighborhood Access (Bonus Evaluation Criteria)**	**100**	**5**
	K.1	Plan to reduce Spring-Long Street Bridge Construction period and maintain neighborhood connectivity	50	2.5
	K.2	Plan to reduce Broad St / Long St / Spring St / Cleveland ramp closure period and maintain traffic movements during construction	50	2.5
L	**Overall**	**Project Duration**	**Scored Separately***	

Three prequalified teams submitted proposals. One was deemed non-responsive and not scored. Including the bonus points for the adjacent neighborhood access, the other two proposals earned technical evaluation scores of 80.1 and 78.3. To determine the overall score of the respective bidders, the technical scores were combined with the proposed price and project duration by means of a normalized weighted formula. In other words, the bidder's total score was calculated as shown in Figure 5.

$$\text{Bidder's Score} = 35 \times \left(\frac{\text{Bidder's Technical Proposal Score}}{\text{Highest Technical Proposal Score}} \right) + 60 \times \left(\frac{\text{Lowest Price Proposal}}{\text{Bidder's Price Proposal}} \right) + 5 \times \left(\frac{\text{Shortest Project Duration}}{\text{Bidder's Project Duration}} \right)$$

Figure 5. Equation. Calculation of bidder's total score.

The Kokosing team proposed the lowest price for the project. In addition, the Kokosing team proposed a construction duration of 162 weeks, while the competitor proposed 164 weeks. With the highest technical score, shortest duration, and lowest price, the Kokosing team was awarded the contract on April 26, 2011, with a score of 100. The competitor's overall score was 94.9. The following list summarizes some highlights of the Kokosing's proposal:

1. Minimize construction duration by maximizing the work areas available in each phase of the construction.

2. Reduce closure periods at the Cleveland Avenue/Jack Gibbs Boulevard ramp to I-670 westbound and at Long Street (saving 150 total days of closures).

3. Use 12-foot (rather than 11-foot) lane widths and wider shoulder buffers at portable concrete barriers where possible.

4. Minimize major traffic shifts to promote driver familiarity within the work zone.

5. Limit construction ingress/egress points to reduce congestion.

6. Utilize law enforcement officers to communicate traffic shifts to drivers.

7. Create larger work zones to allow more room for driver corrections.

8. Staff a worksite traffic supervisor to improve communications and quality assurance and address maintenance of traffic during weekly management team meetings.

9. Provide safety training for all personnel. All project engineers, managers, supervisors, and foremen will have successfully completed Ohio Contractors Association Traffic Control Supervisory Training. All design employees who work in the field are required to complete a corporate field safety training program.

10. Conduct site-specific safety orientation to identify, evaluate, and communicate potential hazards.

11. Provide a safety incentive program for employees, allowing them to earn points for hours worked without incident or accident that can be redeemed for rewards from the company such as coats, hats, and other merchandise.

12. Provide for construction duration of 162 weeks. ODOT determined that this was less than half of the time that could have been achieved under a traditional procurement.

13. Provide alternate routes and temporary detours to reduce the demand for the roadway affected by construction. These alternate routes and detours will be conveyed to the public via radio and social media. The DB team will also develop a detailed incident management plan detailing the response to a variety of traffic incidents ranging from a disabled vehicle on the shoulder to a major hazardous incident requiring a full-road closure.

HFL PERFORMANCE GOALS

A complete project-related data set required to evaluate the HfL performance goals has not been collected for the I-71/I-670 interchange. A brief summary of the available data is presented here.

SAFETY

Between 2007 and 2009, there were a total of 920 crashes (or 2.62 crashes per million vehicle miles traveled), including 245 injury crashes and one fatal crash within the boundaries of the FRA-71-17.76 project. Crash statistics during and after construction have not been made available to the HfL project team.

CONSTRUCTION CONGESTION

To assess the impact of the construction project on motorists, the floating vehicle methodology was used to collect travel times, attempting to mimic the typical driving speed of other vehicles along the various roadway segments. No preconstruction data are available. The available data were collected in July 2012 during daytime and nighttime hours. More specifically, data were collected in the a.m. peak (7 to 9 a.m.), p.m. peak (4 to 6 p.m.), and off peak (2 to 3 p.m. and after 6 p.m.) periods. The limits of the data collection were selected to include the major interstate highway routes around the I-71/I-670 interchange and are as follows:

1. Eastbound and westbound I-70 from North Hague Avenue to Miller Avenue, approximately 7.1 miles (shown in Figure 6).
2. Eastbound and westbound I-70/I-670 from North Hague Avenue to East 5th Avenue, approximately 8.3 miles (shown in Figure 7).
3. Northbound and southbound I-71/I-70 from East 11th Avenue to Miller Avenue, approximately 3.8 miles (shown in Figure 8).

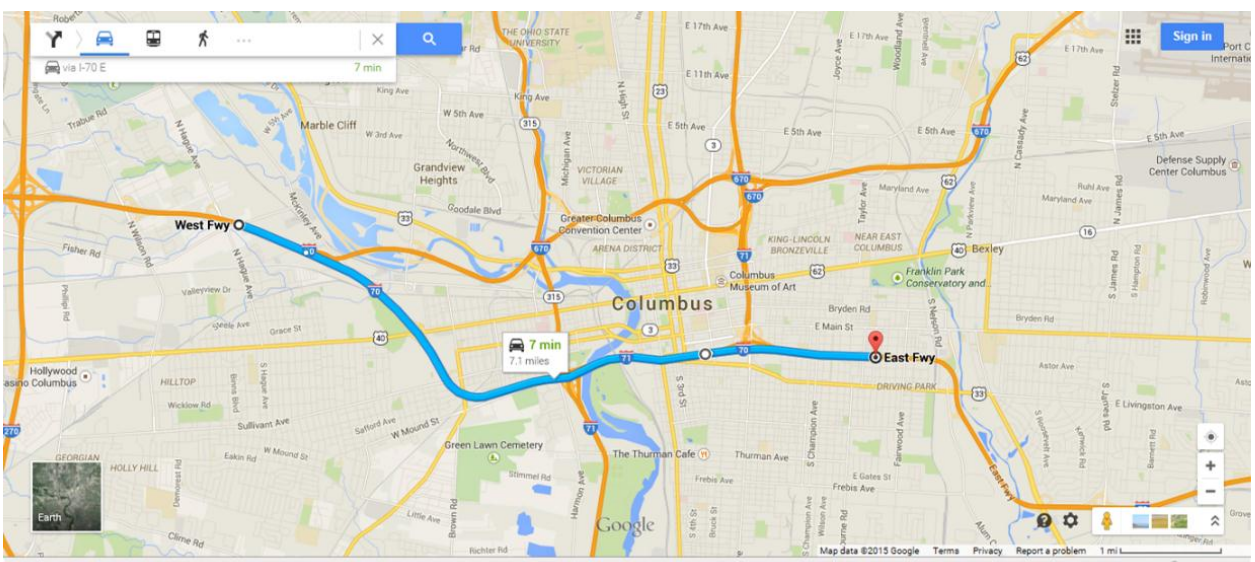


Figure 6. Map. I-70 limits of travel time study.

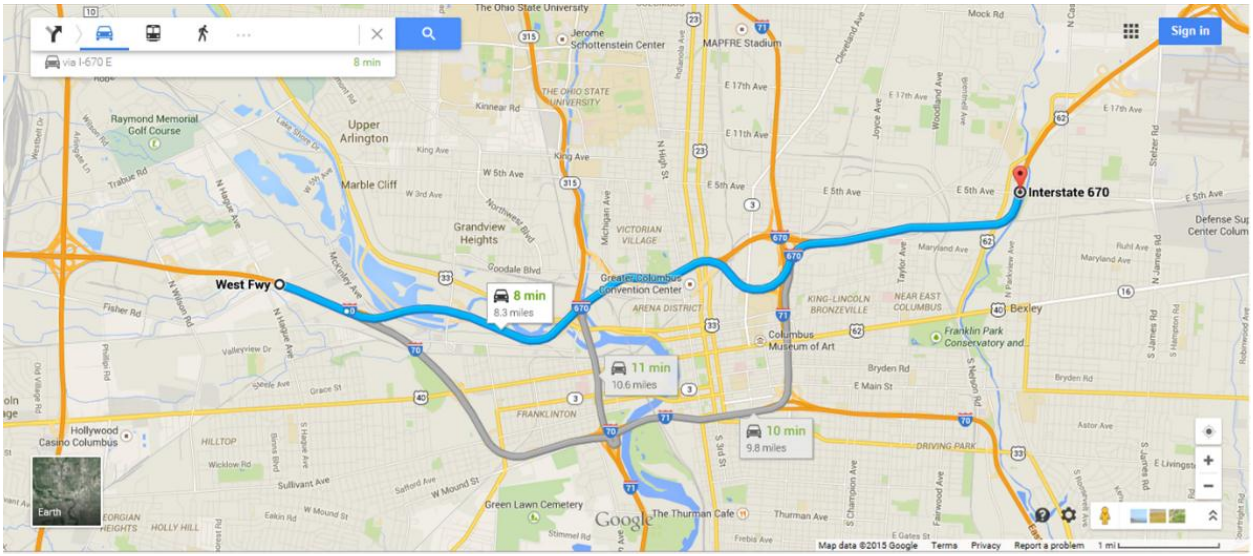


Figure 7. Map. I-70/I-670 limits of travel time study.

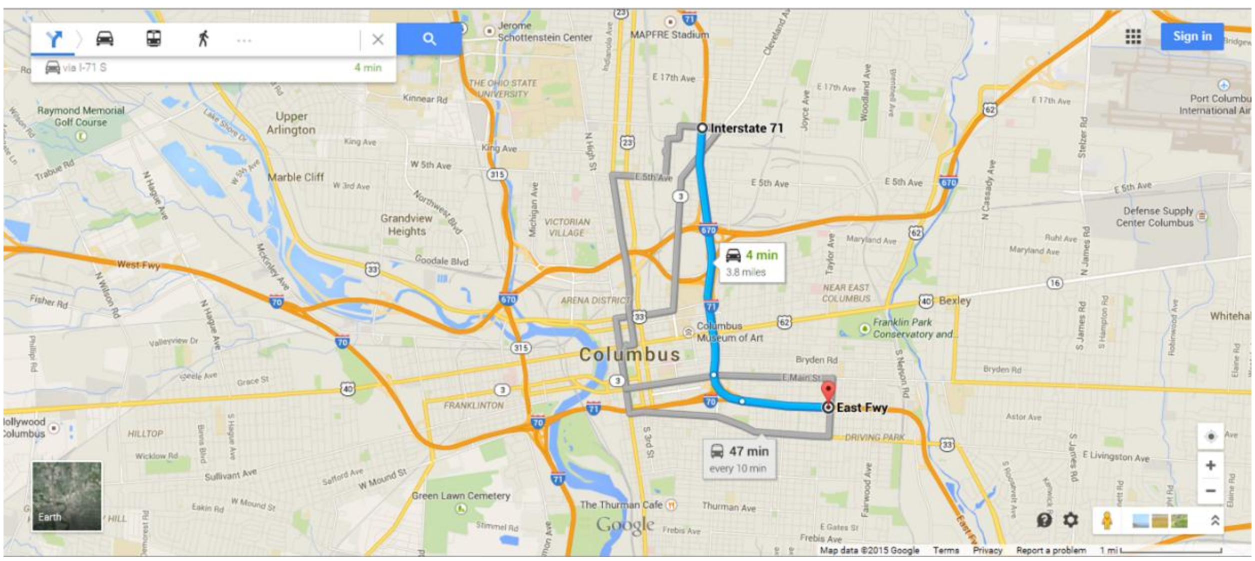


Figure 8. Map. I-71/I-70 limits of travel time study.

Travel times in each direction were averaged across two to three runs in each of the three time periods (a.m. peak, p.m. peak, and off peak). These average travel times are shown in Table 3.

Average travel times ranged from 7.0 to 20.6 minutes for I-70, 7.9 to 11.4 minutes for I-70/I-670, and 4.1 to 5.8 minutes for I-71/I-70. As mentioned, the project was already underway when the data were collected, so no preconstruction data are available. However, assuming that the off peak travel time is a reasonable estimate of the preconstruction condition and using it as a baseline, the increase in travel time during peak hours (a.m. and p.m.) could be estimated. The percent increase in travel time calculated with this assumption is summarized in Table 4. As shown in the table, the afternoon peak hour traffic was most significantly affected by construction, with 105.1 percent (10.6 minutes) and 127.8 percent (9.0 minutes) increase in travel time for the eastbound and westbound directions, respectively. The greatest increase in travel time for I-670 was observed in the westbound direction during morning peak hours (40.7 percent or 3.3 minutes). For I-71/I-70, the greatest increase in travel time was observed in the northbound direction during afternoon peak hours, which corresponds to 31.7 percent (or 1.4 minutes).

Table 3. Travel times (in minutes), July 2012.

Time Period	Run Number	I-70		I-70/I-670		I-71/I-70	
		Eastbound	Westbound	Eastbound	Westbound	Northbound	Southbound
a.m.	Run 1	6.3	7.2	9.0	11.7	4.4	4.3
	Run 2	7.6	7.2	9.0	12.4	3.9	4.3
	Run 3	-	-	7.8	10.1	4.3	4.7
	Average	**7.0**	**7.2**	**8.5**	**11.4**	**4.2**	**4.4**
p.m.	Run 1	21.8	10.8	11.5	8.3	5.1	3.9
	Run 2	19.4	21.4	8.3	7.9	5.8	3.7
	Run 3	-	-	8.1	12.5	6.5	5.6
	Average	**20.6**	**16.1**	**9.3**	**9.6**	**5.8**	**4.4**
Off Peak	Run 1	10.7	7.1	7.9	8.3	4.3	4.2
	Run 2	9.4	7.0	7.9	8.5	4.2	4.1
	Run 3	-	-	7.9	7.4	4.7	4.1
	Average	**10.0**	**7.1**	**7.9**	**8.1**	**4.4**	**4.1**

Table 4. Percent increase in travel time calculated assuming off peak data as baseline.

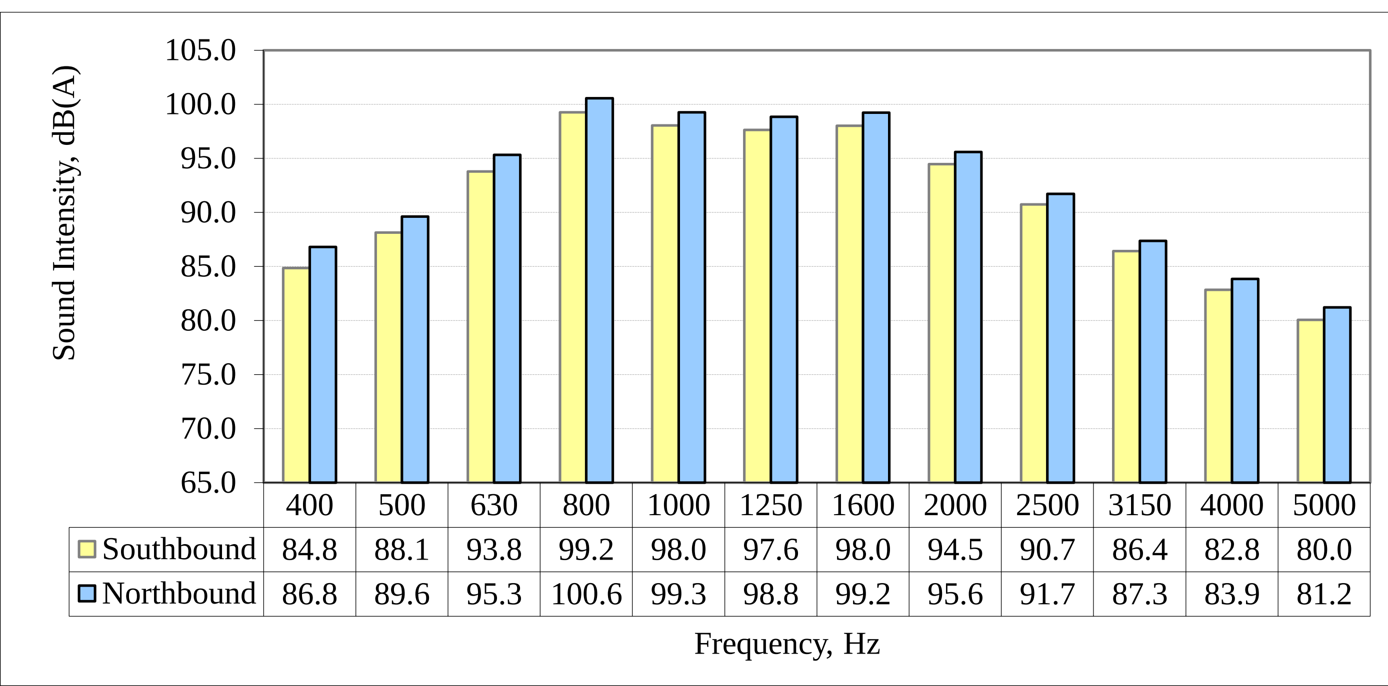
Time Period	I-70		I-670		I-71/I-70	
	Eastbound	Westbound	Eastbound	Westbound	Northbound	Southbound
a.m.	-30.7	1.8	8.0	40.7	-4.9	7.4
p.m.	105.1	127.8	17.9	18.3	31.7	6.9

SOUND INTENSITY TESTING

Preconstruction sound intensity measurements were made using the current accepted OBSI technique, AASHTO TP 76-10, which includes dual vertical sound intensity probes and an ASTM-recommended Standard Reference Test Tire (SRTT). Data were collected on February 9, 2012, from the inside lanes in both the northbound and southbound direction of I-71 between Long Street and I-670 before construction. The sound intensity measurements were recorded and analyzed using an onboard computer and data collection system. Five runs were made in the right wheelpath with the two microphone probes simultaneously capturing noise data from the leading and trailing tire/pavement contact areas. Figure 9 shows the dual probe instrumentation and the tread pattern of the SRTT.

Figure 9. Photo. OBSI dual probe system and the SRTT.

The average of the front and rear sound intensity values was computed to produce a global sound intensity value. Raw noise data were normalized for the ambient air temperature and barometric pressure at the time of testing. The resulting mean sound intensity levels are A-weighted to produce the sound intensity frequency spectra in one-third octave bands, as shown in Figure 10. The global sound intensity values of the existing pavement were 105.4 dB(A) and 106.7 dB(A) for the northbound and southbound lanes on I-71, respectively. Postconstruction OBSI measurements are not available.



	400	500	630	800	1000	1250	1600	2000	2500	3150	4000	5000
Southbound	84.8	88.1	93.8	99.2	98.0	97.6	98.0	94.5	90.7	86.4	82.8	80.0
Northbound	86.8	89.6	95.3	100.6	99.3	98.8	99.2	95.6	91.7	87.3	83.9	81.2

Smoothness Measurement

Preconstruction smoothness testing was done in conjunction with the sound intensity testing and utilized a high-speed inertial profiler integrated with the test vehicle. The smoothness testing was conducted only on I-71, between Long Street and I-670. The smoothness or profile data were collected from both wheelpaths and averaged to produce an IRI value. A low value is an indication of higher ride quality (i.e., smoother road).

Figure 11 is an image of the test vehicle showing the profiler positioned in line with the right rear wheel. Figure 12 graphically presents the IRI values of the existing northbound and southbound lanes of I-71. The overall IRI values for the existing pavement were found to be 98 inches/mile for the northbound lane and 92 inches/mile for the southbound lane. Postconstruction smoothness measurements are not available.

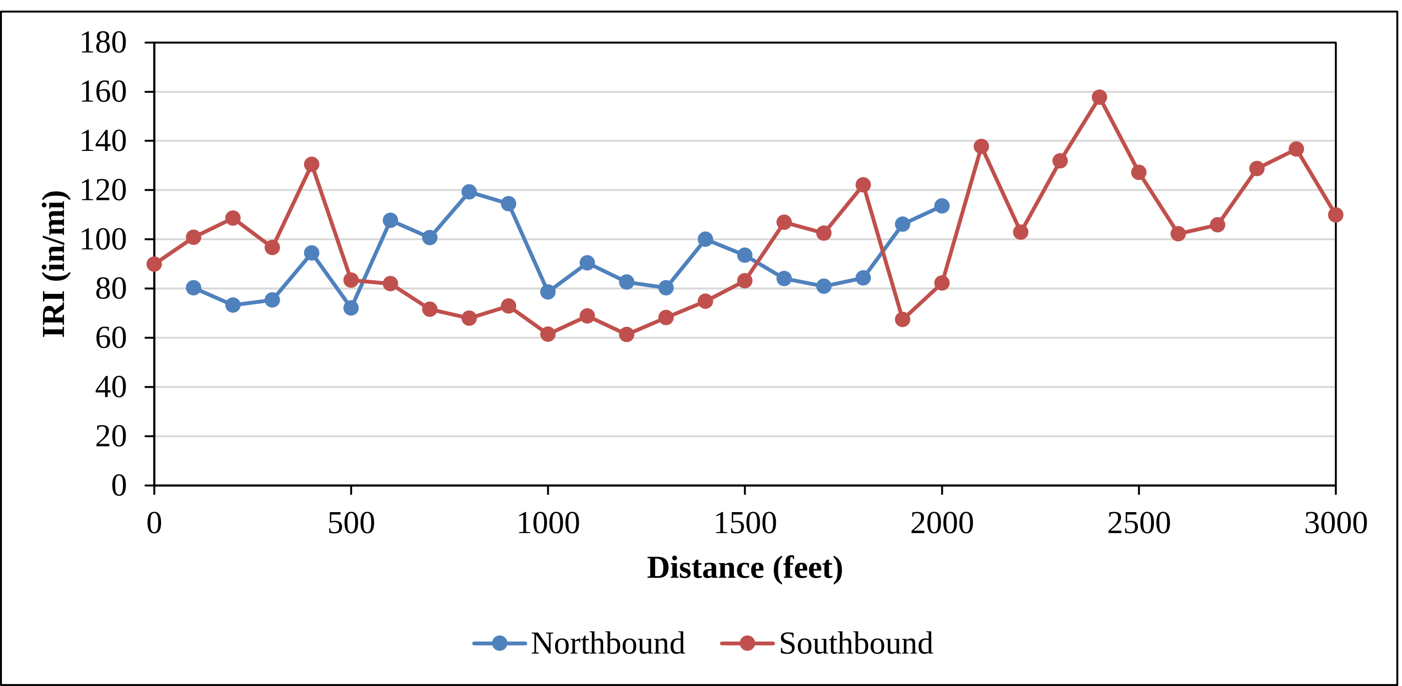
Figure 11. Photo. High-speed inertial profiler mounted behind the test vehicle.

Figure 12. Graph. Mean IRI values of existing I-71 from Long Street to I-670.

SUMMARY

This project is a result of Ohio Department of Transportation's (ODOT) I-70/I-71 Split Planning Study, Environmental Impact Statement and Record of Decision, which described a program of construction projects for reconstruction of the existing interstate highways in and around the central business district of Columbus. The overall objective of this project was to improve the operational efficiency and safety of the I-71/I-670 interchange. To achieve this objective, the project consisted of reconstruction of the I-71/I-670 interchange, including 0.58 miles of I-71 and 1.16 miles of I-670. The project also included construction of connections between the freeways and the local urban corridor street system and a total of 19 bridge structures, including 2 long curved bridges over the interchange area.

The key innovation of this project was the best-value based DB contracting method, which is not a standard practice for ODOT. It is believed that this project will help ODOT to set the standard for innovative contracting practices and pave the way for further implementation of the DB method.



ACKNOWLEDGMENTS

The project team acknowledges the invaluable insights and guidance of Highways for LIFE Team Leader Byron Lord and Program Coordinator Ewa Flom, who served as the technical panel on this demonstration project. Their vast knowledge and experience with the various aspects of construction, technology deployment, and technology transfer helped immensely in developing both the approach and the technical matter for this document. The team also is indebted to ODOT Engineer Brad Jones and FHWA Engineers Mark VonderEmbse and Jason Spilak, for their advice and assistance during this project.