Alabama Demonstration Project:

Improvements to the US 280 Corridor from Hollywood Blvd. to Doug Baker Blvd. in Birmingham, Alabama

Final Report
August 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.

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16. Abstract

As a part of the HfL initiative, the FHWA provided a $2,000,000 grant to the Alabama Department of Transportation (ALDOT) to modify 26 signalized intersections along this route by eliminating or modifying the access points, turning movements, or median crossings, adding turning lanes, or modifying side streets to improve traffic flow. The project is located along a section of US 280 between Hollywood Boulevard and Doug Baker Boulevard, a distance of about 8.2 miles, along one of the busiest corridors in Birmingham.

ALDOT gained valuable experience from the use of HfL innovations on the Birmingham US 280 project. The costs associated with traditional solutions in urban areas make it necessary to maximize the efficiency of existing facilities before considering expansion options. For this project, the traditional solutions would be increasing capacity through addition of travel lanes. However, expanding the number of lanes was not considered practical due to the right-of-way costs involved, so no cost estimate was available. While the cost of a double deck solution for a portion of the project length was put in the program, it was never considered practical due to the high costs ($950 million). Success—as measured in reduced congestion, reduced crash incidents, and user satisfaction with the project—will encourage the future use of these technologies.

17. Key Words	18. Distribution Statement
Highways for LIFE, capacity, adaptive signals, adaptive traffic control, ITS, intelligent transportation systems	No restriction. This document is available to the public through the Highways for LIFE website: http://www.fhwa.dot.gov/hfl/

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Unclassified	Unclassified	38	

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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)

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ABBREVIATIONS AND SYMBOLS

ADT	average daily traffic
ALDOT	Alabama Department of Transportation
dB(A)	A-weighted decibel
FHWA	Federal Highway Administration
HfL	Highways for LIFE
IRI	International Roughness Index
ITS	intelligent transportation system
OBSI	onboard sound intensity
OSHA	Occupational Safety and Health Administration
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users

INTRODUCTION

HIGHWAYS FOR LIFE DEMONSTRATION PROJECTS

The Highways for LIFE (HfL) pilot program, the Federal Highway Administration (FHWA) initiative to accelerate innovation in the highway community, provides incentive funding for demonstration construction projects. Through these projects, the HfL program promotes and documents improvements in safety, construction-related congestion, and quality that can be achieved by setting performance goals and adopting innovations.

The HfL program—described in the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU)—may provide incentives to a maximum of 15 demonstration projects a year. The funding amount may total up to 20 percent of the project cost, but not more than $5 million. Also, the Federal share for an HfL project may be up to 100 percent, thus waiving the typical State-match portion. At the State's request, a combination of funding and waived match may be applied to a project.

To be considered for HfL funding, a project must involve constructing, reconstructing, or rehabilitating a route or connection on an eligible Federal-aid highway. It must use innovative technologies, manufacturing processes, financing, or contracting methods that improve safety, reduce construction congestion, and enhance quality and user satisfaction. To provide a target for each of these areas, HfL has established demonstration project performance goals.

The performance goals emphasize the needs of highway users and reinforce the importance of addressing safety, congestion, user satisfaction, and quality in every project. The goals define the desired result while encouraging innovative solutions, raising the bar in highway transportation service and safety. User-based performance goals also serve as a new business model for how agencies can manage the highway project delivery process.

HfL project promotion involves showing the highway community and the public how demonstration projects are designed and built and how they perform. Broadly promoting successes encourages more widespread application of performance goals and innovations in the future.

Project Solicitation, Evaluation, and Selection

FHWA has issued open solicitations for HfL project applications annually since fiscal year 2006. State highway agencies submitted applications through FHWA Divisions. The HfL team reviewed each application for completeness and clarity, and contacted applicants to discuss technical issues and obtain commitments on project issues. Documentation of these questions and comments was sent to applicants, who responded in writing.

The project selection panel consisted of representatives of the FHWA offices of Infrastructure, Safety, and Operations; the Resource Center Construction and Project Management team; the Division offices; and the HfL team. After evaluating and rating the applications and supplemental information, panel members convened to reach a consensus on the projects to recommend for approval. The panel gave priority to projects that accomplish the following:

- Address the HfL performance goals for safety, construction congestion, quality, and user satisfaction.
- 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.
- Include innovations that will change administration of the State's highway program to more quickly build long-lasting, high-quality, cost-effective projects that improve safety and reduce congestion.
- Will be ready for construction within 1 year of approval of the project application. For the HfL program, FHWA considers a project ready for construction when the FHWA Division authorizes it.
- Demonstrate the willingness of the applicant department of transportation to participate in technology transfer and information dissemination activities associated with the project.

HfL Project Performance Goals

The HfL performance goals 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. States are encouraged to use all applicable goals on a project:

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 via 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 per 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.

1. **User Satisfaction**
    a. User satisfaction—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 rating of 4 or more points on a 7-point Likert scale.

REPORT SCOPE AND ORGANIZATION

This report documents the Alabama Department of Transportation's (ALDOT) HfL demonstration project, which involved the use of innovative construction techniques and intelligent transportation system (ITS) components during the reconfiguration of a section of US 280 from Hollywood Boulevard to Doug Baker Boulevard in Birmingham. The report presents project details relevant to the HfL program, including safety, construction congestion, and user satisfaction. HFL performance metrics and economic analysis lessons learned are also discussed, along with innovative methods of public involvement and technology transfer.

PROJECT OVERVIEW AND LESSONS LEARNED

PROJECT OVERVIEW

The project is located along a section of US 280 between Hollywood Boulevard and Doug Baker Boulevard, a distance of about 8.2 miles, in Birmingham. The scope of the project was to modify 26 signalized intersections along this route by eliminating or modifying the access points, turning movements, or median crossings, adding turning lanes, or modifying side streets to improve traffic flow along one of the busiest corridors in Birmingham.

Many of the existing signals gave less than 40 percent of the green time to the main arterial. Turning movements at each intersection were evaluated, and decisions were made to modify or eliminate these intersections based on the availability of alternate routes. Approach lanes were added or modified on side streets based on these studies as well.

Prior to construction, the facility was modified by the installation of an adaptive traffic signal control system. This system analyzes the volume of all intersections along the route and coordinates each signal in the system in real time. All work conducted under this project was coordinated with this adaptive signal system.

An extensive study was conducted over a period of years before this scenario was selected. Most traditional solutions would have included widening and lane additions, which were cost prohibitive and unpopular with the public. This project is expected to increase traffic flow and reduce conflict points while minimizing the cost to the agency and inconvenience to the public.

This HfL project involved several innovative technologies:

- The integration of proposed improvements with the existing adaptive traffic control systems.
- The use of temporary 10-foot lanes that result in the same number of lanes in use prior to construction.
- The exclusive use of night work for all construction.

The experience gained through this project is expected to better enable the ALDOT to provide a safe, smooth, and long-term solution to the challenges related to maintaining the serviceability of their highway facilities.

HFL PERFORMANCE GOALS

On HfL projects, data are collected before, during, and after construction, as appropriate, to demonstrate that the featured innovations can be deployed while simultaneously meeting the HfL performance goals in key areas:

2. **Safety**
3. Work zone safety during construction—no data were available at the time of this report concerning work zone crashes.

4. Worker safety during construction—No worker injuries occurred during construction, which exceeded the goal of less than a 4.0 rating on the OSHA 300 form.
5. Facility safety after construction—The elimination of several access points and the modification of others (including the construction of U-turn facilities and additional turn lanes) is expected to have an immediate and continuing impact on safety. In addition, the application of an open graded friction course is expected to greatly improve safety through increased friction and increased visibility due to reduced spray.

6. **Construction Congestion**
7. Faster construction—The use of nighttime construction and the decision to stage construction such that only a few intersections were impacted at a time did not result in faster overall project completion. ALDOT placed greater importance on working only during periods of lesser traffic and minimizing the impact to the public.
8. Trip time during construction—The use of nighttime construction when traffic volumes were reduced resulted in very little impact to trip times.
9. Queue length during construction—As stated above, the use of nighttime work eliminated traffic queues during construction.

10. **Quality**
11. Smoothness—Due to the relatively short length of the improvements along the route, no smoothness goal was established for this project.
12. Noise—The open graded friction course is expected to provide an excellent low noise wearing surface. However, because it was constructed to match the existing facility, no change in noise levels is expected and, thus, no goal was established.

13. **User satisfaction**
14. User satisfaction—No formal user satisfaction survey was conducted, but ALDOT plans to monitor and report all public comments concerning the project for a period of 6 months after completing of the project and report the results.

ECONOMIC ANALYSIS

A cost comparison for this innovation versus a traditional solution is not considered realistic. For this project, the traditional solutions would be increasing capacity through addition of travel lanes. However, expanding the number of lanes was not considered practical due to the right-of-way costs involved, so no cost estimate was available. While the cost of a double deck solution for a portion of the project length was put in the program, it was never considered practical due to the high costs ($950 million).

LESSONS LEARNED

ALDOT gained valuable experience from the use of HfL innovations on the Birmingham US 280 project. The costs associated with traditional solutions in urban areas make it necessary to maximize the efficiency of existing facilities before considering expansion options. Success—as measured in reduced congestion, reduced crash incidents, and user satisfaction with the project—will encourage the future use of these technologies.

PROJECT DETAILS

BACKGROUND

The project is located along a section of US 280 between Hollywood Boulevard and Doug Baker Boulevard in Birmingham. The existing corridor consisted of a six-lane section, carrying between 60 and 80 thousand vehicles per day, with a speed limit of 55 miles per hour. There were 24 signals in the original study area, covering nearly 9 miles. A previous project implemented an adaptive traffic signal system along this route.

The purpose of this HfL project was to modify or remove 26 intersections along the corridor to improve the efficiency of the adaptive traffic signal system. Construction included the addition or modification of turning lanes, the implementation of indirect turning movements, or the complete elimination of signalized intersections.

More than a dozen alternative solutions were considered over the last 15 years, with none implemented due to extreme cost ($300 to $800 million) or public concerns. More than $8 million was spent on these studies alone.

Figure 1 below shows the overall project limits. Figures 2 and 3 show typical roadways view at the termini prior to construction.

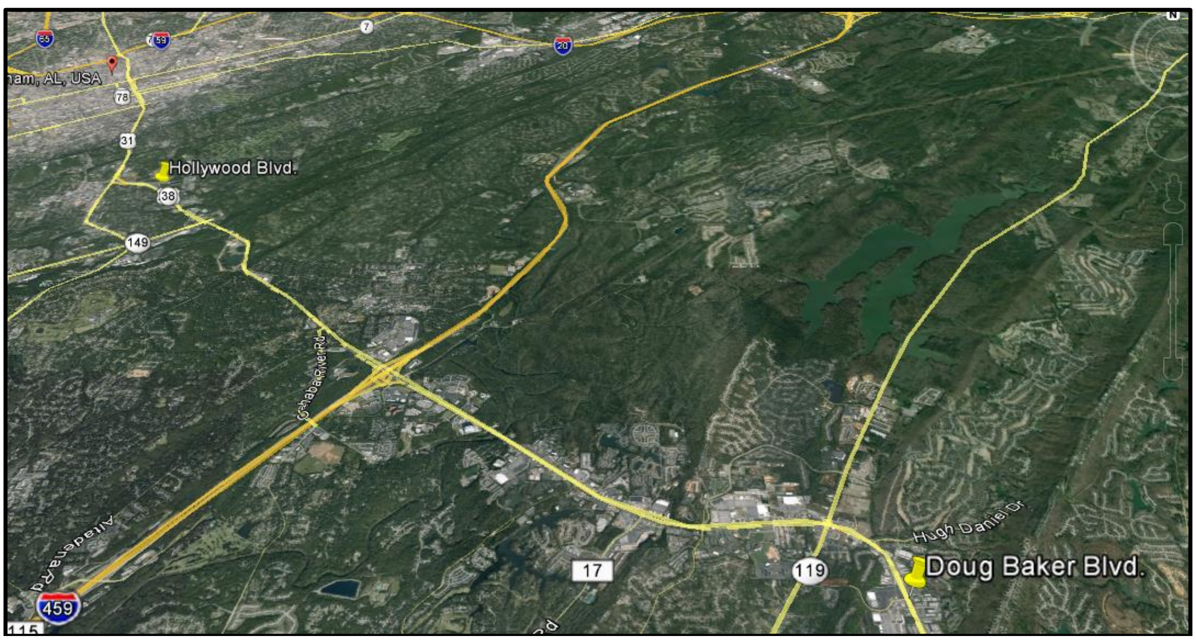

Figure 1. Photo. General location (courtesy Google Earth).

Figure 2. Photo. Typical view of US 280 at Doug Baker Boulevard looking east (courtesy Google Earth).

Figure 3. Photo. Typical view of US 280 at Hollywood Boulevard looking east (courtesy Google Earth).

PROJECT DESCRIPTION

In general, the final template of the completed work fit within the existing US 280 right-of-way. Much of the work was done on the intersecting roadways, with every effort made to minimize the need for right-of-way. All work was done at night to reduce the impact to the driving public.

Due to the size of the project, construction activities took places in phases. Several intersections were improved in each phase; thus, not all intersections were under constructions at the same time. A reduction of the speed limit from 55 to 45 miles per hour was also implemented to provide a safer work environment.

Figures 4 through 25 illustrate the modifications preformed at each intersection along the project.

U.S. HIGHWAY 280 @ KOVAC CENTER/HAMPTON INN

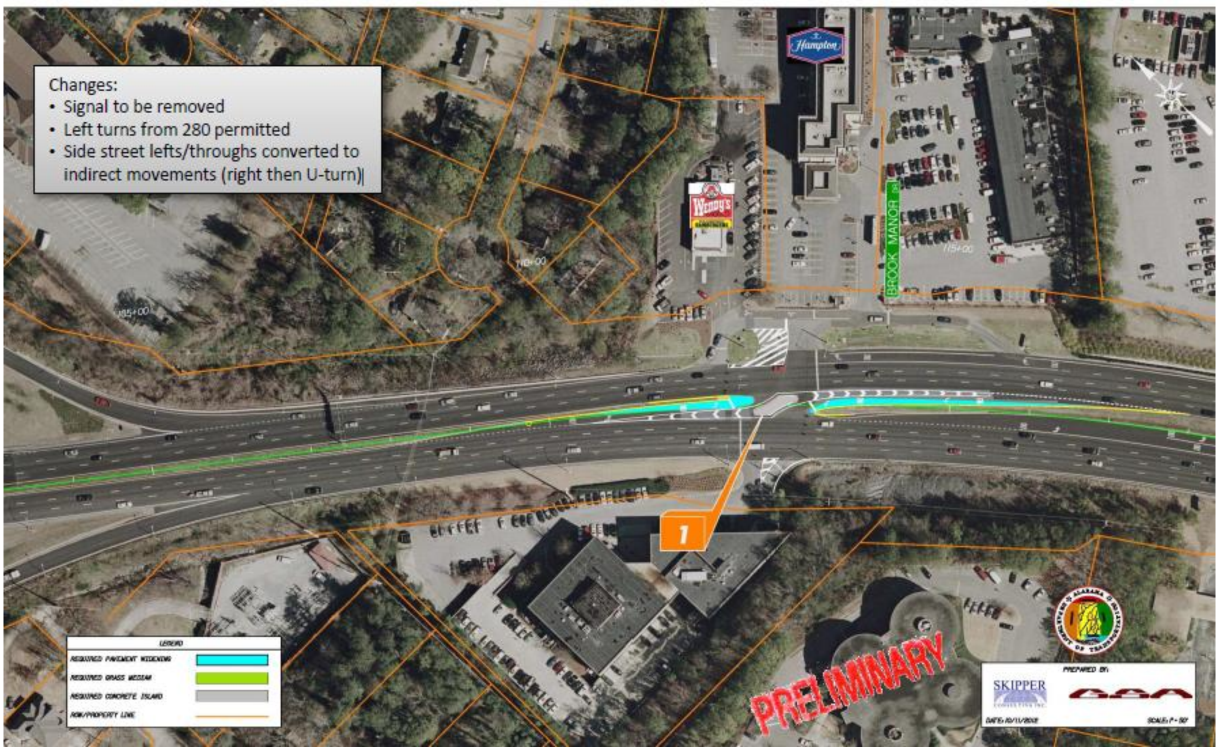

Figure 4. Annotated photo. Work completed on US 280 at Kovac Center (courtesy ALDOT).

Figure 5. Annotated photo. Work completed on US 280 at Office Park (courtesy ALDOT).

Figure 6. Annotated photo. Work completed on US 280 at Cherokee Road (courtesy ALDOT).

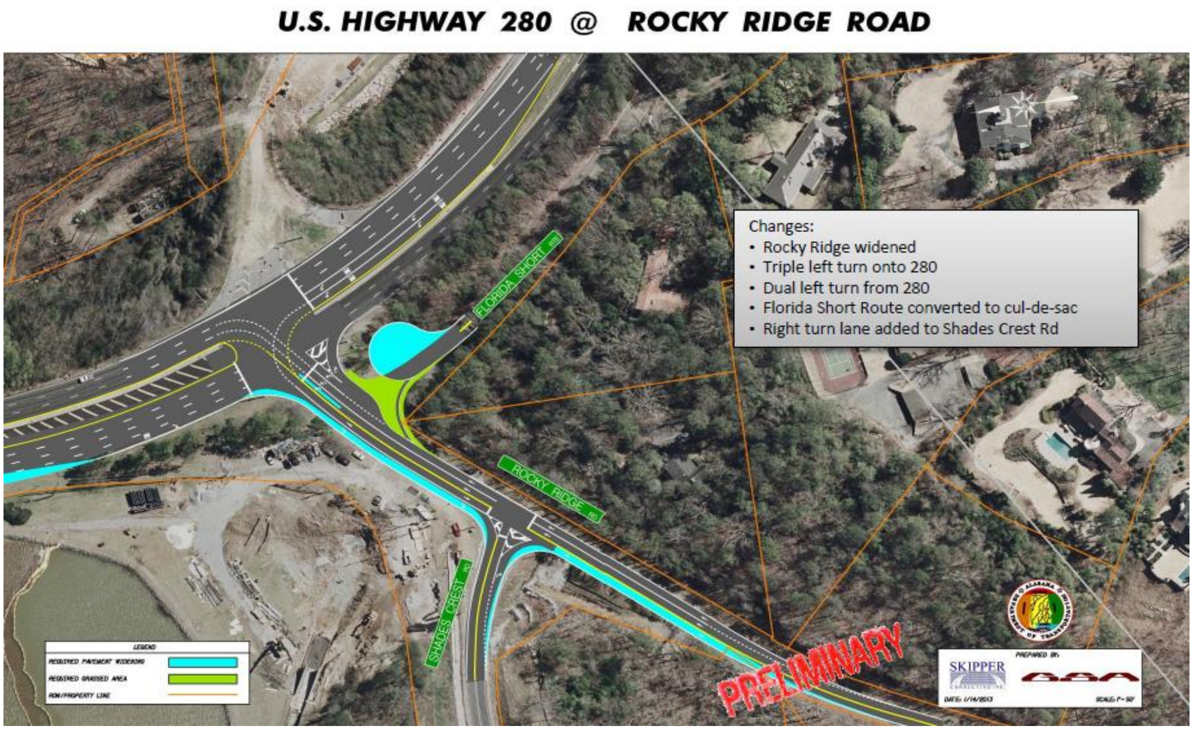

Figure 7. Annotated photo. Work completed on US 280 at Rocky Ridge Road (courtesy ALDOT).

Figure 8. Annotated photo. Work completed on US 280 at Green Valley Road (courtesy ALDOT).

Figure 9. Annotated photo. Work completed on US 280 at Brookwood Trace (west) Center (courtesy ALDOT).

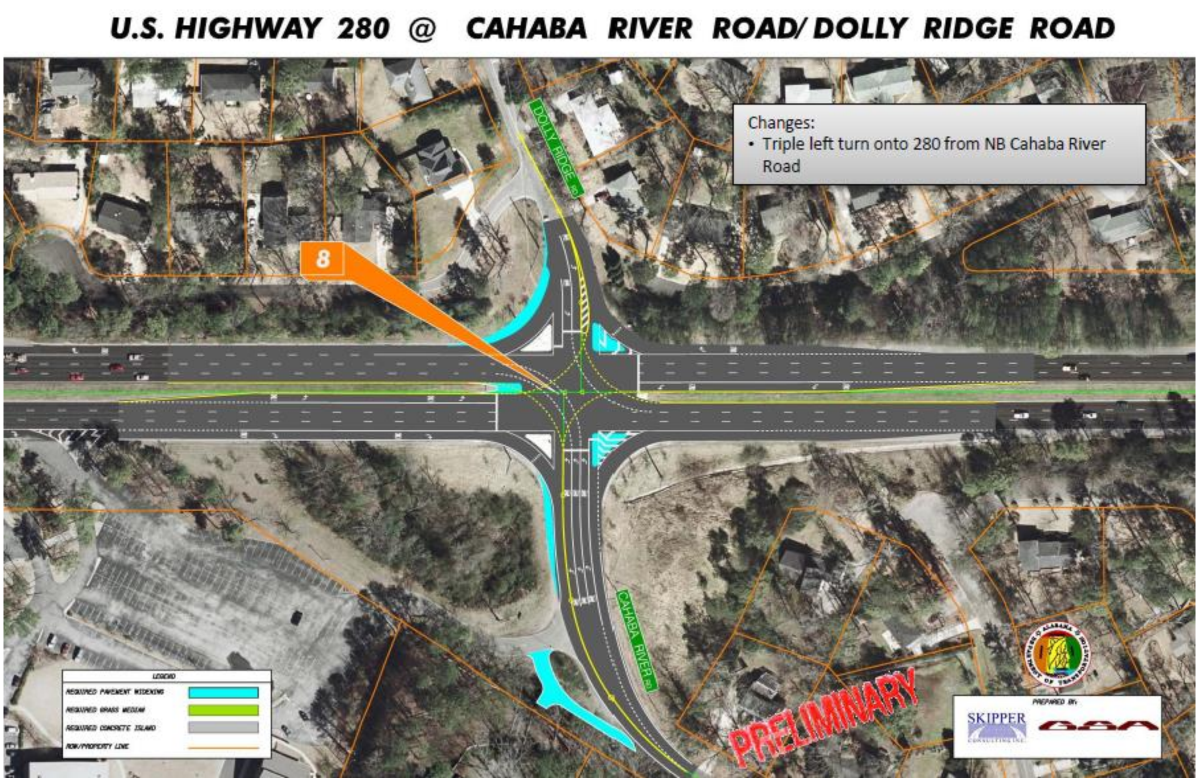

Figure 10. Annotated photo. Work completed on US 280 at Kovac Center (courtesy ALDOT).

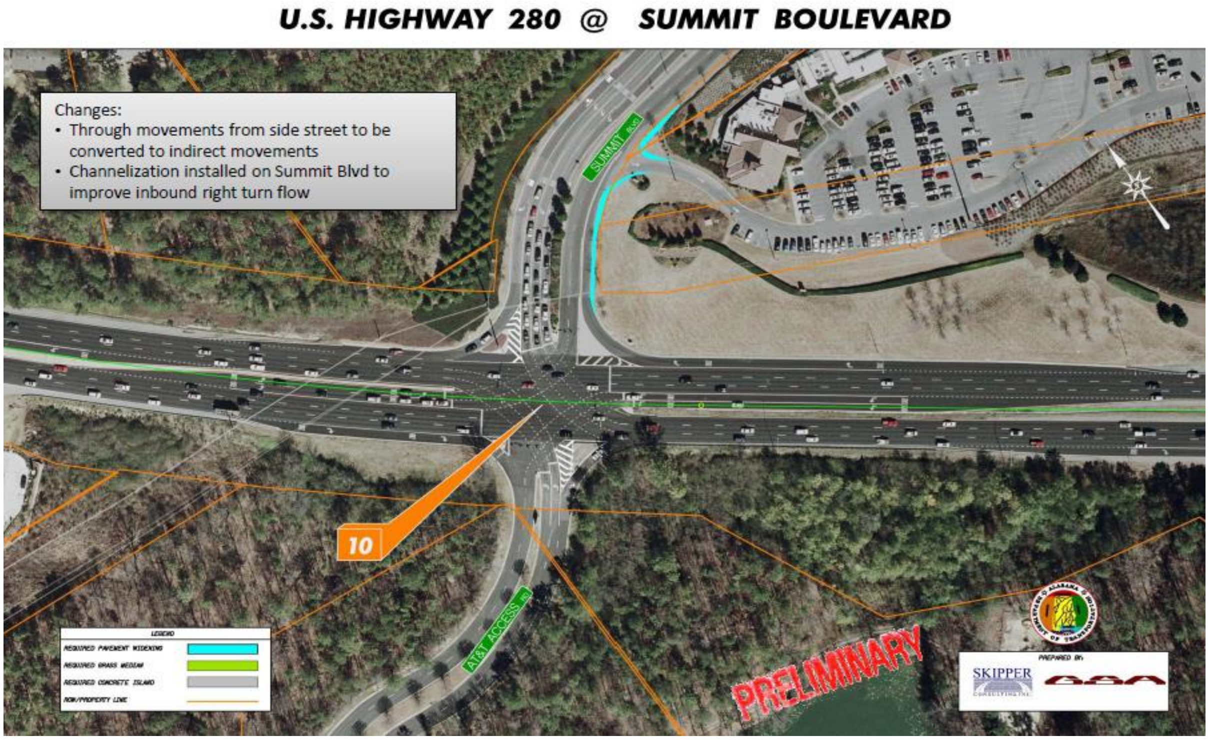

Figure 11. Annotated photo. Work completed on US 280 at Summit Boulevard (courtesy ALDOT).

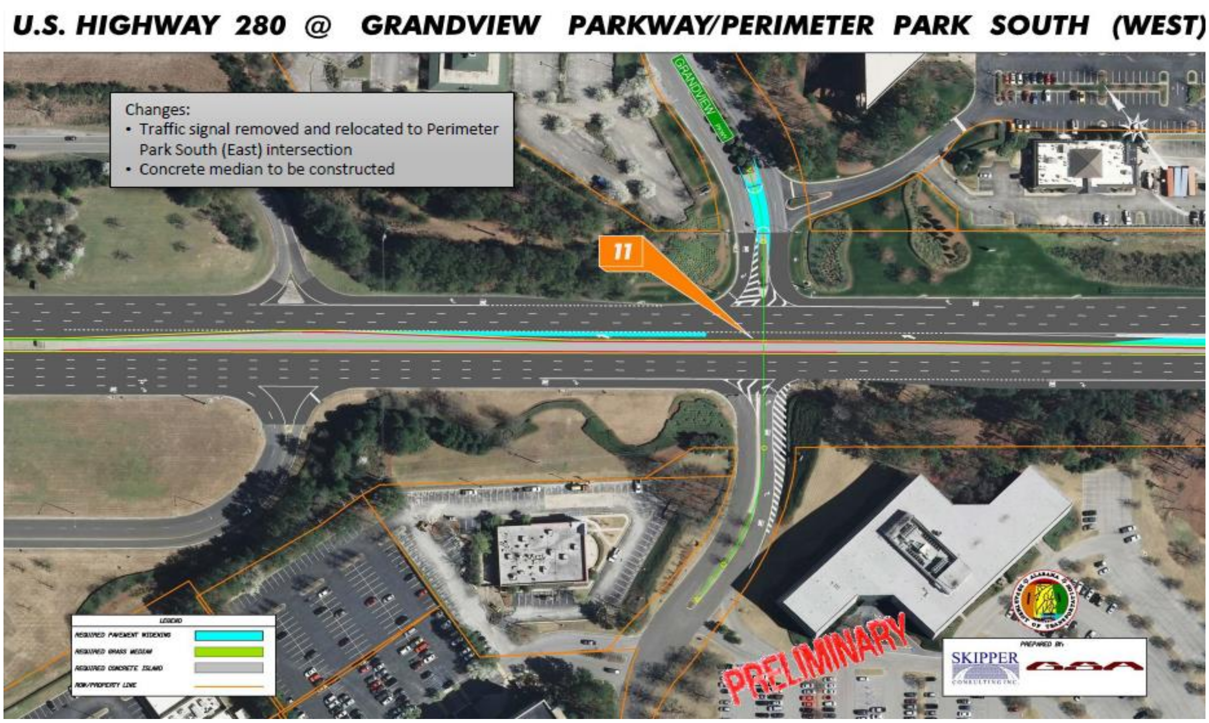

Figure 12. Annotated photo. Work completed on US 280 at Grandview Parkway (courtesy ALDOT).

U.S. HIGHWAY 280 @ PERIMETER PARK SOUTH (EAST INTERSECTION)

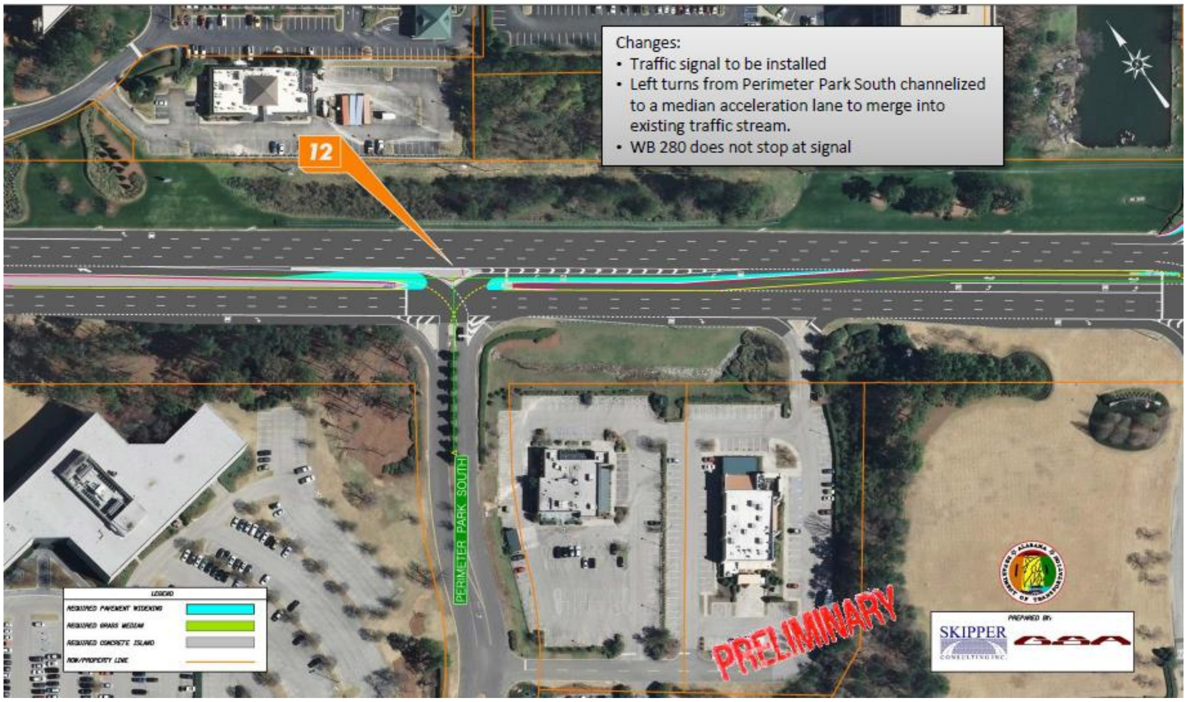

Figure 13. Annotated photo. Work completed on US 280 at Perimeter Park South (courtesy ALDOT).

U.S. HIGHWAY 280 @ GRANDVIEW PARKWAY (EAST INTERSECTION)

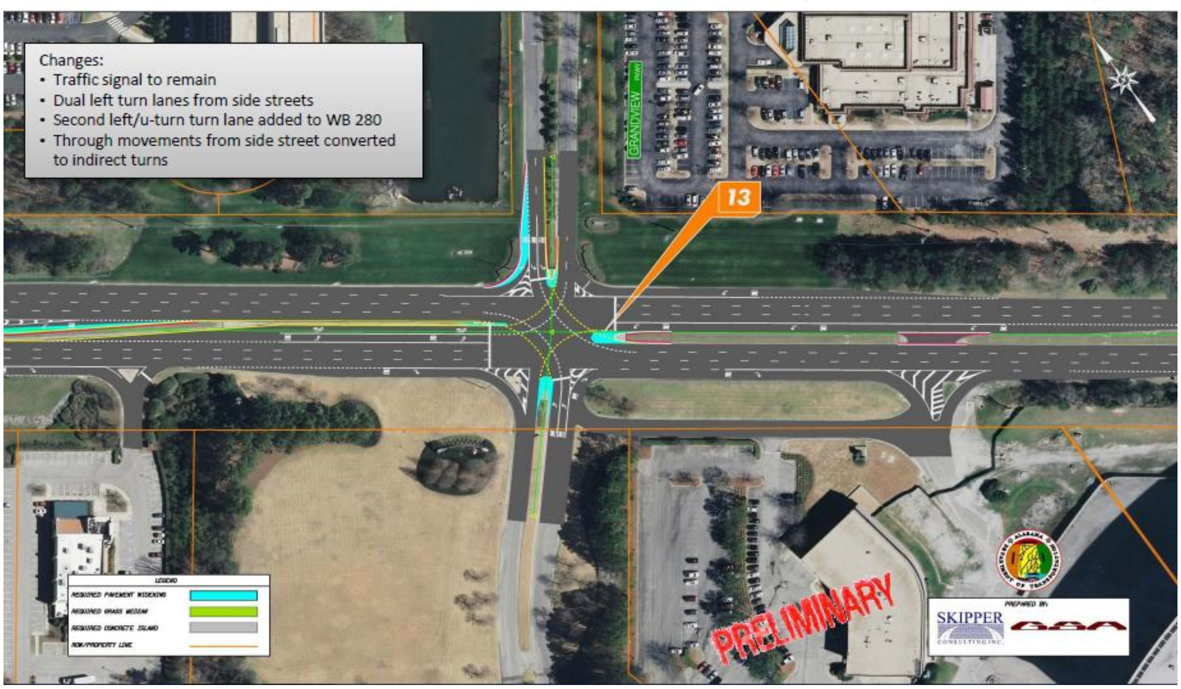

Figure 14. Annotated photo. Work completed on US 280 at Grandview Parkway (East) (courtesy ALDOT).

U.S. HIGHWAY 280 @ CAHABA RIVER ROAD /FIRE STATION

Figure 15. Annotated photo. Work completed on US 280 at Cahaba River Road (courtesy ALDOT).

U.S. HIGHWAY 280 @ RIVERVIEW ROAD

Figure 16. Annotated photo. Work completed on US 280 at Riverview Road (courtesy ALDOT).

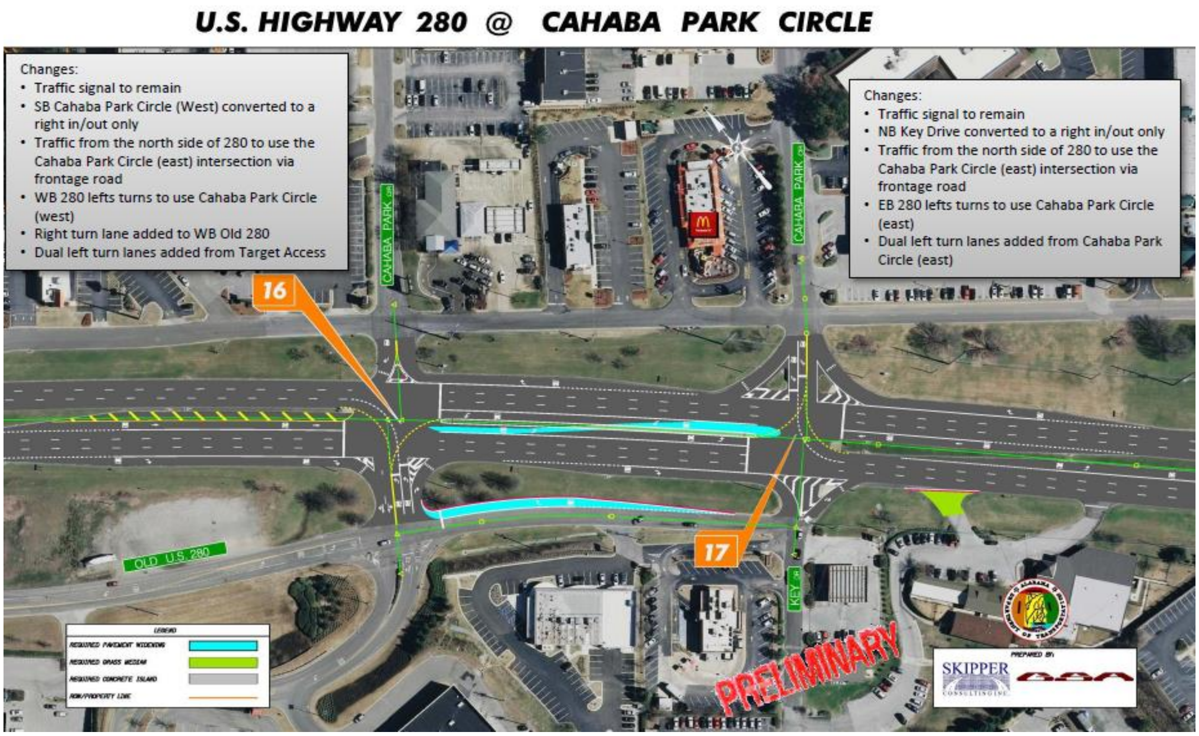

Figure 17. Annotated photo. Work completed on US 280 at Cahaba Park Circle (courtesy ALDOT).

Figure 18. Annotated photo. Work completed on US 280 at Resource Center Drive (courtesy ALDOT).

U.S. HIGHWAY 280 @ INVERNESS PARKWAY/EAST INVERNESS PARKWAY

Figure 19. Annotated photo. Work completed on US 280 at Inverness Parkway (courtesy ALDOT).

U.S. HIGHWAY 280 @ INVERNESS CENTER DRIVE/GREENHILL PARKWAY

Figure 20. Annotated photo. Work completed on US 280 at Greenhill Parkway (courtesy ALDOT).

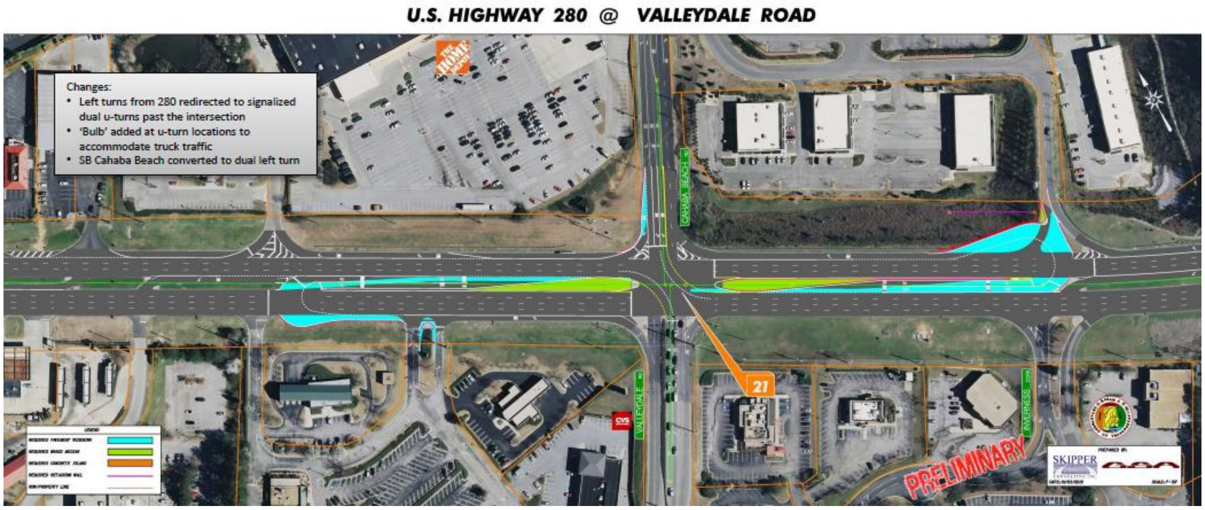

Figure 21. Annotated photo. Work completed on US 280 at Valleydale Road (courtesy ALDOT).

Figure 22. Annotated photo. Work completed on US 280 at Meadow Brook Road (courtesy ALDOT).

Figure 23. Annotated photo. Work completed on US 280 at Corporate Parkway (courtesy ALDOT).

Figure 24. Annotated photo. Work completed on US 280 at Meadowlark Drive (courtesy ALDOT).

Figure 25. Annotated photo. Work completed on US 280 at Hugh Daniel Drive (courtesy ALDOT).

PUBLIC OUTREACH

Extensive preconstruction public involvement was conducted before this particular solution was selected. A formal public satisfaction survey was not conducted. Hoewever, ALDOT has committed to document all comments received for a period of 6 months after completion of the project and supply those results when available

DATA ACQUISITION AND ANALYSIS

As appropriate, safety, construction congestion, and quality data were collected before and after the project construction to determine if this project met the HfL performance goals. The primary objective of this data acquisition and analysis was to quantify the project performance, to provide an objective basis to determine the feasibility of the project innovations, and to demonstrate that the innovations can be used to do the following:

1. Achieve a safer work environment for the traveling public and workers.
2. Reduce construction time and minimize traffic interruptions.
3. Produce a high-quality project and gain user satisfaction.

This section discusses how well the ALDOT project met the specific HfL performance goals related to these areas.

SAFETY

Safety goals for HfL projects are based on worker safety during construction and traveler safety during and after project completion. The worker safety goal is set at a 4.0 or less based on the OSHA 300 form available from the contractor. The public goal is a crash rate equal to or less than the preconstruction crash rate.

Table 1 presents the crash history at the project location from January 1, 2009, through December 31, 2013. Assuming an average traffic volume of 68,492, the 5-year crash rate for the project location was calculated to be 463 per million vehicle miles traveled, compared to a statewide average of 197.

Table 1. Crash history for limits of HfL project, 2009-2013.

Location	Total Crashes	Fatal	Injury	Property Damage Only
US 280 from Hollywood Boulevard to Doug Baker Boulevard (8.87 miles)	5,134	6	706	4,422

While a 5-year history of crashes is available at this location, there were no crash data available for the period under construction, making it impossible to directly assess the safety costs associated with the construction of this project. However, if we assume that the crash rate in this construction zone behaves in a manner similar to national norms, we can assume that the rate would increase approximately 30 percent. Based on the numbers presented above for the construction area only, we could expect 1,026 crashes per year, or 2.81 crashes per day, to occur within the project limits with no construction present. ALDOT indicated that the most likely traditional solution would have been the addition of lanes along the facility. Given this assumption, the traditional construction duration was estimated to be 720 days, during which an estimated 2,023 crashes could occur. Assuming the 30 percent increase for an active work zone, this would be expanded to about 2,630 crashes, 607 of which could be attributed to the work zone.

The innovations employed here reduced the construction time to 130 days, or 590 days less than with traditional methods. Using the same logic as above, the crashes attributed to the work zone would be 110. Given these assumptions, the reduction of construction time would have eliminated 497 crashes.

No worker injuries were reported on this project. The performance goal of achieving an incident rate for worker injuries of less than 4.0 (based on OSHA Form 300) was thus met for this project.

CONSTRUCTION CONGESTION AND TRAVEL TIME STUDY

One of the HfL performance goals was to achieve a 50 percent reduction in the time highway users are impacted during construction compared to traditional practices. In the case of US 280, there really are no "traditional" alternatives available. The ability to add lanes was minimal due to the limited right-of-way. The adaptive signal system had already been implemented, to maximize the ability to flow traffic within the existing footprint. The alternative considered in this case was a double decking of the existing facility, but the cost made this an impractical solution.

This lack of a traditional solution made the goal of a 50 percent reduction in construction time impossible to calculate. However, ALDOT's decision to conduct all work at night, along with the staging of the work to minimize delay and inconvenience to the public, was enforced.

Traffic Study

Data Collection/Analysis

Traffic data for preconstruction conditions were collected on July 22, 2013. Based on feedback from ALDOT engineers, morning peak is considered to be from 6 am to 9 am, and off-peak is from 9 am to 11:30 am. The floating car method was used to measure travel times on various road segments, as shown in Table 2. The travel times seem to indicate a steady speed of about 30.7 mph during the morning peak and about 35.4 mph during the off-peak period. The travel time data on US 280 reflect the delay at the intersections. Delay or travel time data on side streets were not collected, as the traffic volumes are much lower, in general, than those on US 280.

Table 2. Travel time and speed on US 280 before the construction activities.

Crossing Road Name	AM Peak Travel Time (min:sec)	Off-peak Travel Time (min:sec)	AM Peak Speed, (mph)	Off-peak Speed, (mph)	Diff in Speed	Mean Speed (mph)
Doug Baker	0	0				
Valleydale	3:29	3:35	37.9	36.8	-1.1	37.5
Grandview Parkway/Perimeter	4:28	3:58	28.3	31.9	3.6	29.8
Dolly Ridge	2:27	2:54	31.6	26.7	-4.9	29.4
Rocky Ridge	3:11	1:42	23.6	44.1	20.6	29.4
Hollywood	3:25	2:35	32.5	43.0	10.5	36.2
Average			30.7	35.4		32.6
Hollywood	0	0				
Rocky Ridge	3:35	3:03	31.0	36.4	5.4	33.0
Dolly Ridge	2:13	1:56	33.8	38.8	5.0	35.7
Grandview Parkway/Perimeter	2:38	2:44	29.4	28.3	-1.1	29.0
Valleydale	4:43	5:00	26.8	25.3	-1.5	26.2
Doug Baker	3:37	4:27	36.5	29.7	-6.8	33.3
Average			31.1	30.4		30.8

Data during construction were collected on October 21, 2013. The construction activities took place at night, so there were no daytime lane closures. Field data collection began at 10 pm on Monday, under clear skies. At about 11:30 pm it started raining, and at 1:30 am it started raining hard enough that the street signs were hard to read. Data collection was halted until 3 am when the rain stopped. Data collection continued until 5 am.

For most intersections, the side street traffic at night was assumed to be low and not to create congestion on US 280. At several intersections where left turn and/or through movements on minor streets were prohibited due to intersection geometric changes, the side street traffic had to reroute or travel extra distance to make a U-turn. ALDOT provided intersection turning movement data that are used to quantify the additional delay to motorists. Travel time data for the side street traffic during construction were not collected because the additional distance traveled by the minor street traffic can be determined from already available roadway maps.

For the major street, travel time data were collected using the floating car method. Table 3 shows the travel time on each segment of US 280 during the nighttime construction. As expected, the traffic volume at night was much lower than during the day, and the average travel speed reflects that. When nighttime construction was going on, the average speed was 8 to 9 mph higher than t daytime traffic.

Table 3. Travel time and speed on US 280 prior to and during construction.

	During Construction (nighttime)	Prior to Construction (daytime)

Crossing Road Name	Travel Time (min:sec)	Travel Speed (mph)	Travel Time (min:sec)	Travel Speed (mph)
Doug Baker	0	0	0	0
Valleydale	3:19	39.8	3:31	37.5
Grandview Parkway/Perimeter	2:50	44.7	4:15	29.8
Dolly Ridge	2:09	36.0	2:38	29.4
Rocky Ridge	1:46	42.5	2:33	29.4
Hollywood	2:47	39.9	3:04	36.2
Average		40.6		32.6
Hollywood	0	0	0	0
Rocky Ridge	2:46	40.1	3:22	33.0
Dolly Ridge	1:45	42.9	2:06	35.7
Grandview Parkway/Perimeter	2:20	33.2	2:40	29.0
Valleydale	2:51	44.4	4:50	26.2
Doug Baker	3:21	39.4	3:58	33.3
Average		39.8		30.8

Travel Time Impact

Travel time delay is often caused by a lower travel speed on the segment or inefficient traffic operation at intersections. Field data were collected before and during construction to evaluate the effect that construction activities may have on travelers. The floating car method measured travel time along a segment of a corridor that may include one or more links and one or more intersections.

In Tables 2 and 3, the travel times and speeds are given for different segments. As the values indicate, the average travel time during construction is lower than the average travel time in preconstruction conditions because the construction took place at night, when traffic volumes are lower. The average speed in the preconstruction period was about 8 mph lower than during construction. This difference is mainly due to the lower traffic volume at night and is not attributable to construction activities. Thus, it can be concluded that there was not an increase in travel time for travelers that stayed on a straight path on US 280. However, for those who traveled on minor streets and those who faced a restriction on their maneuverability, there was some delay.

At several intersections the minor street through and/or left turn movements were not allowed, in an effort to improve overall efficiency of traffic flow on the corridor (see Table 4). During construction, these travelers had to select alternate paths to get to their destinations. Taking the alternate paths often required additional travel distance and time. On the other hand, these movements had to make a right turn maneuver instead of left or through maneuvers. Thus, their wait time to make a right turn would generally be less than the wait time for left and through maneuvers.

Table 4. Peak hour traffic volumes on the minor streets that crossed US 280 in the before construction conditions.

Location	Minor St. movements not allowed				Major street Left turn not allowed	
Mountain Brook Dr	NB T, 0(7)	SB T, 2(0)	NB L, 4(25)	SB L, 24(37)	-	-
Office Park Dr	NB T, 2(13)	SB T, 20(4)				
Cherokee Rd[#]	NB T, 15(61)	SB T, 52(17)	NB L, 83(63)	SB L, 98(63)		WB L, 28(24)
Chevron Access			NB L, 21(23)			
Summit Blvd	NB T, 3(5)					
Perimeter Park South/Grandview Parkway[#]	NB L, 21(29)	SB L, 5(6)			EB L, 82(71)	WB L, 14(38)
Grandview Parkway	NB T, 0(3)	SB T, 0(0)				
Cahaba Park Circle/Target Access	NB T, 15(40)	SB T, 19(27)			EB L*, 81(79)	
Cahaba Park Circle/Key Dr	NB T, 7(17)	SB T, 22(20)	NB L, 48(38)	-		
Resource Center Dr	NB T, 0(3)	SB T, 0(2)	NB L, 15(42)	SB L, 18(20)		
Inverness Parkway	NB T, 47(124)	SB T, 29(54)				
Inverness Center R	NB T, 28(22)	SB T, 22(12)				
Valleydale RD[#]					EB L, 124(225)	WB L, 304(386)
Corporate Parkway	NB T, 17(75)	SB T, 21(46)				
Meadow Lake Dr	NB T, 0(1)	SB T, 1(3)	NB L, 2(10)	SB L, 7(8)		
Hugh Daniel Dr	NB T, 9(30)					

Northbound through (NB T), southbound through (SB T), northbound left (NB L), southbound left (SB L), eastbound left (EB L), westbound left (WB L). Table shows AM volume outside parenthesis and PM volume within the parenthesis. At Cahaba Park Circle/Target Access, * indicates that a left turning opportunity is provided before the left turn traffic reaches the intersection, so left turn traffic traveled the same distance as if they made left turn at the intersection. This symbol # indicates that specific delay calculations are done for the intersections.

An attempt was made to quantify how much additional time the restricted movement travelers may have spent. To find this, signal timing information at those intersections is needed. ALDOT staff provided traffic signal timing data at the request of the evaluators. At all the intersections, loop detectors were used to determine traffic demand. The number of phases varies from three to five depending on whether the minor street through movement is allowed or the U-turns on the major street left turners get their protected phase.

Signal timing varied due to the nature of the traffic signal system used on this corridor. The traffic signal controller type used at the intersections is EPAC300 operated under a SCAT system. For all the intersections in this corridor, cycle length varied between 213 and 236 seconds in the morning peak period and between 191 and 206 seconds in the afternoon peak hours (based on the data ALDOT staff provided to the evaluation team). Most of the cycle time is allocated as green time to through traffic on US 280. On average, the green time for the through traffic varied from 93 to 197 seconds during the morning peak and from 86 to 163 during the afternoon peak. The low ends of the green times were only two or three intersections. When the through green was at the lowest range of these values, the duration of the left phase for the major street traffic was 59 seconds in the morning and 60 seconds in the afternoon. Thus, the minor street through or left turners had to wait at least 93+59=152 seconds during the morning peak and 86+60=146 seconds during the afternoon peak to get a green phase. On average, the left and through movements on the minor street would experience a delay that would be approximately half of the time they waited for green phase ((152+146)/2)/2=75 seconds.

At the intersections where the left turn or through movements of the minor streets are prohibited, these travelers would spend less time on that approach of the intersection by making a right turn to take an alternate path. They wait only a portion of the time during which the minor street movements have exclusive green phases. The right turners do not need to wait the entire green time, but they can use the gaps to make the right turn.

Considering the randomness in arrival of the right turners and availability of the gaps, it is reasonable to assume that half will find a gap and the other half will wait for the entire green phase. Thus, on average the wait time for them would be about half of the green times allocated to the minor street movement. The minor street green times varied from 18 to 64 seconds during the morning peak and from 19 to 55 seconds during the afternoon peak. Therefore, the right turners' wait time in most cases would be under 21 second (((18+64)/2)/2) during the morning peak and 19 seconds (((19+55)/2)/2) during the afternoon peak. Thus, on average the wait time would be approximately 56 seconds (75-19=56).

However, to accomplish the intended maneuver the right turners have to travel extra distance and use one more intersection (or a U-turning facility). To make a U-turn at an intersection, the rerouted traffic has to wait for an exclusive green phase. This wait time could approximately 92 seconds (184/2) during the morning peak and about 83 seconds (165/2) during the afternoon peak. Thus, the extra time the rerouted traffic would spend at the two intersections would be 36 second (92-56) in the morning and 27 seconds (83-56) in the afternoon. The extra distance for most of the restricted movements would be approximately 3,000 ft (1,500 ft to go and 1,500 ft to come back, on average). Assuming they travel at the average speed of the corridor (30 mph), the time to travel the 3,000 ft would be 68 seconds. Therefore, the additional travel time for the restricted movements would be 36+68=104 seconds during the morning peak and 27+68=95 seconds during the afternoon peak. Figure 26 shows traffic volumes on all movements.

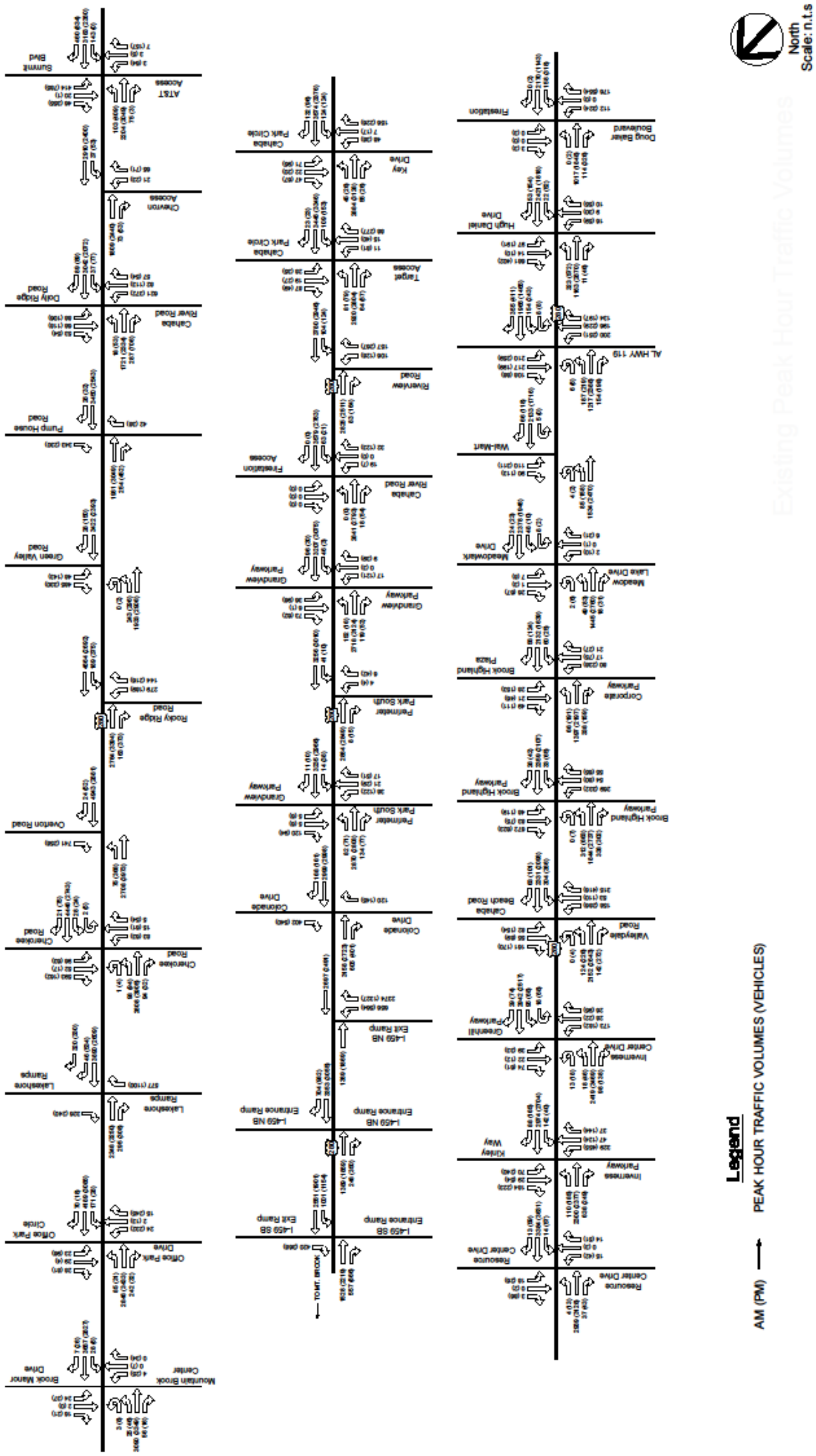

Figure 26. Diagram. Turning movement data (courtesy ALDOT).

These delay figures are used here in the calculations for the intersections with low through or left turn volume from the minor streets (see Table 4). The total hourly volume on the prohibited movements (left and through) of the minor streets, except those intersections marked in Table 4 with pound (#) sign and asterisk (*), is 393 for the morning peak period and 691 for the afternoon peak period. Delay for these movements is estimated as shown below, assuming that 10 percent of the average daily traffic (ADT) is during the average peak hour:

Delay= [(Daily volume)(average delay per vehicle)(no of days this happened)]/3,600

Delay=[(((393+691)/2)/0.1)((104+95)/2)(30)]/3600=4,494 hours

For the intersections at which the traffic volume is not very low (such as Cherokee and Valleydale), separate calculations were performed to quantify the intersection delay and the extra travel time due to restricting some of the movements.

At the intersections of US 280 with Inverness Parkway, Inverness Center Drive Corporate Parkway, and Meadow Lake Drive, two U-turn phases (one for each direction) are used to accommodate the left turners and U-turners. At the first three intersections the minor street through movements are not allowed to directly cross US 280. They have to make a right turn and a U-turn and another right turn to accomplish the crossing of US 280. At those three intersections, there are four phases, of which one left turn phase is allocated to handle the left turner from the minor streets. At Meadow Lake Drive there are five phases, and two of them are given to minor street traffic (a left turn phase and a through phase).

At Valleydale Road, which is located in the middle of these four intersections, turning left from US 280 onto Valleydale Road is not allowed. The left turners should go through the intersection and make a U-turn at facilities that are located about 700 to 800 ft on each side of Valleydale Road. This signal has three phases, one for through traffic on US 280, one for through traffic, and one for left turning traffic on Valleydale Road. The left and through movement restrictions may alter the path drivers would take. The extra distance traveled by the left turners from US 280 onto Valleydale Road can be estimated easily, since the distance from that intersection to the nearest U-turn facilities is known. There might be a number of drivers who avoided doing this by turning earlier and using other side streets to get to their destination. However, the impact of construction activities on such travelers is not known since the data on the actual path these drivers took are not available. So it is assumed that there were no such diversions.

The data in Table 4 indicate that peak hour traffic volumes in all of the minor street movements that were prohibited were below 50 vehicles during peak hours, except at Cherokee Road. For the lower volume intersections the construction effects are quantified as discussed before. For Cherokee Road and two other intersections, specific calculations are presented below.

Cherokee Road. At Cherokee Road, the northbound through and left turns can make a right turn and then a U-turn before reaching the nest intersection (Overton Road). This distance is about 2,800 feet, and a vehicle has to travel about 1 mile more to accomplish the left or through movement. Drivers familiar with this restriction could alter their path to avoid the extra travel distance. Filed data on route selection of these drivers are not available, so it is not possible to quantify the extra distance traveled by this group during the construction time. A rough estimated delay for northbound traffic, assuming all of them use the nearest U-turn facility, can be made as shown below:

Delay= [(Daily volume)(extra miles traveled)(no of days this happened)]/speed
Delay=[(((83+15+63+61)/2)/0.10)(2,800*2/5,280)(30)]/35=1,009 hours

It was assumed that 10 percent of ADT is during the average peak hour, construction activities lasted for 2 months at this intersection, and travel speed on US 280 was about 35 mph around Cherokee Road.

The left turn and through volumes of the southbound traffic are very similar to those of the northbound traffic. It is reasonable to assume that the southbound traffic would also experience a similar amount of delay. Delay for the left turners from southbound US 280 onto Cherokee Drive can be estimated conservatively using the same approach, as shown below:

Delay= [(((98+94)/2)/0.1)(5,600/5,180)(30)]/35=873 hours

Assuming that none of these travelers would divert and take alternative routes, the delay for prohibited movements during construction is estimated to be 1,882 hours (1,009+873=1,882).

Perimeter Park South. Perimeter Park South/Grandview Parkway is another location where there may be delay due to construction activities for the left turners from US 280. The westbound traffic is light, and drivers can easily turn at the nearby Perimeter Park South intersection. Therefore, no significant construction delay is considered for this group. However, the left turners from eastbound traffic on US 280 have limited choices to turn left before reaching this point. They have to go through this intersection and make a U-turn or a left turn at the nearest downstream intersection (Grandview Parkway). For these travelers, the delay due to the construction activities is estimated in the same way discussed before:

Delay= [(Daily volume)(extra miles traveled)(no of days this happened)]/speed
Delay=[(((82+71)/2)/0.10)(3,000/5,280)(30)]/30=435 hours

As noted previously, the extra distance traveled is 1,500 ft one way or 3,000 feet both ways, and the speed at this location is 30 mph. It is assumed there is no diversion at this intersection, since there are not many attractive alternative paths for the left turners to reroute.

Valleydale Road. Another potential location for construction delay is the intersection of Valleydale Road/Cahaba Beach Road and US 280. At this location, direct left turning from US 280 onto this street is prohibited. The left turners have to go through the intersection and make a U-turn, then come back to the intersection and make a right turn. The delay due to the extra distance traveled is computed below.

Delay= [(Daily volume)(extra miles traveled)(no of days this happened)]/speed
Delay=[(((124+304+225+386)/2/0.10)(700+800)/5,280)(30)]/32=1,384 hours

The travel speed around this intersection is 32 mph (see Table 2), and the percentage of ADT that happens during the peak hour is assumed to be 0.10. The U-turn facilities are 700 ft (in the westbound direction) and 800 feet (in the eastbound direction) away from this intersection.

Overall Effects on Corridor Travel Time

The effect of the construction on all travelers on the corridor can be estimated by summing the computed delays. The total delay, assuming zero diversions, is estimated to be approximately 8,195 hours (4494+1882+435+1384=8,195). In real-world traffic, familiar drivers alter their paths to accommodate the restricted movements. For this project, the exact amount of diversion is not known because no such field data are available. However, it is reasonable to assume that there were some diversions. Since most of the restricted movements are on the minor streets and people using them could easily take a different route to avoid the extra distance traveled, a conservative estimate of the diversion for this project would be one-quarter to one-third. Thus, a reasonable estimate for the additional delay would be 5,463 to 6,146 hours.

QUALITY

Sound and Smoothness

The urban nature, lower speed limits, and the short length of the intersection segments affected by the construction make noise and smoothness less critical. However, ALDOT did incorporate an open graded friction course where paving was required to match the existing surface texture. It is expected that this will result in adequate friction and noise benefits.

Smoothness and noise data were not collected for pre- or post-construction scenarios.

USER SATISFACTION

ALDOT did not conduct a formal user satisfaction survey. However, they have committed to collect all public comments on the project for a period of 6 months after completion and make that information available in the future.

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