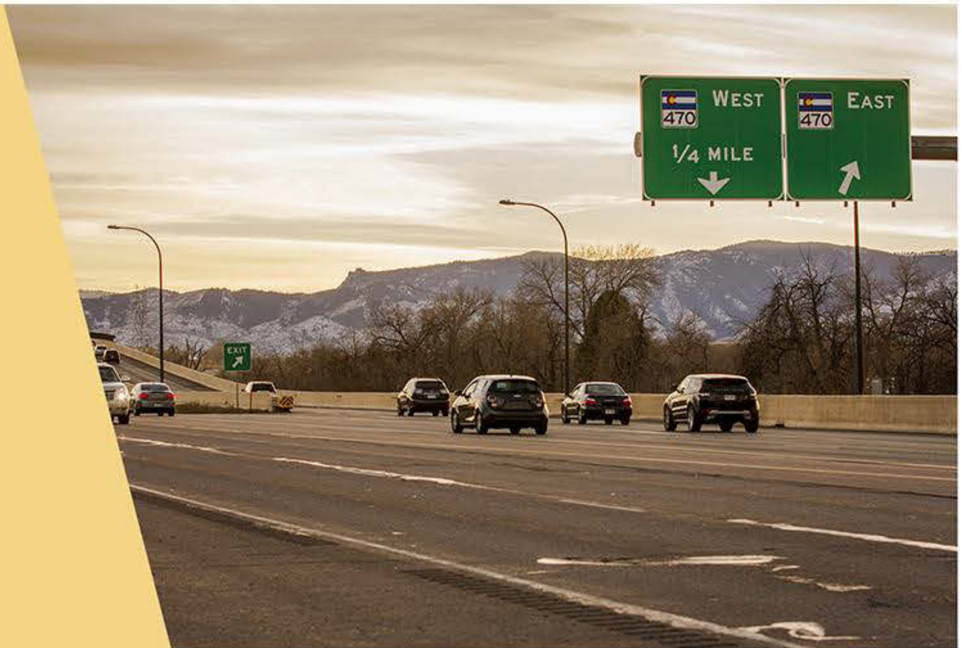

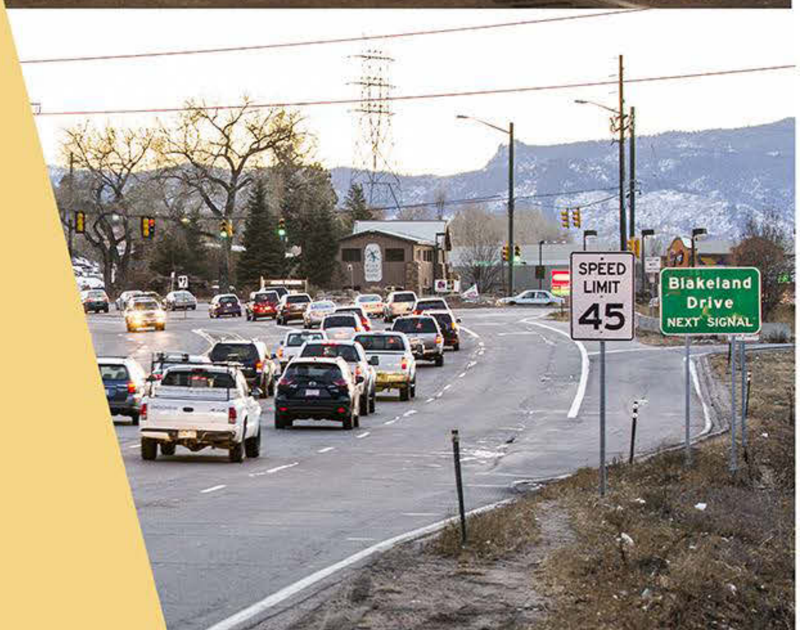

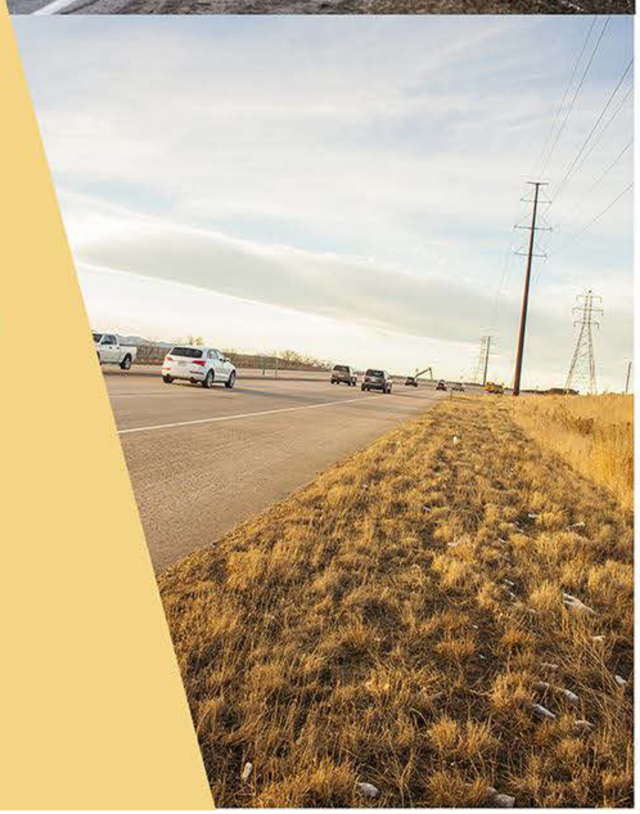

TRANSPORTATION TECHNICAL REPORT

2002 South I-25 Corridor and
US 85 Corridor Record of Decision
Reevaluation and Section 4(f) Evaluation

US 85 Highlands Ranch Parkway to C-470

May 2017

85 CORRIDOR IMPROVEMENTS
Highlands Ranch Pkwy to C-470

HDR

2002 SOUTH I-25 CORRIDOR AND US 85 CORRIDOR RECORD OF DECISION REEVALUATION AND SECTION 4(f) EVALUATION

US 85 Highlands Ranch Parkway to C-470

Transportation Technical Report

Prepared for:

Prepared by:

May 2017

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Acronyms and Abbreviations

402L	402 Limited
ADA	Americans with Disabilities Act of 1990
ADT	average daily traffic
C-470	Colorado State Highway 470
CDOT	Colorado Department of Transportation
CFI	continuous flow intersection
CFR	Code of Federal Regulations
DRCOG	Denver Regional Council of Governments
FEIS	Final Environmental Impact Statement
FHWA	Federal Highway Administration
HCS	Highway Capacity Software
I-25	Interstate 25
ITS	Intelligent Transportation Systems
LOS	level of service
NEPA	National Environmental Policy Act
PEL	Planning and Environmental Linkages
ROD	Record of Decision
RTD	Regional Transportation District
TDM	Transportation Demand Management
TSM	Transportation Systems Management
UDOT	Utah Department of Transportation
US 85	U.S. Highway 85

1.0 Introduction and Background

1.1 History

The United States Highway 85 (US 85) South Corridor extends 25.5 miles from Interstate 25 (I-25) in Denver to the Town of Castle Rock in Douglas County. From a regional perspective, this corridor is a multimodal major arterial for longer-distance, regional trips. The corridor also provides access to numerous commercial and residential developments that are crucial to Douglas County's economy.

In May 2001, the Colorado Department of Transportation (CDOT) and the Federal Highway Administration (FHWA) completed the *South I-25/US 85 Final Environmental Impact Statement* (FEIS) (CDOT 2001a). A Record of Decision (ROD) was signed in August 2001 that selected the Preferred Alternative from the FEIS, referred to as the Selected Alternative. A *Revised Record of Decision* was signed in 2002. There were no changes to the Selected Alternative in the 2001 ROD in the 2002 Revised ROD (CDOT 2002).

The FEIS/ROD outlined a set of improvements to address transportation needs for a 2020 horizon year along US 85 from approximately Meadows Parkway to Blakeland Drive. Since then, Douglas County has helped provide funding to CDOT to combine with their own funding to design and construct six segments of the Selected Alternative from the FEIS/ROD. In addition, funding has been provided to improve sections of I-25.

The US 85 Corridor segments and their status are shown in Figure 1.

As additional residential and commercial growth occurs in the northwest portion of the county, further studies have been conducted to identify what transportation improvements are necessary to support the development. Douglas County is conducting two separate but coordinated studies of US 85.

- The *US 85 Corridor Improvements Planning and Environmental Linkages (PEL) Study Report* (Douglas County 2016) updated the 2002 FEIS/ROD recommendations for transportation improvements to US 85 from approximately State Highway 67 (SH 67) in Sedalia to 0.5 mile north of County Line Road. The PEL study identified the long-term transportation needs beyond 2040. It was done primarily to determine what improvements are needed in addition to those selected in the FEIS/ROD. The PEL study defined a Purpose and Need, developed and evaluated a set of alternatives, and recommended improvements for the study area. Near-term improvements to 2020 include providing six through lanes with continuous flow intersections between Highlands Ranch Parkway and Colorado State Highway 470 (C-470) (which includes a multiuse path on the east side of US 85) and providing six through lanes from C-470 to 1,200 feet north of County Line Road (including a new bridge over C-470, a grade-separated Centennial Trail, and a flyover ramp for northbound to westbound traffic). More details about the recommendations and improvements beyond 2020 are in the PEL study document.

- The Highlands Ranch Parkway to C-470 Project is another segment of the FEIS/ROD Selected Alternative. Douglas County obtained funding from the Denver Regional Council of Governments (DRCOG) to construct this project beginning in 2019. Before design can proceed, the 2002 FEIS/ROD needs to be reevaluated to reflect current conditions. This National Environmental Policy Act (NEPA) Reevaluation determines if the findings from the FEIS/ROD remain valid, so that this segment of the FEIS/ROD Selected Alternative can proceed to final design and construction.

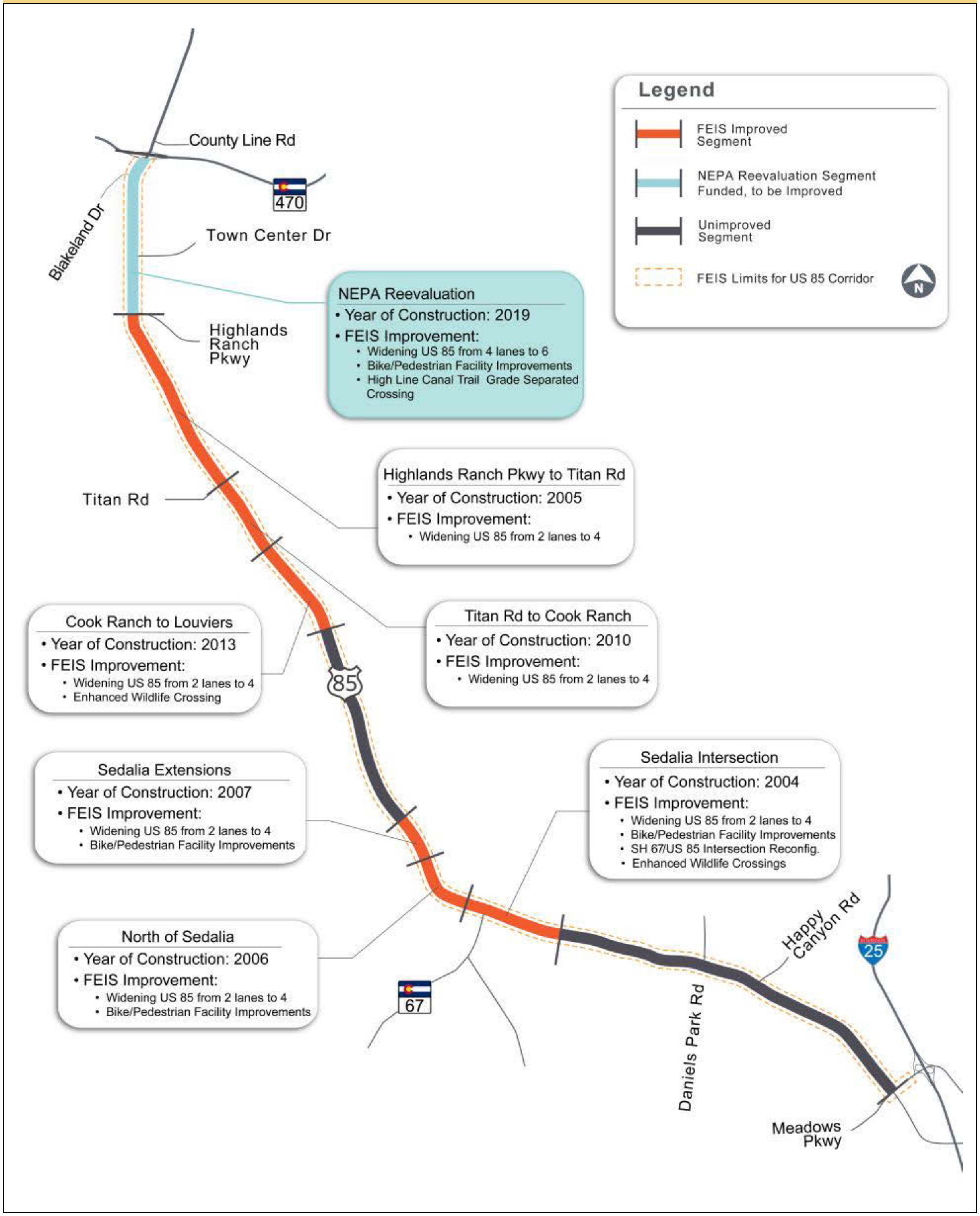
1.2 Study Area

The approximate 312-acre environmental resource study area for this NEPA Reevaluation is located in Douglas County along two miles of US 85, from Highlands Ranch Parkway to C-470. The study area begins approximately 1,900 feet south of the intersection of US 85 and Highlands Ranch Parkway and extends north to C-470, as shown in Figure 2. The eastern and western boundaries vary along the length of the study area but extend an average of 500 feet to 700 feet in either direction of US 85. The boundaries were set to encompass areas on either side of US 85 associated with the Refined Selected Alternative improvements to be evaluated for direct and indirect impacts.

1.3 Purpose for Reevaluation

The purpose for this Reevaluation is to reevaluate the 2002 FEIS/ROD to address changes to conditions that have occurred since it was issued by FHWA, and to reanalyze impacts of recommended improvements for the Highlands Ranch Parkway to C-470 project. The Reevaluation uses data from the most recent fiscally constrained 2040 Regional Transportation Plan. The FEIS/ROD used data from the 2020 Regional Transportation Plan. The Reevaluation identifies changed existing and future conditions; identifies a refined Selected Alternative for improvements to improve capacity, operational performance and safety for traffic volumes in 2040; identifies changes in legislation, regulations, and guidance related to the improvements; reanalyzes impacts; and develops needed changes to the mitigation measures identified in the FEIS/ROD.

Figure 1. Status of US 85 Corridor Segments



Source: HDR 2016.

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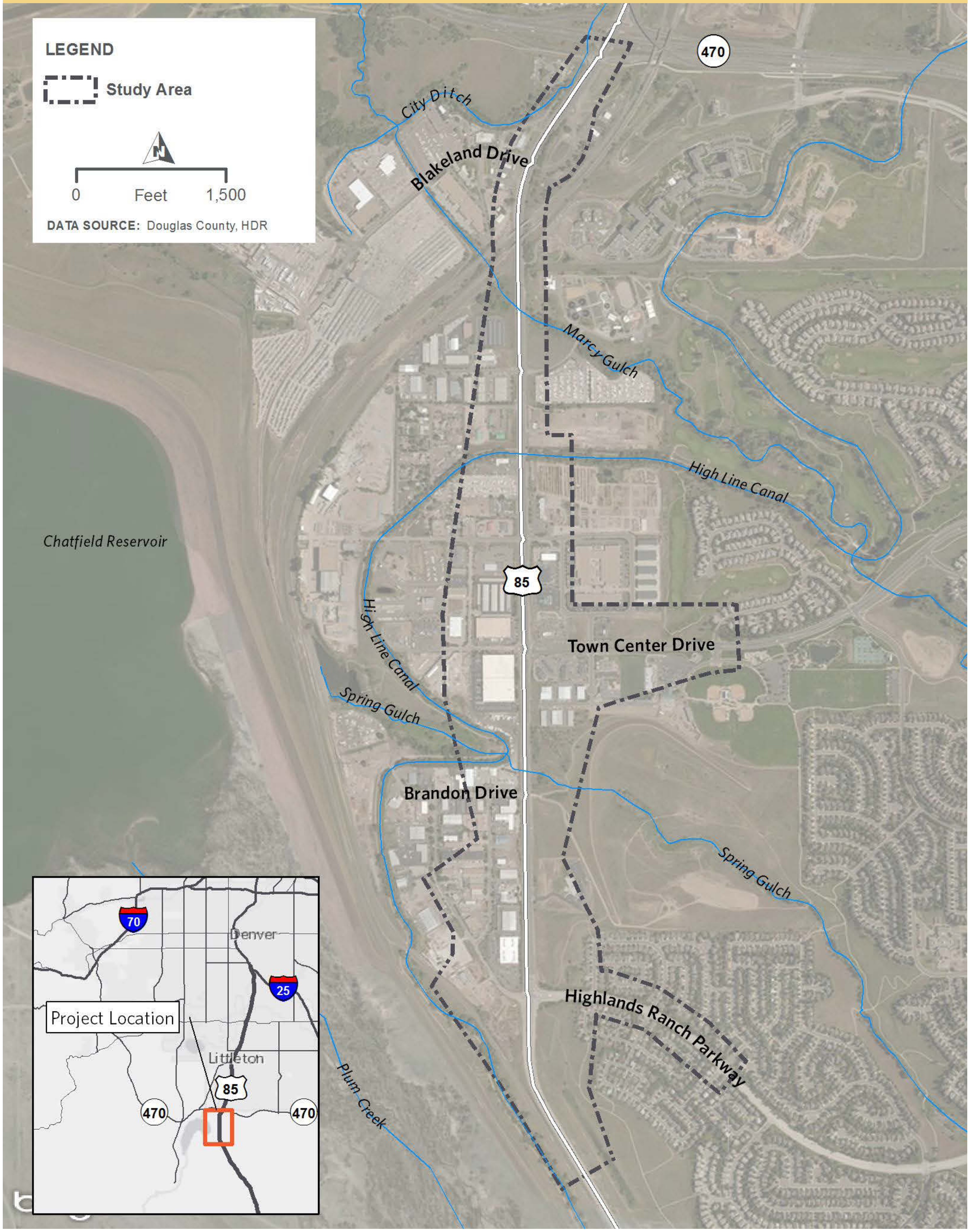
Figure 2. US 85 Reevaluation Study Area



Source: HDR 2016.

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2.0 Transportation Conditions

2.1 Summary from FEIS/ROD

Population growth in Douglas County had increased, causing increased congestion on US 85. US 85 was a multilane highway that served regional trips, as well as many local trips. It was two lanes in each direction within the study area. In some locations, left and right turn lanes did not exist. Turning on and off of US 85 was difficult because of the speed and volume of the mainline traffic. This resulted in a high number of crashes and dangerous driving, such as passing vehicles on the shoulders. There were no bicycle paths or sidewalks on the US 85 Corridor within the study area.

2.2 Changes since FEIS/ROD

Geometry

There are some minor differences in geometry between the existing conditions described by the FEIS/ROD and current existing conditions. The four through lanes on US 85 are supplemented by auxiliary lanes between some of the minor access points. There are now left-turn lanes and right-turn lanes at most of the minor intersections and at the major intersections of ramps to C 470, Blakeland Drive, Town Center Drive, and Highlands Ranch Parkway. These major intersections were all signalized in 1998, with the exception of Town Center Drive, which had stop control in the east-west direction. By 2002, Town Center Drive was signalized.

Volumes

Traffic Forecast Methodology

The Denver Regional Council of Governments (DRCOG) maintains a regional travel demand model for the Denver metropolitan area. It is a planning tool that produces forecasts of future traffic volumes based on estimates of growth in population and employment. The model reflects the current DRCOG long-range fiscally constrained regional transportation plan. DRCOG regularly updates and improves the model. The model was used in the FEIS/ROD to prepare 2020 traffic forecasts and in this Reevaluation to prepare 2040 forecasts. Further information on the application of the 2040 model for the Reevaluation is contained in Appendix A.

Existing Traffic

The general traffic pattern has not changed since the 1998 existing conditions used for the FEIS/ROD. Traffic along the US 85 Corridor increases from south to north as it approaches the Denver metropolitan area.

Updated average daily traffic (ADT) counts were collected in July 2015 for the Reevaluation. These growth figures for the 1998 EIS/ROD and 2015 Reevaluation ADT volumes are shown in Table 1.

Table 1. 1998 and 2015 Actual Traffic Volume Comparison

Location	1998 Actual ADT	2015 Actual ADT	% Change	Average Annual Growth
Highlands Ranch Parkway to Town Center Drive	29,100	36,950	27%	1.6%
Town Center Drive to South of Blakeland Drive	37,600	42,460	13%	0.8%

Future Traffic

The FEIS/ROD 2020 traffic forecasts were developed using the 2020 DRCOG transportation model. The FEIS/ROD forecasts 2020 No-Action Alternative ADT volumes of 35,100 vehicles between Highlands Ranch Parkway and Town Center Drive, and 43,700 vehicles between Town Center Drive and Blakeland Drive. FEIS/ROD Selected Alternative 2020 ADT volumes are 38,700 vehicles between Highlands Ranch Parkway and Town Center Drive, and 47,700 vehicles Town Center Drive to Blakeland Drive.

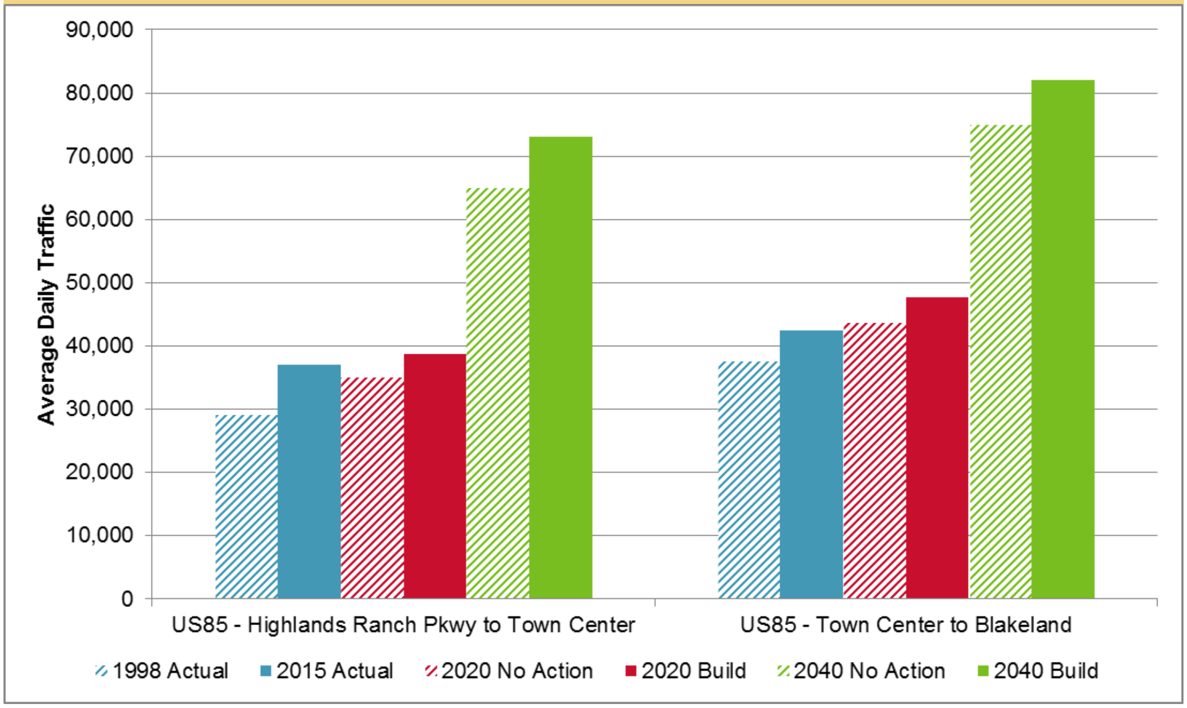
Using the updated 2040 DRCOG model for this Reevaluation, the 2040 No-Action Alternative traffic volume forecasts are 65,000 vehicles between Highlands Ranch Parkway and Town Center Drive, and 75,000 vehicles between Town Center Drive and Blakeland Drive. 2040 ADT volumes for the Refined Selected Alternative are 73,000 vehicles between Highlands Ranch Parkway and Town Center Drive, and 82,000 vehicles from Town Center Drive to Blakeland Drive.

The FEIS/ROD forecasted 2020 No-Action Alternative average annual growth rates for these two segments, Highlands Ranch Parkway to Town Center Drive and Town Center Drive to Blakeland Drive, of 0.94 percent and 0.74 percent respectively. Actual annual growth in traffic volume to 2015 exceeded the FEIS/ROD 2020 No-Action projection between Highlands Ranch Parkway and Town Center Drive, and is comparable with the projected 2020 No-Action traffic volume growth Town Center Drive to Blakeland Drive.

In general, the current forecasts for the 2040 No-Action Alternative assume higher average annual growth rates from 2015 for these two segments of 3.0 percent and 3.1 percent. This is based on the updated population and employment forecasts for 2040 in the Denver metropolitan area.

Figure 3 depicting the observed volumes and forecasted volumes from the FEIS/ROD and reevaluation, shows how traffic has grown on the corridor since the time of the FEIS/ROD, how 2015 observed volumes compare to the FEIS/ROD 2020 forecasts, and the updated 2040 forecasts.

Figure 3. Existing and Future ADT



Note: 2020 Build is the FEIS/ROD Selected Alternative, 2040 Build is the Reevaluation Refined Selected Alternative.

2020 and 2040 Traffic Volumes Compared to No-Action Alternatives

The forecasts for the 2020 Selected Alternative and the 2040 Refined Selected Alternative show similar increases in traffic over their respective No-Action Alternatives. The 2020 Selected Alternative ADT volumes show a 9 to 10 percent increase of the No-Action Alternative. The 2040 Refined Selected Alternative ADT volumes show a 9 percent to 12 percent increase over the No-Action Alternative. ADT volumes are shown in Table 2.

Table 2. 2020 and 2040 Traffic Volumes Compared to No-Action Alternatives

Location	Forecast Year	No-Action Alternative ADT	Alternative ADT	% Change
Highlands Ranch Parkway to Town Center Drive	2020	35,100	38,700	10%
	2040	65,000	73,000	12%
Town Center Drive to South of Blakeland	2020	43,700	57,700	9%
	2040	75,000	82,000	9%

Operations

The condition of traffic operations is expressed in terms of level of service (LOS), a qualitative measure used to describe the condition of traffic flow and delay. LOS is defined by the *Highway Capacity Manual* (TRB 2010) as ranging from free-flow conditions (LOS A), to breakdown of operation where conditions are poor or volume exceeds capacity (LOS F).

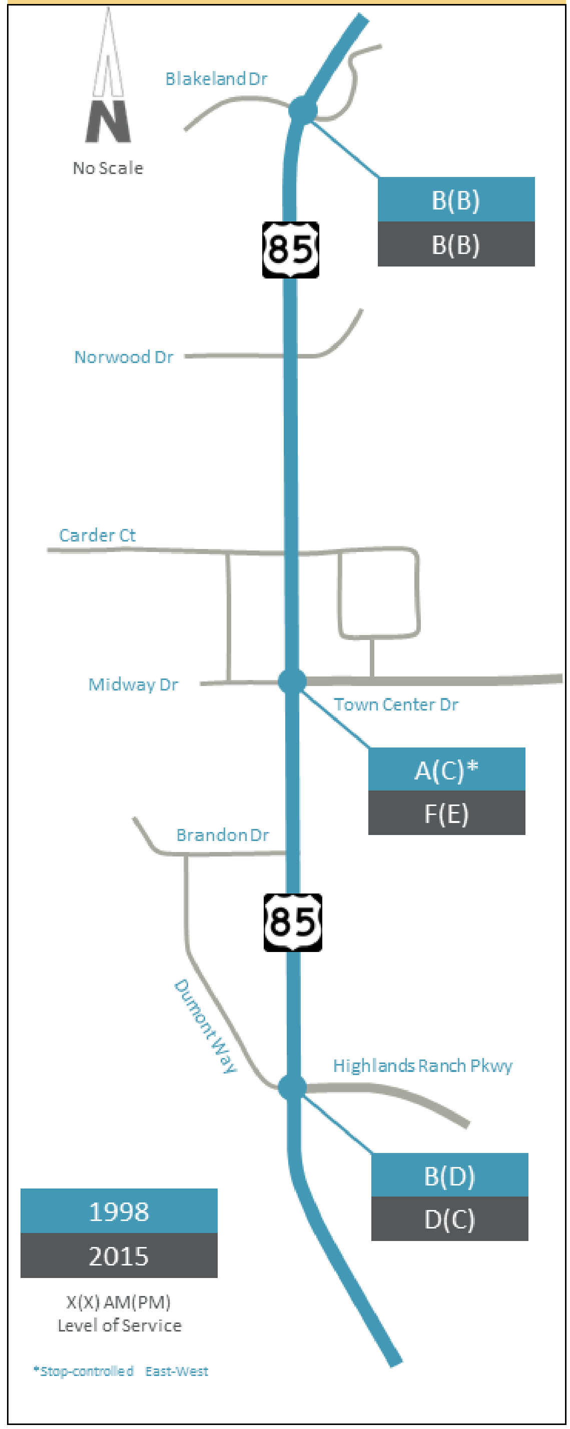
The FEIS/ROD existing conditions analysis for 1998 traffic volumes utilized Highway Capacity Software (HCS) for AM and PM peak hour periods. The FEIS/ROD existing intersection LOS is reported in the *I-25/US 85 Corridor Existing Traffic Operations* report for the South I-25 Corridor EIS (CDOT 1999).

Existing 2015 traffic operations for the NEPA Reevaluation were analyzed using Synchro 9.1 and reported by intersection in the *US 85 Corridor Improvements PEL Study Existing Conditions Report* (Douglas County 2016b).

Results of the intersections operations analyses for existing conditions for the FEIS/ROD in 1998 and the NEPA Reevaluation in 2015 are presented in Figure 4. The Blakeland Drive intersection shows consistent LOS for both 1998 and 2015 traffic volumes. Operations at the Highlands Ranch Parkway intersection show degradation from LOS B to LOS D in the AM peak period, and a small improvement in the PM peak from LOS D to C from 1998 to 2015.

The Town Center Drive intersection was operating stop-controlled on the east and west legs in 1998; traffic signals were installed by 2002. Overall, intersection operations at Town Center Drive degraded significantly to LOS F during the AM and LOS E during the PM peak hour. LOS F indicates the intersection suffers from cycle failure for at least the PM peak hour.

Figure 4. Existing Conditions LOS (1998 and 2015)

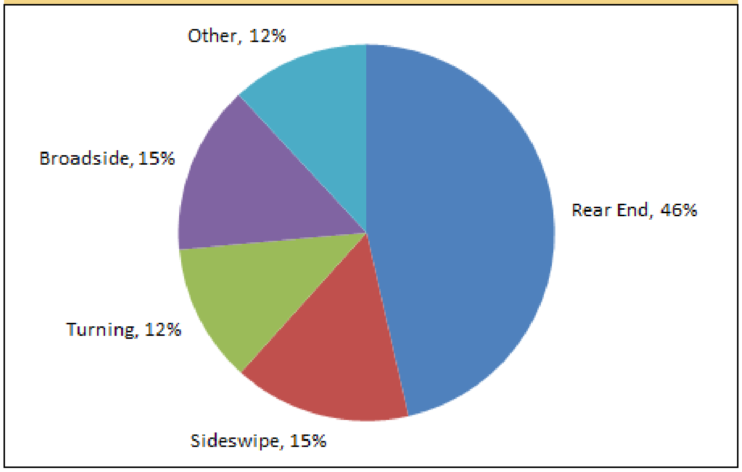


Safety

The number of crashes per year has increased since the FEIS/ROD. Crash data is available for the US 85 Corridor between County Line Road and Highlands Ranch Parkway (approximately 2 miles) for the comparison. For this segment, there were 172 crashes during the three-year period of 1995 to 1997, a yearly average of 57. Eighty-two percent of these crashes were related to intersections.

For the five-year period of 2010 to 2014, there were 420 crashes on this same corridor segment, a yearly average of 84. Eighty-seven percent of these crashes occurred at intersections. Figure 5 shows the recent history of crash types on the corridor. Rear-end accidents account for almost 50 percent of all accidents.

Figure 5. Types of Crashes on the Corridor



Crash data from 2010 through 2014; Highlands Ranch Parkway to County Line Road

The traffic volumes in the study area have also increased, contributing to a higher number of crashes. Crash rates expressed as number of crashes per million vehicle miles traveled allows for a direct crash comparison based on exposure. ADT and crash data provided in the *I-25/US 85 Corridor Existing Traffic Operations* report for the South I-25 Corridor EIS (CDOT 1999) and the *US 85 Corridor Improvements PEL Study Existing Conditions Report* (Douglas County 2016b) show a slight degradation in crash rate from 2.6 to 2.8 crashes per million vehicle miles traveled for the periods 1995 to 1997 and 2010 to 2014 respectively.

Bicycle/Pedestrian Facilities

Along US 85, conditions of bicycle and pedestrian facilities are largely unchanged from what was reported in the FEIS/ROD. There still are no sidewalks, paths, or bikeway facilities along US 85, although the shoulders along the highway are bikeable. In 1998, the highway shoulder width varied from 2 feet to 8 feet. Currently, the shoulder is a minimum of 4 feet to 6 feet, and widens to 10 feet in some locations. However, in the vicinity of intersections and areas where there are continuous acceleration and deceleration lanes, the shoulder width narrows to 1 to 2 feet.

The FEIS/ROD recommended improvements to both on-street and off-street bicycle and pedestrian facilities. These improvements have been partially implemented, as shown in Table 3.

Table 3. Status of Bicycle and Pedestrian Improvements Recommended in the FEIS/ROD

Location	Recommended Facility Type	Side(s)	Position	Status
Highlands Ranch Parkway to Blakeland Drive	10-foot-wide multiuse path with 5-foot buffer	East	Detached	Not Implemented
Blakeland Drive to C-470	8-foot-wide shoulder	East/ West	Attached	Partially Implemented

Bicycle/pedestrian facilities that connect to US 85 in the study area include:

- The C-470 Trail (formerly Centennial Bike Trail) is a multiuse trail extending about 25 miles along C-470 from Belleview Avenue to near the town of Parker. The trail crosses US 85 at grade immediately south of the US 85/C-470 interchange.
- The High Line Canal Trail, a 48-mile multiuse trail between Chatfield State Park and Aurora, crosses US 85 at grade between Carder Court and Norwood Drive.
- Highlands Ranch Parkway has 6- to 7-foot-wide dedicated bicycle lanes along both sides of the roadway. The bike lanes begin approximately 400 feet east of US 85.
- Town Center Drive has 6-foot dedicated bicycle lanes along both sides of the roadway. The bicycle lanes begin approximately 600 feet east of US 85, just past Commercial Center Street.

Transit

Transit service in the study area remains limited, similar to FEIS/ROD conditions. US 85 is generally the boundary of the Regional Transportation District (RTD) within the study area. In 1998, RTD operated a Highlands Ranch Town Center Express route. This has since been reconfigured to the 402 Limited (402L), which runs north-south on US 85 from the RTD light rail Mineral Station and turns east on Highlands Ranch Parkway to travel east-west. The 402L has half-hour service frequency during the peak periods and hourly service during the off-peak periods. The 402L has stops in the study area at Highlands Ranch Parkway, Town Center Drive, and Blakeland Drive. These bus stops have no amenities or connecting pedestrian and bicycle facilities.

In 2004, voters within the RTD district approved the FasTracks transit expansion program. This plan includes an extension of the Southwest light rail line to a new end-of-line near the C-470 and Lucent Boulevard interchange, about 1.5 miles east of US 85. However, this extension is currently unfunded.

2.3 Changes in Laws, Regulations and Guidance

The following CDOT policies have changed since the publication of the FEIS/ROD.

In December 2012, the Colorado Transportation Commission adopted Policy Directive 1603 requiring that managed lanes be strongly considered during the planning and development of capacity improvements on state highway facilities (Colorado Transportation Commission 2012). Managed lanes were considered for US 85 during the US 85 Improvements PEL Study process.

In October 2009, the Colorado Transportation Commission adopted Policy Directive 1602 and Procedural Directive 1602.1, requiring CDOT to provide transportation infrastructure that accommodates bicycle and pedestrian use of the highways in a manner that is safe and reliable for all highway users. The needs of bicyclists and pedestrians are to be included in the planning, design, and operation of transportation facilities, as a matter of routine. The shared-use path in the Refined Selected Alternative meets the intent of this directive.

3.0 Description of the Alternatives

3.1 No-Action Alternative

The No-Action Alternative consists of leaving US 85 in its current condition between Highlands Ranch Parkway and C-470, with two general purpose lanes in each direction. Improvements to other sections of US 85 and to portions of I-25 as adopted in the 2002 ROD have already been implemented and are assumed as part of the No-Action Alternative network. The No-Action Alternative also includes improvements to C-470 as defined in the recent Finding of No Significant Impact.

3.2 Refined Selected Alternative

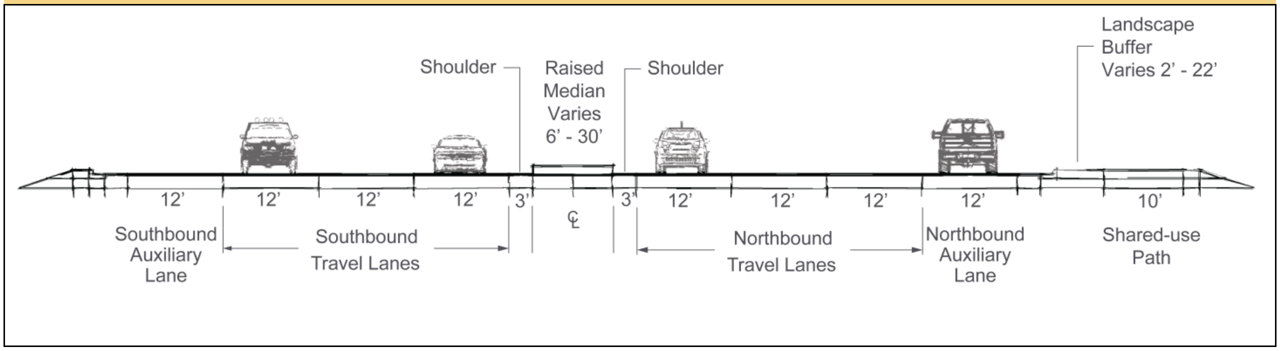
The 2002 FEIS/ROD Selected Alternative included widening both US 85 and I-25. The I-25 recommendations included widening to eight lanes between C-470 and Meadows Parkway and six lanes between Meadows Parkway and Douglas Lane. An east side frontage road was included between Schweiger Interchange and Castle Pines Parkway. Interchange modifications were included at Schweiger, Surrey Ridge Road, Castle Pines Parkway and Plum Creek Parkway. All improvements on I-25 that were in the Revised ROD have been completed, except for the widening of the Happy Canyon Road bridge.

For US 85, widening to six lanes between Highlands Ranch Parkway and C-470 and four lanes south to Meadows Parkway was recommended. The SH 67 interchange was to be reconfigured, a frontage road was recommended at Sedalia, and a minor realignment was recommended at Cook Ranch. Bicycle and pedestrian facilities were to be included all along US 85, a grade separation at the High Line Canal trail was included, and enhanced wildlife crossings were recommended.

Improvements in the 2002 FEIS/ROD Selected Alternative between Highlands Ranch Parkway and C-470 included a six-through-lane section (eight lanes including the auxiliary lanes) with a total width that ranges from 106 to 131 feet. The travel lanes are 12 feet wide. The alternative includes a raised median, inside curb and gutter, outside curb and gutter, inside shoulders, continuous auxiliary lanes, and a shared-use path. It also includes improvements to the High Line Canal Trail by changing the existing at-grade crossing to a grade-separated crossing under US 85. Access consolidation includes modification to right-in/right-out accesses, based on the *Final US 85 Access Management Plan, South I-25 Corridor and US 85 Corridor EIS* (CDOT 2001).

The Refined Selected Alternative includes all of the features described above, most of which are illustrated in the cross-section in Figure 6.

Figure 6. Refined Selected Alternative Typical Section



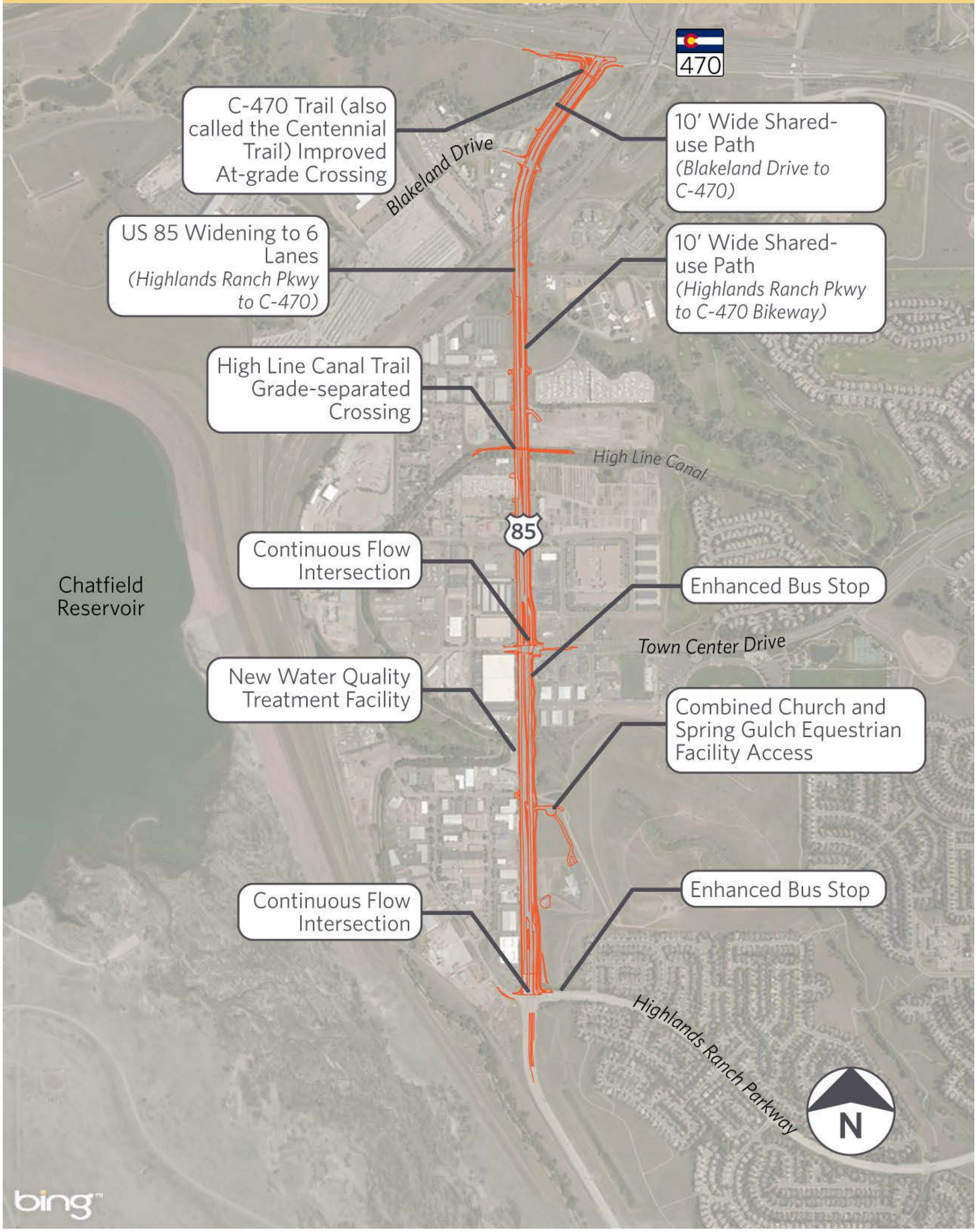
Source: HDR 2016.

Design Changes Included in the Refined Selected Alternative

Changes in the Refined Selected Alternative design compared to the Selected Alternative include continuous flow intersections at Town Center Drive and Highlands Ranch Parkway and minor changes to access and some elements of the cross-section, culvert sizes, bus stop enhancements, and retaining walls (Figure 7). All of these changes are minor refinements to the same basic alternative.

US 85 Mainline. The width of the auxiliary lane increased 10 feet to 12 feet. In some locations, to minimize impacts, the auxiliary lane may be 11 feet. The FEIS/ROD design had included an alignment shift to the west. This is no longer a part of the Refined Selected Alternative. It also includes a wider raised median (30 feet compared to 10 feet) and no inside shoulders at the continuous flow intersections.

Figure 7. US 85 Highlands Ranch Parkway to C-470 Refined Selected Alternative

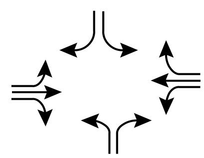
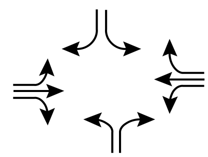
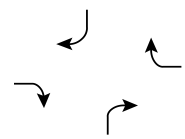
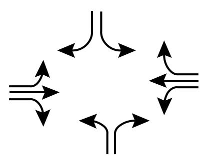
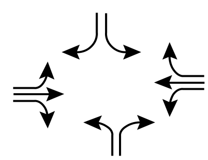
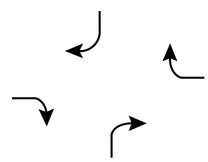
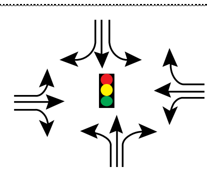
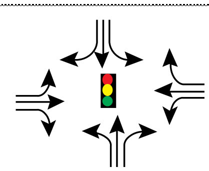
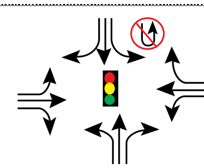
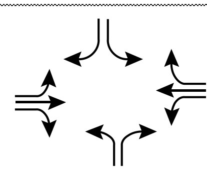
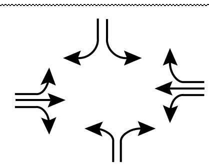
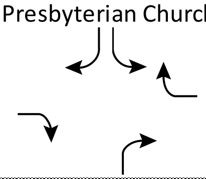
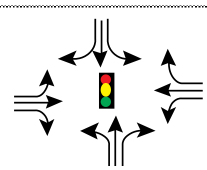
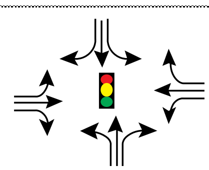
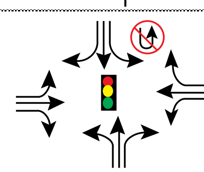


Source: HDR 2016.

Intersection and Access Improvements. Changes in access and turning movements are described in Figure 8. There are notable changes at the intersections below. They are described and illustrated on the following pages.

- Highlands Ranch Parkway and Town Center Drive.
- Norwood Drive, Carder Court, and Brandon Drive.
- Spring Gulch Equestrian Facility and Grace Presbyterian Church.

Figure 8. Changes in Access and Turning Movements

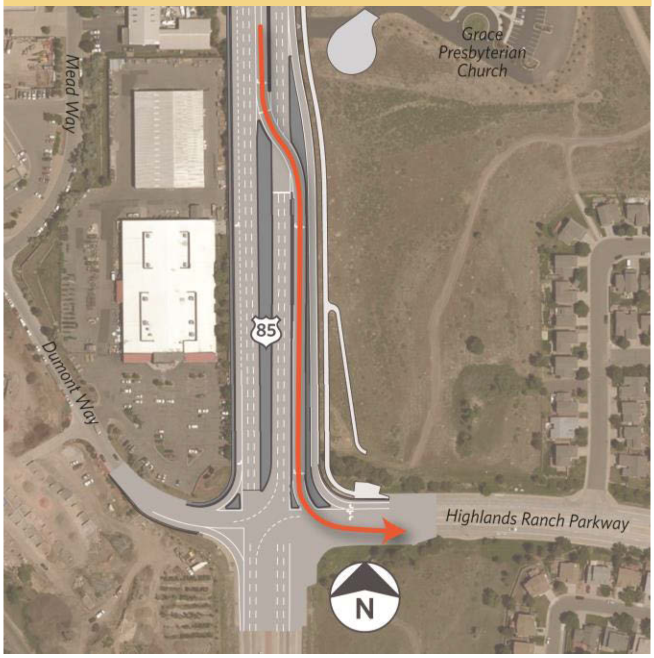
	FEIS/ROD Access		NEPA Reevaluation Access	
Location	**Existing Conditions**	**2002 Selected Alternative**	**Refined Selected Alternative**	**Change from FEIS/ROD**
Norwood Drive				Left turns and east/west through movements displaced
Carder Court				Left turns and east/west through movements displaced
Midway - Town Center Drive				No U-turn southbound to northbound
Brandon Drive - Spring Gulch Equestrian Facility			Combined access to Spring Gulch Equestrian Facility and Grace Presbyterian Church	Left turns (except southbound) and east/west through movements displaced
Grace Presbyterian Church	No Access Documented (Church constructed 2012)			No change
Highlands Ranch Parkway - Dumont Way				No U-turn southbound to northbound

Note: N/S through movements assumed for all intersections

Source: HDR 2016.

At Highlands Ranch Parkway and Town Center Drive, there are continuous flow intersections. This innovative intersection design improves operations for intersections with a high number of left-turn movements. This type of traffic pattern exists on US 85 within the study area, and the Refined Selected Alternative incorporates this design modification at the Highlands Ranch Parkway and Town Center Drive intersections. When compared to a traditional signal-controlled intersection, the primary differentiating feature of the continuous flow intersection is the relocation of left-turn movements on an approach to the other side of the opposing traffic flow. Figure 9 and Figure 10 display the continuous flow intersection layouts at Highlands Ranch Parkway and Town Center Drive with the relocated left-turn movement highlighted.

Figure 9. Highlands Ranch Parkway Continuous Flow Intersection



Source: HDR 2016.

Figure 10. Town Center Drive Continuous Flow Intersection

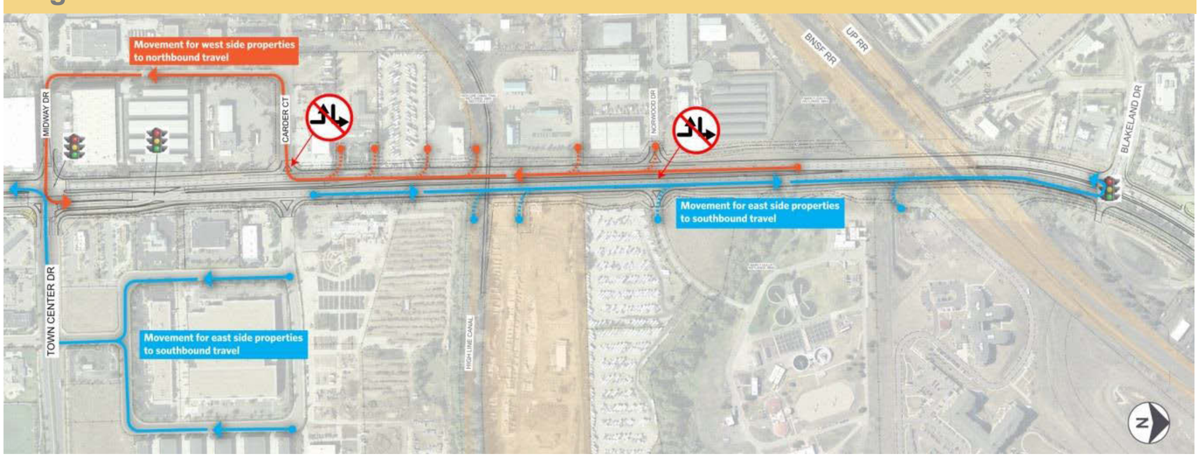
Source: HDR 2016.

At Norwood Drive, Carder Court, and Brandon Drive, the intersections are right-in/right-out. Left-turning traffic is relocated to adjacent intersections, as shown in Figure 11 and Figure 12.

Figure 11. Highlands Ranch Parkway Continuous Flow Intersection U-Turn Access

Source: HDR 2016.

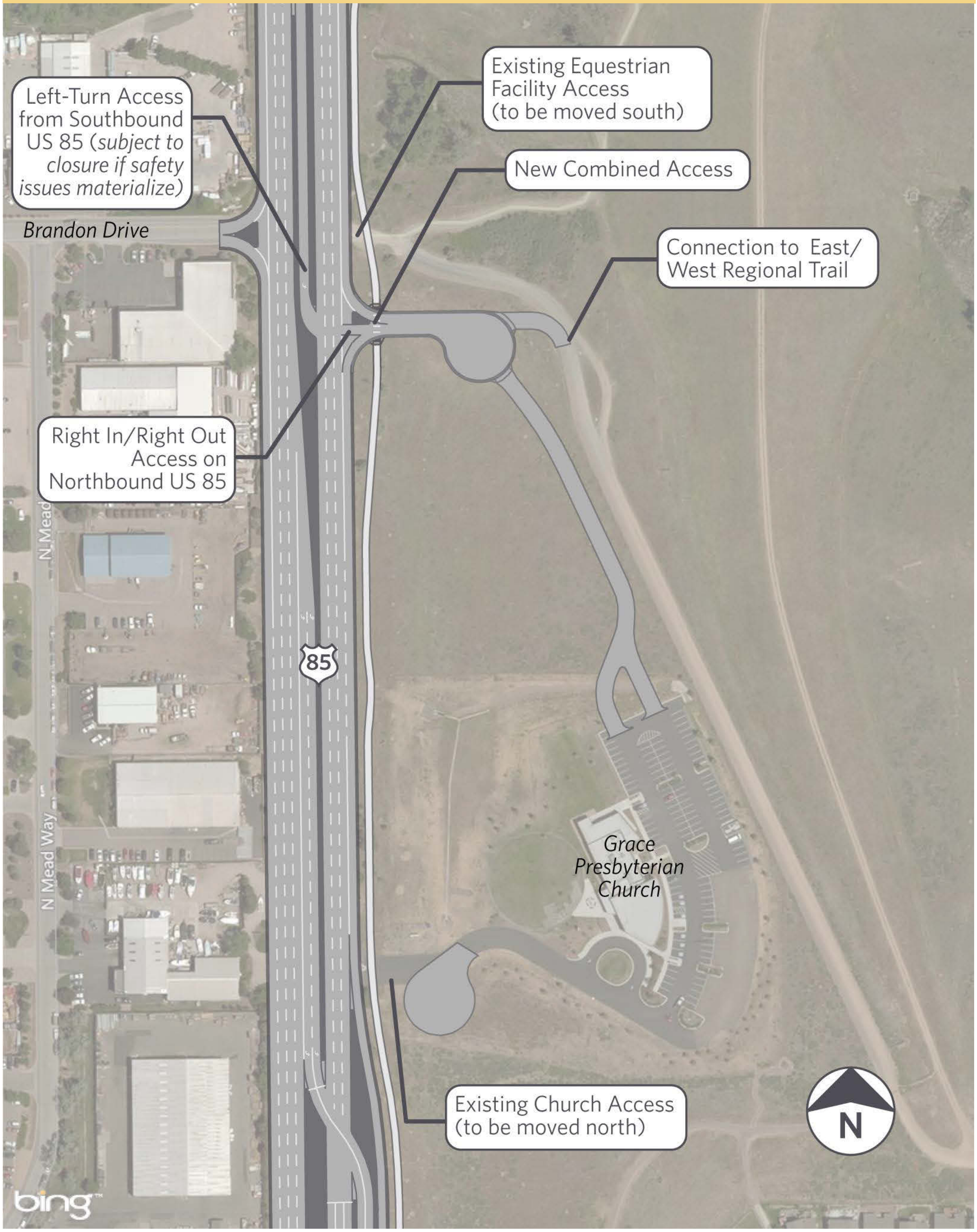
Figure 12. Town Center Drive Continuous Flow Intersection U-Turn Access



Source: HDR 2016.

Access to the Spring Gulch Equestrian Facility (owned by the U.S. Army Corps of Engineers) is combined with access to Grace Presbyterian Church. This is a 3/4 movement; however, the southbound left turn movement may be eliminated at CDOT's discretion if safety issues materialize. Traffic destined to southbound US 85 from this access would make a U-turn at Town Center Drive. This change includes paving of the driving entrance and relocating the entrance 120 feet south (Figure 13). The Grace Presbyterian Church was not in this location in 2002, so the project setting has changed.

Figure 13. Combined Access for Spring Gulch Equestrian Facility and Grace Presbyterian Church



Source: HDR 2016.

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Retaining Walls. There are more retaining walls (approximately 80,000 square feet) to avoid or minimize parking or property impacts, minimize riparian vegetation impacts, minimize impacts to water quality treatment and drainage features, minimize impacts to Section 4(f) historic and recreation properties, and minimize impacts to the railroad bridge substructure and foundations.

Improved Bus Stops and Connections. The design now includes improvements to the existing RTD 402L bus stops:

- The stop on US 85 north of Highlands Ranch Parkway is being eliminated. The existing stop on the north side of Highlands Ranch Parkway east of US 85 is being moved and enhanced with a bench, shelter, and bike racks.

- The stop on US 85 north of Town Center Drive is being moved to south of Town Center Drive and enhanced with bench, shelter, bike racks, and bike lockers.

  For both southbound and northbound stops, the Refined Selected Alternative includes sidewalk connections from the bus stop to the adjacent side street.

Shared-use Path. There are minor changes in the width of shared-use path and the width of separation between the roadway and path.

- *Highlands Ranch Parkway to Blakeland Drive*. Rather than a consistent 5-foot landscaped buffer, the path has 2-foot gravel shoulders, and its distance from the roadway generally varies from between 2 and 22 feet with landscaping in the buffer where there is adequate room. At the railroad crossings south of Blakeland Drive, the path is detached and set back from the roadway by 14 feet.

- Blakeland Drive to C-470. The Refined Selected Alternative has a wider path (10 feet instead of 8 feet) that is detached on the east side of US 85 with landscaping in the buffer where there is adequate room. On the west side, it is also 10 feet wide but attached.

- C-470 Trail (also called the Centennial Trail). The shared-use path is connected to the C-470 Trail with an improved at-grade crossing of US 85. The at-grade crossing enhancements for the C-470 Trail include restriping the crosswalks, adding new Americans with Disabilities Act of 1990 (ADA) ramps, reconfiguring the existing median island, and providing better wayfinding through the intersection. A future grade-separated crossing will be constructed in a later project when funded.

Water Quality Treatment. To meet current municipal separate storm sewer systems (MS4) requirements, the Refined Selected Alternative assumes conversion of an existing parcel owned by Douglas County (north of Brandon Drive) by the High Line Canal to a water quality facility. This location has been tentatively selected at this phase of design, but specific details may change during the final design process. If the changes result in additional environmental impacts, those will be documented in a reevaluation.

High Line Canal Trail Grade-separated Crossing. The culvert for the High Line Canal Trail underpass at US 85 (Figure 14) is now 2 feet higher and wider than the Selected Alternative—12 feet high and 14 feet wide.

Figure 14. High Line Canal Trail Grade-separated Crossing: Existing Condition and Future Condition Simulation

Source: CDOT 2002.

4.0 Transportation Impacts Analysis

In this section, the transportation impacts of the Refined Selected Alternative are compared to the transportation impacts documented for the Selected Alternative in the FEIS/ROD.

4.1 Traffic LOS Analysis

Methodology

FEIS/ROD Selected Alternatives Analysis

The FEIS/ROD 2020 Selected Alternative was analyzed using Highway Capacity Software (HCS) for AM and PM peak hour periods. Findings are summarized in the FEIS/ROD and detailed in the *I-25/US 85 Corridor Future (2020) Traffic Operations* report for the South I-25 Corridor EIS (CDOT 2000). The FEIS/ROD includes 2020 LOS for the US 85 mainline of the Selected Alternative, and the operations report provides intersection LOS.

For comparison of alternatives, traffic operations analysis considers the cumulative delay of both the crossover and main intersection components of the CFI. Air quality hot-spot analysis treats each crossover and main intersections of the CFI as individual elements. As a result, there is a discrepancy between the LOS discussion within the following sections, and the LOS results presented in the *Air Quality Technical Report* (HDR 2016). More detail about the LOS calculations can be in Appendix E.

Reevaluation Refined Selected Alternatives Analysis

2040 traffic operations for the Refined Selected Alternative were analyzed using the VISSIM version 7.00 microsimulation tool. VISSIM is a microscopic, time step, and behavior-based simulation model with geometric flexibility suited to the complexity of the Refined Selected Alternative.

2040 traffic modeling was completed for the AM and PM peak one hour periods using 15-minute volume intervals, with vehicle delay recorded for the signalized intersections using the VISSIM node evaluation. The model data is reported as the average of 10 model runs. Total average intersection delay at the Highlands Ranch Parkway and Town Center Drive intersections is reported as a summation of crossover and main intersection delay.

Analysis for the 2040 No-Action Alternative, which includes only conventional intersections, was completed using Synchro 9.1. Model output for the 2040 No-Action Alternative and Refined Selected Alternative is provided in Appendix B.

2020 Selected Alternative Compared to the 2040 Refined Selected Alternative

The FEIS/ROD Selected Alternative 2020 operations analysis shows the Blakeland Drive and Town Center Drive intersections to operate at LOS D or better for both peak hour periods. The Highlands Ranch Parkway intersection is shown as LOS F for both AM and PM peak hours.

The 2040 operations analysis for the Refined Selected Alternative shows the same operational performance at the Blakeland Drive and Town Center Drive intersections as the 2020 Selected Alternative, but with significantly improved operations at Highlands Ranch Parkway of LOS D during AM and PM peak hour periods.

A comparison of 2020 and 2040 traffic operations under each build alternative is presented in Figure 15.

2040 No-Action Alternative Compared to the 2040 Refined Selected Alternative

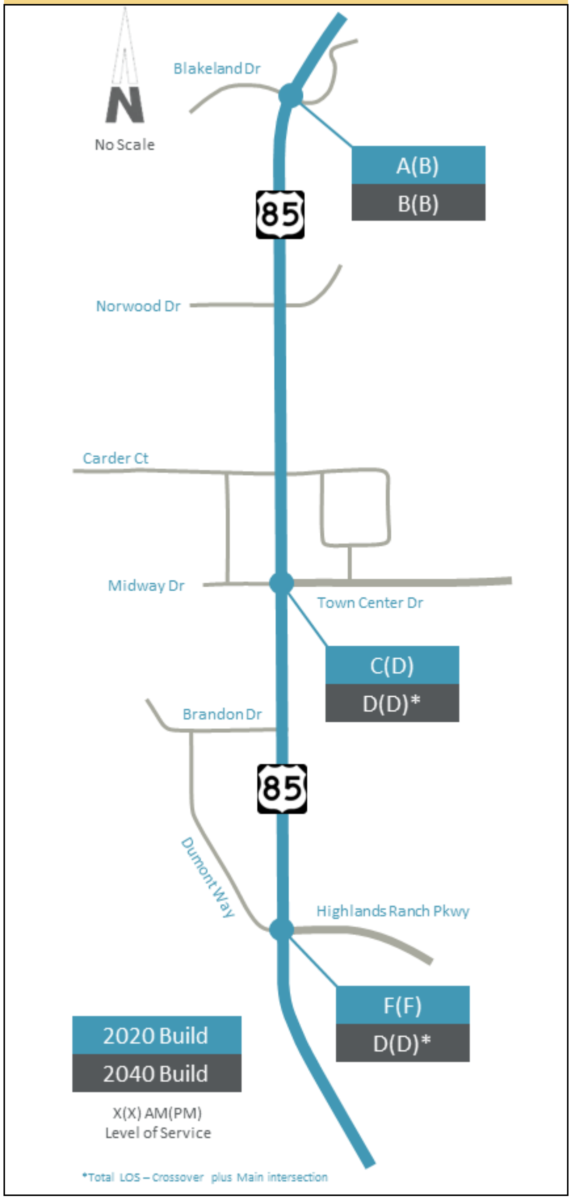
The 2040 No-Action Alternative operations (based on 2015 conditions) fail at LOS F at all US 85 intersections within the study area.

The 2040 Refined Selected Alternative traffic operations analysis shows a significant improvement over the No-Action Alternative, with all intersections in the study area operating at LOS D or better overall. A comparison of 2040 No-Action Alternative and 2040 Refined Selected Alternative traffic operations is presented in Figure 16.

4.2 Access and Traffic Impacts on Local Streets

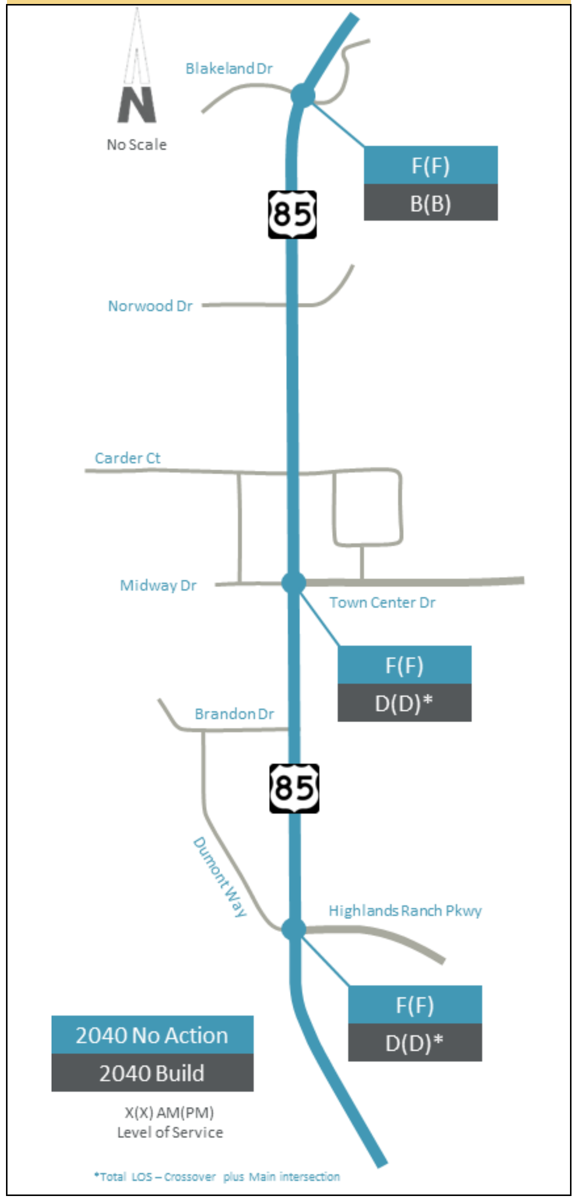
The FEIS/ROD Selected Alternative included access control measures to address safety and operations on US 85 and to meet CDOT access standards. The Refined Selected Alternative

Figure 15. 2020 Selected Alternative LOS Compared to the 2040 Refined Selected Alternative LOS



Note: 2020 Build is the FEIS/ROD Selected Alternative, 2040 Build is the Reevaluation Refined Selected Alternative.

Figure 16. 2040 Reevaluation No-Action Alternative Compared to 2040 Refined Selected Alternative LOS



Note: 2020 Build is the FEIS/ROD Selected Alternative, 2040 Build is the Reevaluation Refined Selected Alternative.

includes the access control measures of the FEIS/ROD Selected Alternative, with additional access control at Norwood Drive, Carder Court, and Brandon Drive. These intersections remained unsignalized, full-movement in the Selected Alternative. For the Refined Selected Alternative, all three intersections operate as right-in, right-out. A summary of access management by driveway is provided in Appendix C of this document.

Change of access control to right-in, right-out movements at Norwood Drive, Carder Court, and Brandon Drive affects local streets through relocation of left-turning traffic to adjacent intersections. Existing left-turn traffic accessing Norwood Drive is required to U-turn at Blakeland Drive or reroute via Town Center Drive and Lucent Boulevard. Left-turn traffic accessing Carder Court is rerouted via Division Street (west side) or Commerce Center Circle (east side) and the US 85 / Town Center Drive signalized intersection. Left-turn Brandon Drive traffic is rerouted via Mead Way or Dumont Way and the US 85 / Highlands Ranch Parkway signalized intersection.

The Spring Gulch Equestrian Facility access formed the east leg of the Brandon Drive intersection in the FEIS/ROD Selected Alternative, and is consolidated with Grace Presbyterian Church in a three-quarter movement for the Refined Selected Alternative. Traffic exiting southbound from the Equestrian Facility is required to turn right and U-turn at Blakeland Drive, or route via Town Center Drive, Lucent Boulevard, and Highlands Ranch Parkway.

2040 AM and PM rerouted peak hour traffic volumes for Carder Court and Brandon Drive are summarized in Figure 17. Rerouted traffic volumes are generally low; the highest is only 150 vehicles per hour (two additional vehicles per minute than under existing conditions). The additional volume is expected to have a negligible impact on the overall capacity and operation of these local streets.

4.3 Parking

There are no changes to parking in either the Selected Alternative and the Refined Selected Alternative.

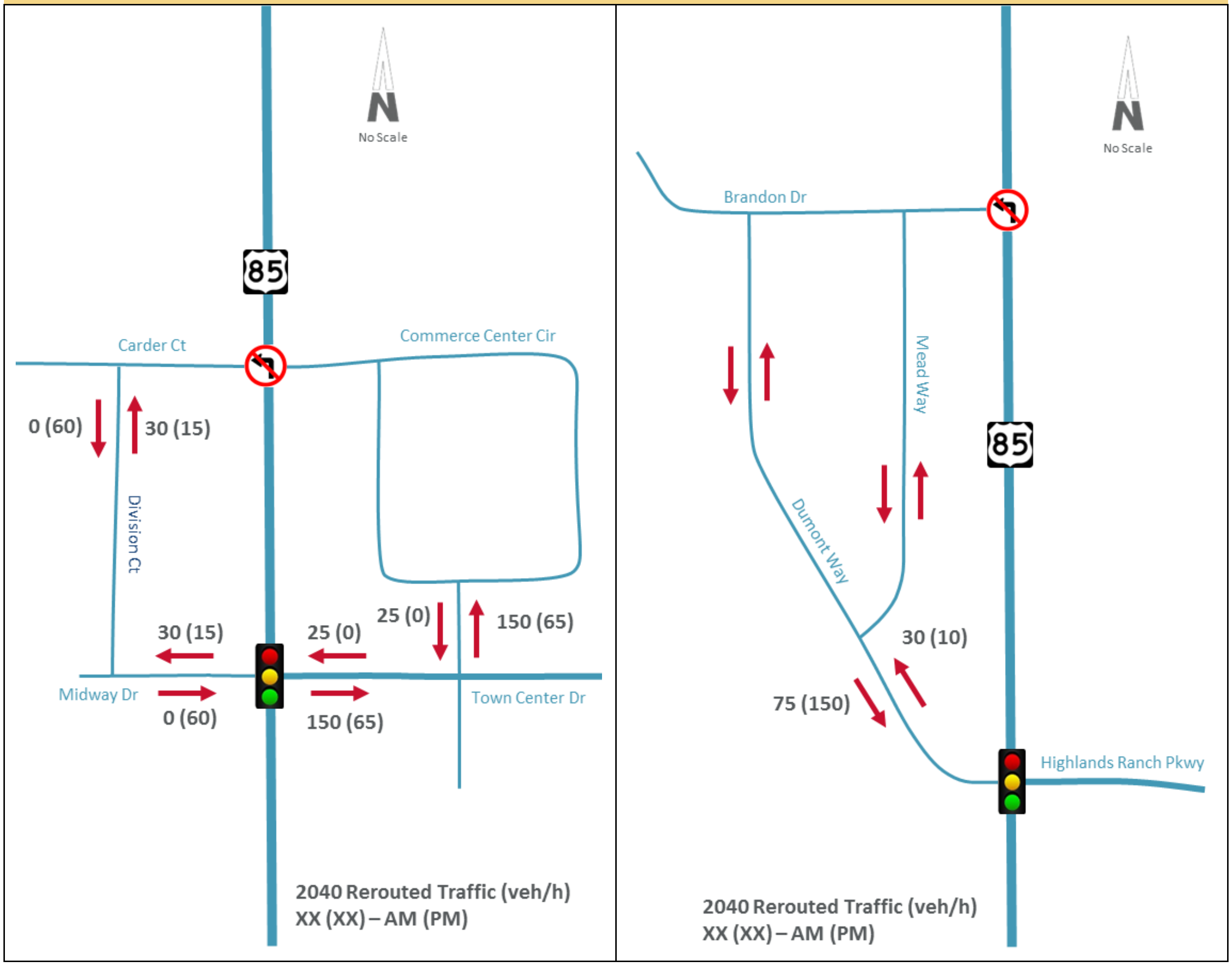
4.4 Safety Analysis

The Selected Alternative and Refined Selected Alternative have similar roadway design and operating conditions. The Refined Selected Alternative has two primary differences that could improve safety conditions – changes to access, and the southbound continuous flow intersections of US 85 with Town Center Drive and Highlands Ranch Parkway.

Access Changes

The Refined Selected Alternative changes access at Norwood Drive, Carder Court, and Brandon Drive by removing the unprotected left turns of the Selected Alternative and relocating traffic to the protected movements at the signalized intersections. This could result in fewer conflict points, and could reduce the occurrence of head-on or left-turn crashes.

Figure 17. 2040 Rerouted Traffic for Carder Court (left) and Brandon Drive (right)



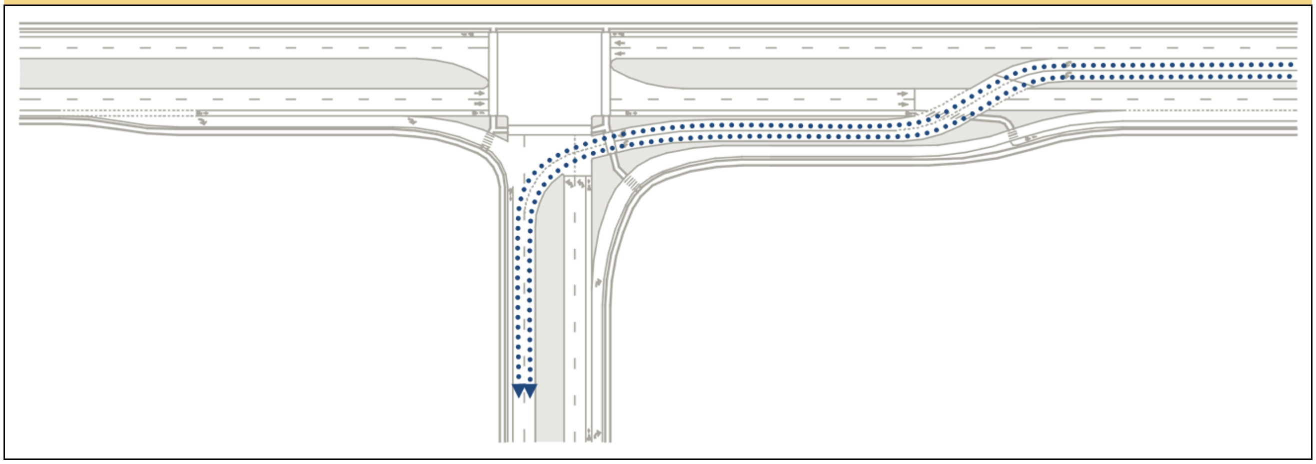
Continuous Flow Intersections

Since the time of the FEIS/ROD, several innovative intersection designs have been introduced and implemented in the United States. One such intersection type, the continuous flow intersection, is designed to improve operations for intersections with a high number of left-turn movements. This type of traffic pattern exists on US 85 within the study area, and the Refined Selected Alternative incorporates this design modification at the Highlands Ranch Parkway and Town Center Drive intersections.

In comparison to conventional intersections, continuous flow intersections reduce or spread out the total number of intersection conflict points. FHWA's *Alternative Intersections/Interchanges: Informational Report Informational Report* (FHWA 2010) analyzed a single intersection in Louisiana as a case study, and showed a reduced crash rate after implementation of a continuous flow intersection. The Utah Department of Transportation (UDOT) operates at least 11 continuous flow intersections, which have been evaluated to determine whether continuous flow intersections are safer than other intersection types. UDOT's *CFI Guideline—A UDOT Guide to Continuous Flow Intersections* (UDOT 2013) contains preliminary data that indicate continuous flow intersections are about as safe for vehicular traffic as other intersection types, and that crash incidence tends to decrease after the first year of implementation as driver familiarity improves. Continuous flow intersection operation for pedestrians is similar to that of a conventional intersection, with a slightly longer crossing distance on the continuous flow intersection leg of the intersection.

When compared to a traditional signal-controlled intersection, the primary differentiating feature of the continuous flow intersection is the relocation of left-turn movements on an approach to the other side of the opposing traffic flow. The displacement of left-turn movements is facilitated by directing left-turning vehicles across the opposing through traffic at a new signal (the crossover signal) located upstream of the main intersection. A conceptual visualization of the displaced left-turn movement is presented in Figure 18. Additional information comparing a conventional signalized intersection to a continuous flow intersection is included in Appendix D.

Figure 18. Typical Displaced Left-turn Movement at a Continuous Flow Intersection



Displacement of the left-turn movements allows them to proceed simultaneously with the through movements, and eliminates the left-turn phase at the main intersection. The green time saved by eliminating left-turn signal phase(s) at the main intersection is added to the time for through movements, which improves intersection capacity and reduces delay. The crossover signal is timed to turn green prior to the start of the through movement phase at the main intersection.

The Refined Selected Alternative incorporates a crossover signal and displaced left turn for the southbound approach to both the Highlands Ranch Parkway and Town Center Drive intersections with US 85. Figure 19 and Figure 20 show the preliminary design layout of the continuous flow intersections at Highways Ranch Parkway and Town Center Drive, respectively. Figure 21 shows the layout at Blakeland Drive, which remains a standard signalized intersection.

Figure 19. Highlands Ranch Parkway Continuous Flow Intersection

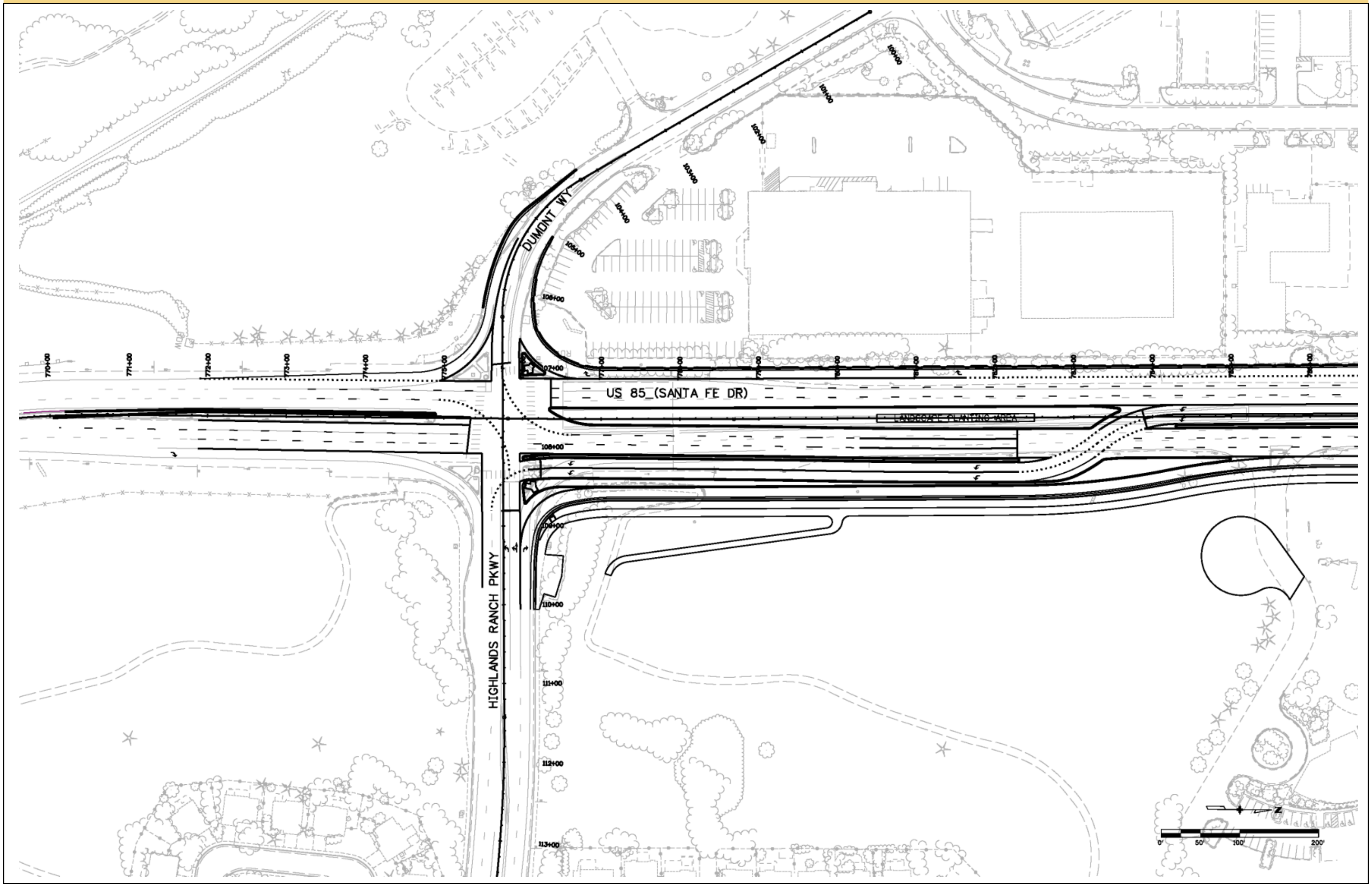


Figure 20. Town Center Drive Continuous Flow Intersection

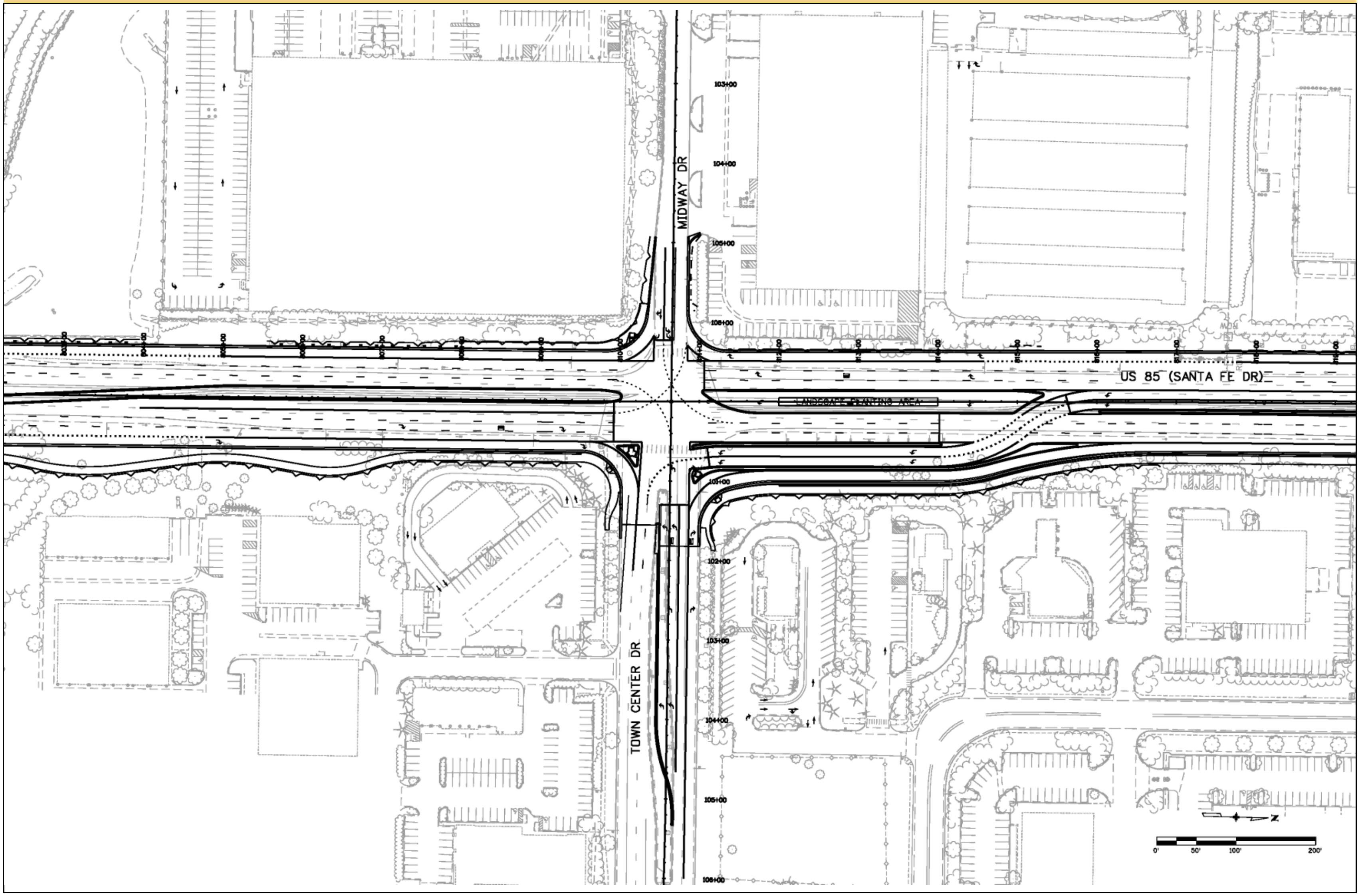
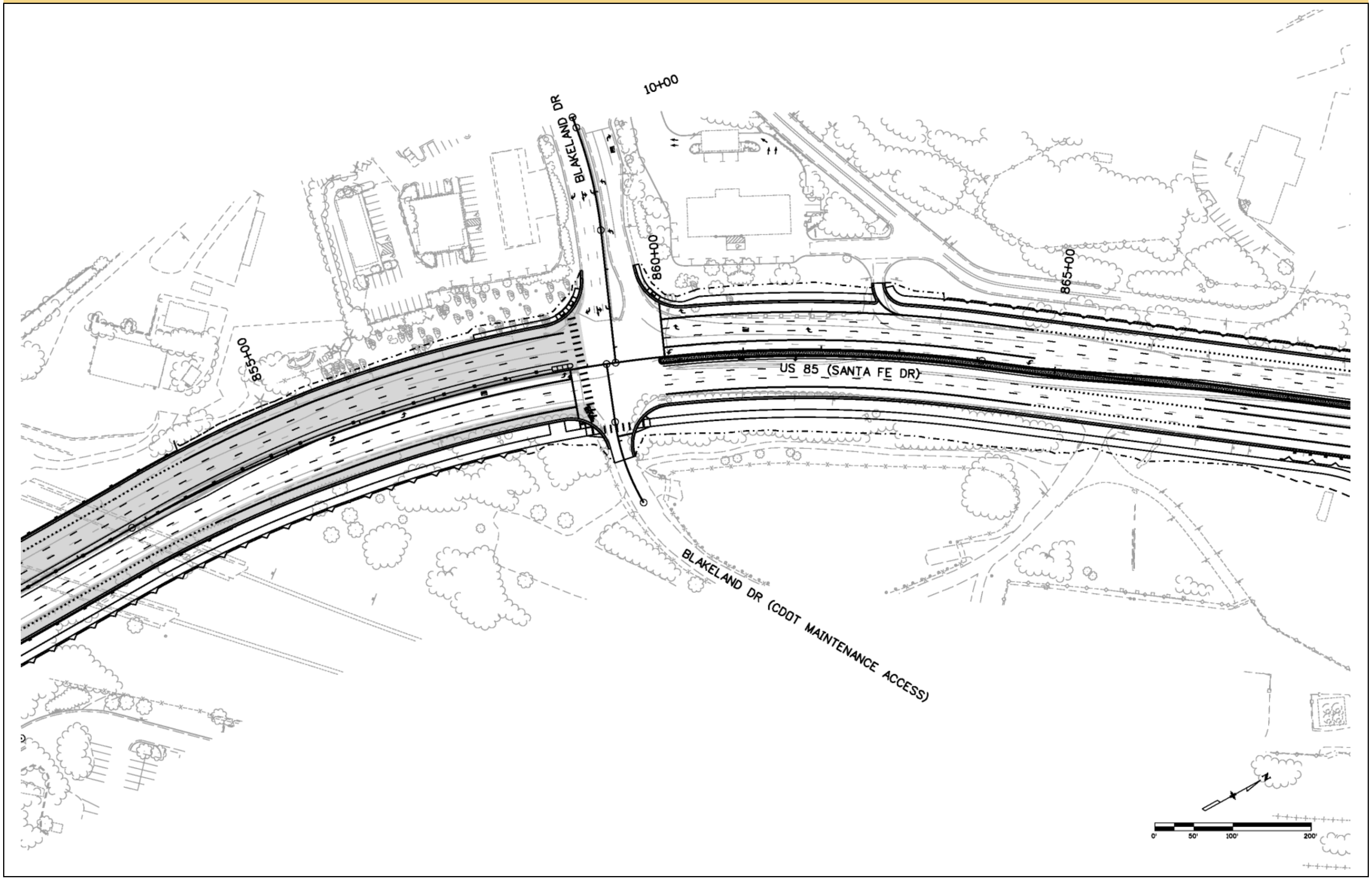


Figure 21. Blakeland Drive Signalized Intersection



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These continuous flow intersections are expected to have similar or improved safety performance over the conventional intersection design in the Selected Alternative. Improved operations of continuous flow intersections and reduction of conflict points could improve safety over time, including reductions in rear-end and other intersection-related crashes, currently accounting for 87 percent of crashes on the corridor.

4.5 Bicycle and Pedestrian Facilities

Improvements to bicycle and pedestrian facilities are largely the same in the Selected Alternative and the Refined Selected Alternative.

Shared-use Path

In both the Selected Alternative and the Refined Selected Alternative, there is a new shared-use path east of US 85 the length of the study area. There are minor changes in the width of shared-use path and the width of separation between the roadway and path.

- *Highlands Ranch Parkway to Blakeland Drive*. Rather than a consistent 5-foot landscaped buffer, the path has 2-foot gravel shoulders, and its distance from the roadway generally varies from between 2 and 22 feet with landscaping in the buffer where there is adequate room. At the railroad crossings south of Blakeland Drive, the path is detached and set back from the roadway by 14 feet.

- *Blakeland Drive to C-470*. The Refined Selected Alternative has a wider path (10 feet instead of 8 feet) that is detached on the east side of US 85 with landscaping in the buffer where there is adequate room. On the west side, it is also 10 feet wide but attached.

  C-470 Trail (also called the Centennial Trail). The shared-use path is connected to the C-470 Trail with an improved at-grade crossing of US 85. The at-grade crossing enhancements for the C-470 Trail include restriping the crosswalks, adding new Americans with Disabilities Act of 1990 (ADA) ramps, reconfiguring the existing median island, and providing better wayfinding through the intersection. A future grade-separated crossing will be constructed in a later project when funded.

  The enhancements of the at-grade crossing will mitigate any potential impacts resulting from potential increased pedestrian and bicyclist activity at the connection of the C-470 Trail and the shared-use path.

High Line Canal Trail

Both alternatives include upgrading the High Line Canal Trail crossing at US 85 from an at-grade crossing to a grade-separated crossing. A new culvert for the grade-separated underpass of High Line Canal Trail under US 85 would be constructed between the maintenance/rider path and the canal. In the Selected Alternative, the underpass is a culvert 10 feet high and 12 feet wide. In the Refined Selected Alternative, the culvert is 2 feet higher and wider—12 feet high and 14 feet wide.

4.6 Transit

Both the Selected Alternative and the Refined Selected Alternative accommodate bus feeder service from Highlands Ranch Parkway to the Mineral light rail station. The former Highland Ranch Town Center Express service, now the 402L Route along US 85, serve the Mineral station from the US 85 corridor. Future bus service from US 85 could similarly serve the Lucent station of the planned FasTracks Southwest Corridor Extension.

In the Refined Selected Alternative, changes are being made to the 402L northbound bus stops at Highlands Ranch Parkway and Town Center Drive to accommodate the continuous flow intersection movements, as follows:

- The stop on US 85 north of Highlands Ranch Parkway is being eliminated. The existing stop on the north side of Highlands Ranch Parkway east of US 85 is being moved west and enhanced with a bench, shelter, and bike racks.

- The existing stop on US 85 north of Town Center Drive is being moved to south of Town Center Drive and being enhanced with bench, shelter, bike racks, and bike lockers.

For both southbound and northbound stops, the Refined Selected Alternative includes sidewalk connections to nearby neighborhoods.

A long-term vision element listed in the FEIS/ROD is the preservation of a future fixed-guideway corridor along the existing rail corridor. Both of the alternatives preserve this corridor by remaining at least 10 feet from the Union Pacific Railroad and the BNSF Railway rights-of-way.

Finally, both of the alternatives accommodate additional supporting measures like TDM, TSM, and ITS that are identified in supporting documentation to the FEIS/ROD.

4.7 Construction Impacts and Mitigation

Traffic impacts due to construction do not differ between the Selected Alternative and the Refined Selected Alternative.

Major construction components on the US 85 Corridor include roadway reconstruction and widening, the reconfiguration of the intersections to continuous flow intersections at Highlands Ranch Parkway and Town Center Drive, the construction of the shared-use path, upgrades to transit facilities, upgrades at the at-grade crossing of the C-470 Trail, and the construction of the grade separation at the High Line Canal Trail.

During construction, traffic flow will be maintained on US 85 via lane shifts as necessary. Temporary access points to properties along US 85 will be provided if the construction requires a temporary closure of a permanent access. Some parking spaces in some parking lots near the highway may be closed off temporarily during construction. There may be temporary detours or closures required at the C-470 Trail.

Construction sequencing, overall construction timeframe, and construction delivery methods have not yet been determined. A detailed Maintenance of Traffic Plan will be prepared to maintain traffic operations for every stage of construction.

Mitigation for construction-related traffic and transportation impacts includes the following:

- A Traffic Management Plan will be developed that identifies a construction-related traffic control plan, work zone management strategies, and contingency plans.
- During construction, the same number of through lanes as existing will be kept open except during some off-peak periods.
- Detour routes will be developed to avoid overloading local streets with detour traffic.
- Access to local businesses and residences will be maintained.
- At the C-470 Trail, bicyclists and pedestrians will be alerted about any closures or detours.

5.0 References

Colorado Department of Transportation (CDOT).1999. I-25/US 85 Corridor Existing Traffic Operations—South I-25 Corridor EIS, for the South I-25 Corridor EIS.

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— — —. 2001a. South I-25 Corridor and US 85 Corridor FEIS. Final Environmental Impact Statement, Section 4(f) Evaluation. May.

— — —. 2001b. Final US 85 Access Management Plan, South I-25 Corridor and US 85 Corridor EIS. March.

— — —. 2002. South I-25 Corridor and US 85 Corridor Revised Record of Decision. October.

Douglas County. 2016a. US 85 Corridor Improvements Planning and Environmental Linkages (PEL) Study Report.

— — —. 2016b. US 85 Corridor Improvements PEL Study Existing Conditions Report.

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Appendix A.
Application of the Travel Demand Model

Introduction

Traffic forecasts were prepared to support the planning and design of the US 85 NEPA Re-evaluation alternatives. The modeling performed for the NEPA Re-evaluation used the latest version of the Denver Regional Council of Governments' (DRCOG) COMPASS Regional Travel Demand Model (TDM). This version is the four-step model that is available for use in alternatives analysis for corridor-specific projects. Note the new FOCUS activity-based model has not been released for use on project-specific applications. This report details the application and results of the COMPASS TDM for the US 85 corridor.

Traffic Forecasting Method

Model Version

DRCOG furnished the latest version of the model to the project team in July 2015. The model version included:

- Network files labeled: GeoRecHwy2010_for2014 and GeoRecHwy2040_RTP40-focus14
- Socioeconomic Dataset labeled: Zone_2010UrbSim_Focus2014 and zone_2040_rtp2040-focus14

The 2010 network with number of lanes, 2040 network with number of lanes, and TAZ geography as received from DRCOG are shown in Figure A-1, Figure A-2, and Figure A-3 respectively.

Figure A-1. 2010 Roadway Network—Number of Lanes

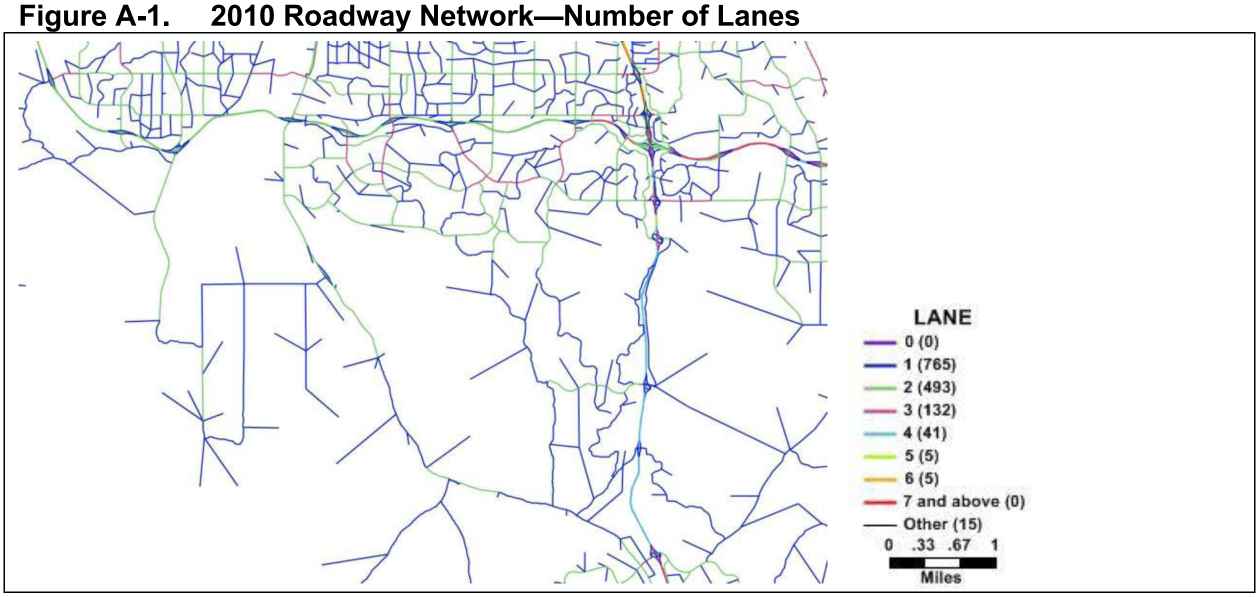


Figure A-2. 2040 Roadway Network—Number of Lanes

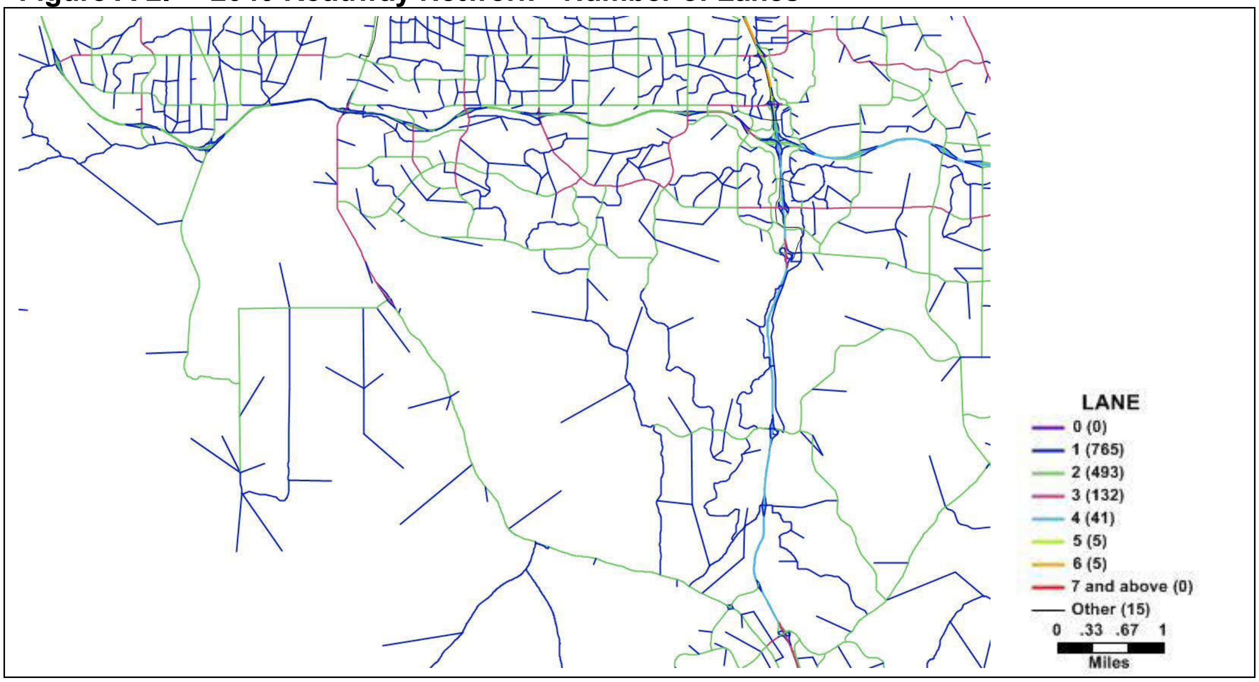
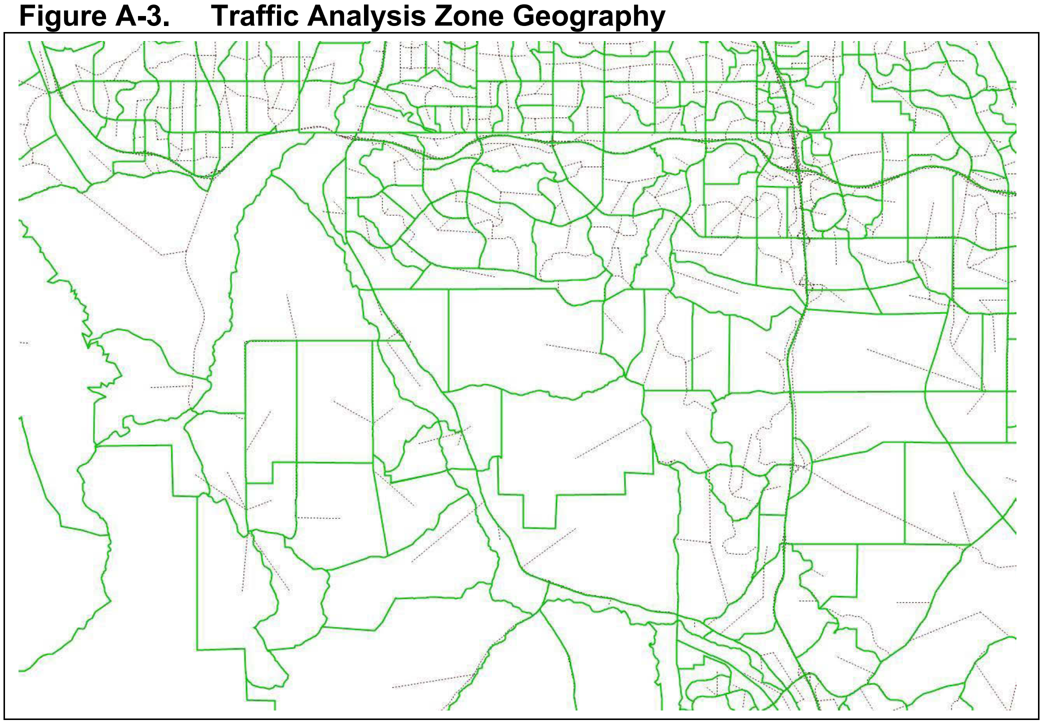


Figure A-3. Traffic Analysis Zone Geography

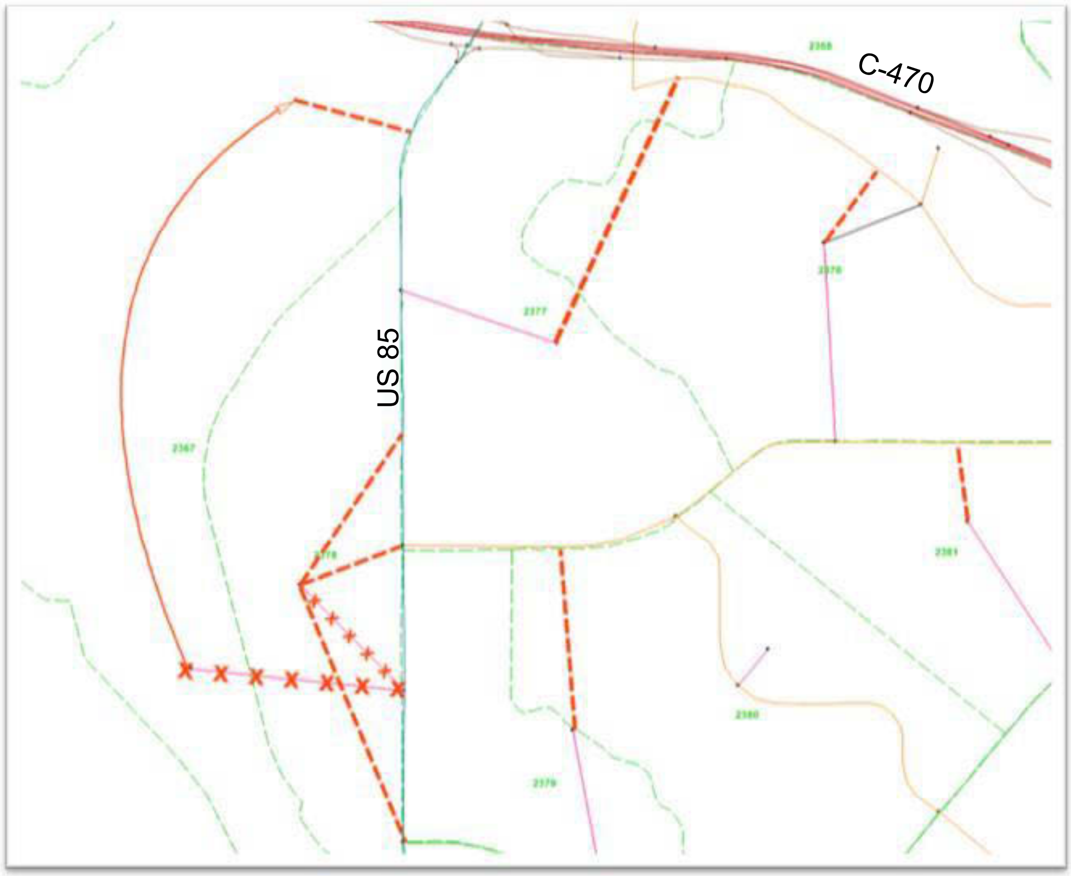


Model Review

The project team conducted comprehensive reviews of both the networks and socioeconomic datasets. This review resulted in the following changes:

- Networks:
  - C-470 express lanes—in 2040 were coded with 2 lanes per direction west of Platte Canyon Road—should only be 1 per direction.
- Centroid modifications (see red dash lines and Xs in Figure A-4):
  - Zone 2377—a second connector was added to connect the zone to Plaza Drive to better represent the network and loading for that zone.
  - Zone 2367—the centroid connector was moved to align with existing Blakeland, which essentially serves the only developed and developable land in that zone.
  - Zone 2376—added a connection to Plaza Drive
  - Zone 2378—changed connections to represent more connectivity for the commercial area
  - Zone 2379—added a connection to Town Center
  - Zone 2381—added a connection to Town Center
- Socioeconomic Dataset:
  - Discovered an error in the 2040 dataset for the Traffic Analysis Zone containing the Lockheed Martin campus—the 2040 dataset contained zero (0) jobs in this TAZ, which is not reasonable. This was corrected by populating the dataset with an equivalent number of jobs as shown in the 2010 dataset.

Figure A-4. Centroid Connection Modifications



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Model Application

The project team performed three official model runs:

- 2010 Base Year Model Run – with the modifications noted above.
- 2040 No Build Model Run – using the DRCOG 2040 RTP network with the modifications noted above and the removal of any widening on US 85 associated with the proposed action.
- 2040 NEPA Build Scenario Model Run – using the same network as the No Build, but including a 6-lane cross-section on US 85 in the NEPA study section.

Model Results

The model results were checked for reasonableness and corrections to errors were fixed if necessary. Daily volumes and other statistics were provided to the traffic operations analysis team for post-processing per industry practice (adjusting volumes to better correlate to observed conditions) and inclusion in micro-simulation modeling. Figure A-5 summarizes the daily volume results for each model run. Plots of the raw model daily volumes are shown in Figure A-6, Figure A-7, and Figure A-8.

Figure A-5. Daily Volume Summaries by Model Run

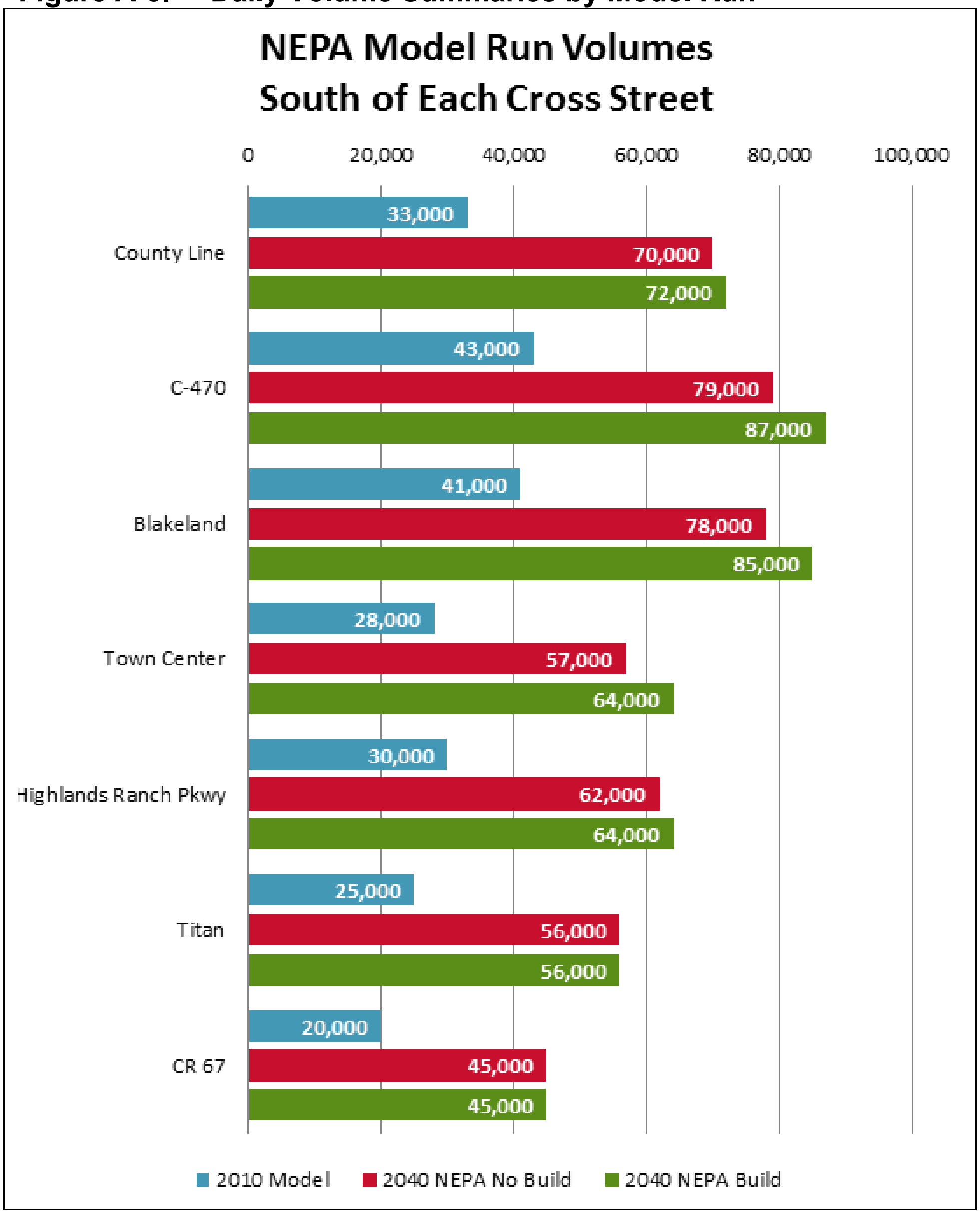

Figure A-6. 2010 Model Results – Daily Volumes

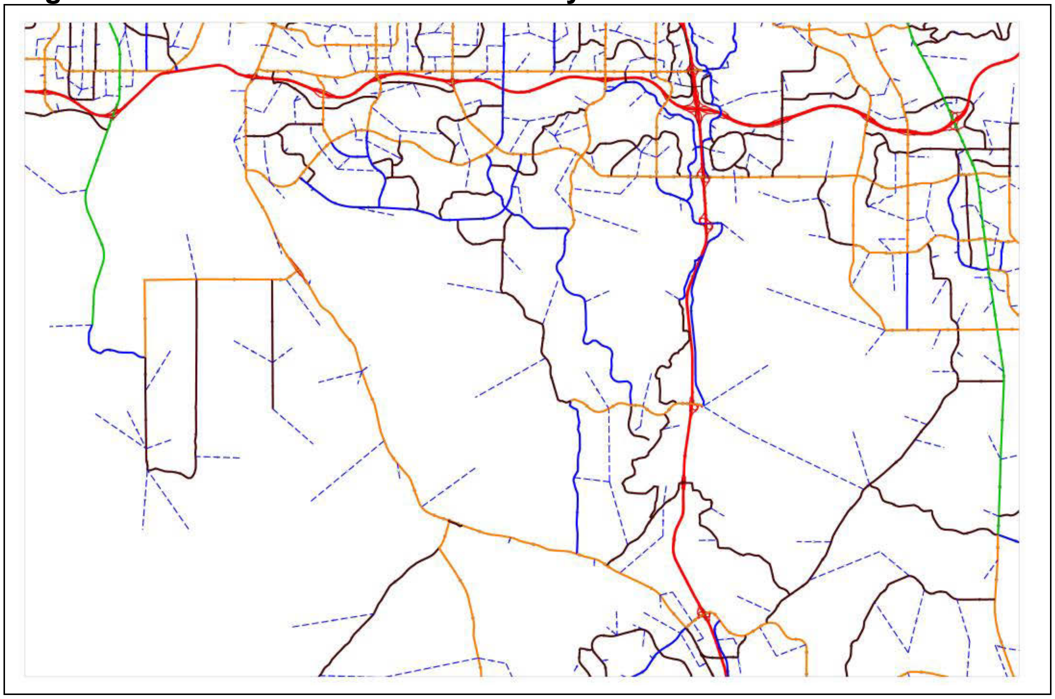

Figure A-7. 2040 No Build Model Results – Daily Volumes

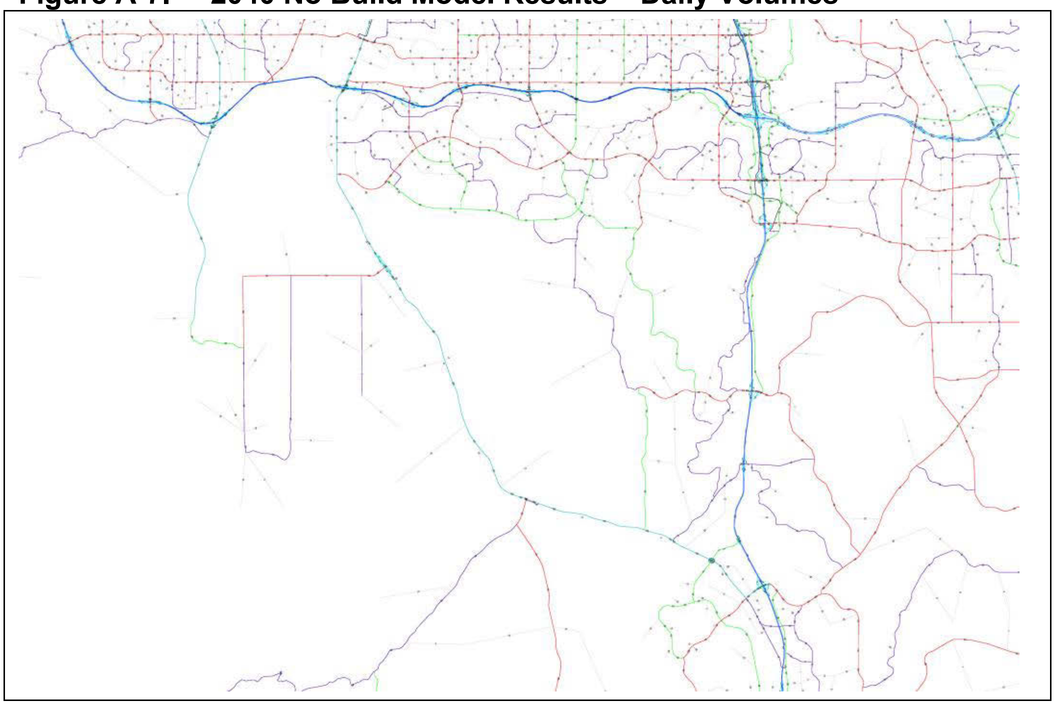

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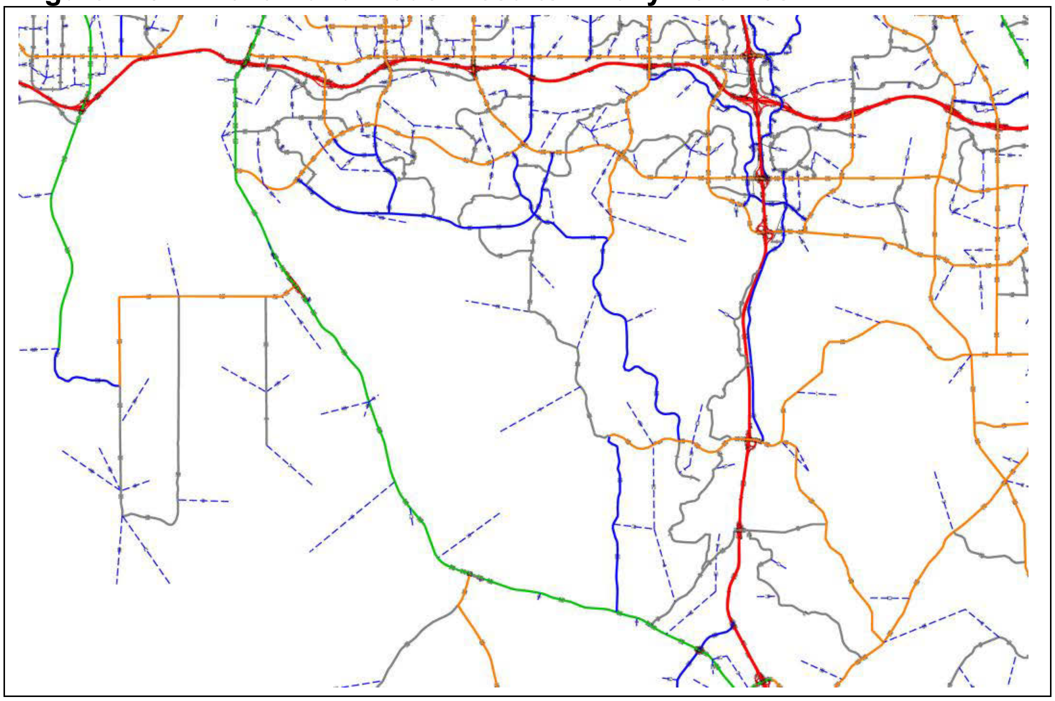
Figure A-8. 2040 Build Model Results – Daily Volumes



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Appendix B.
Traffic LOS Analysis

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	120	0	165	1	0	0	120	3440	1	2	2220	180
Future Volume (vph)	120	0	165	1	0	0	120	3440	1	2	2220	180
Lane Util. Factor	0.95	0.95	1.00	1.00	1.00	1.00	1.00	0.95	0.95	1.00	0.95	1.00
Frt			0.850									0.850
Flt Protected	0.950	0.950		0.950			0.950			0.950		
Satd. Flow (prot)	1441	1441	1538	1556	1638	0	1543	3343	0	1556	3374	1495
Flt Permitted	0.757	0.757		0.667			0.950			0.950		
Satd. Flow (perm)	1148	1148	1538	1092	1638	0	1543	3343	0	1556	3374	1495
Satd. Flow (RTOR)			95									175
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Heavy Vehicles (%)	19%	2%	5%	16%	16%	16%	17%	8%	2%	16%	7%	8%
Adj. Flow (vph)	130	0	179	1	0	0	130	3739	1	2	2413	196
Shared Lane Traffic (%)	50%											
Lane Group Flow (vph)	65	65	179	1	0	0	130	3740	0	2	2413	196
Turn Type	Perm	NA	Perm	Perm			Prot	NA		Prot	NA	Perm
Protected Phases		4			8		5	2		1	6	
Permitted Phases	4		4	8				2				6
Total Split (s)	11.0	11.0	11.0	11.0	11.0		18.0	131.0		8.0	121.0	121.0
Total Lost Time (s)	5.0	5.0	5.0	5.0	5.0		5.0	6.0		5.0	6.0	6.0
Act Effct Green (s)	6.0	6.0	6.0	6.0			13.0	131.4		3.0	115.0	115.0
Actuated g/C Ratio	0.04	0.04	0.04	0.04			0.09	0.88		0.02	0.77	0.77
v/c Ratio	1.44	1.44	1.18	0.02			0.98	1.28		0.06	0.93	0.17
Control Delay	336.1	336.1	155.1	70.0			86.4	152.2		76.5	22.8	1.1
Queue Delay	0.0	0.0	0.0	0.0			0.0	0.0		0.0	2.9	0.0
Total Delay	336.1	336.1	155.1	70.0			86.4	152.2		76.5	25.7	1.1
LOS	F	F	F	E			F	F		E	C	A
Approach Delay		231.3						150.0			23.9	
Approach LOS		F						F			C	

Intersection Summary

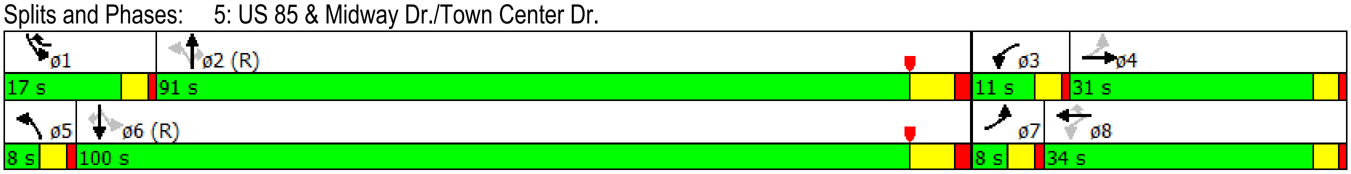
Cycle Length: 150
Actuated Cycle Length: 150
Offset: 0 (0%), Referenced to phase 2:NBT and 6:SBT, Start of Yellow
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 1.44
Intersection Signal Delay: 105.2 Intersection LOS: F
Intersection Capacity Utilization 118.9% ICU Level of Service H
Analysis Period (min) 15

Splits and Phases: 4: US 85 & Blakeland Dr.

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	40	30	35	395	40	505	40	2845	600	335	1680	45
Future Volume (vph)	40	30	35	395	40	505	40	2845	600	335	1680	45
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.95	1.00	1.00	0.95	1.00
Frt		0.920				0.850			0.850			0.850
Flt Protected	0.950			0.950			0.950			0.950		
Satd. Flow (prot)	1736	1688	0	1703	1827	1509	1670	3249	1494	1645	3200	1544
Flt Permitted	0.729			0.420			0.102			0.046		
Satd. Flow (perm)	1332	1688	0	753	1827	1509	179	3249	1494	80	3200	1544
Satd. Flow (RTOR)		34				58			254			65
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Heavy Vehicles (%)	4%	3%	4%	6%	4%	7%	7%	10%	7%	7%	10%	2%
Adj. Flow (vph)	43	33	38	429	43	549	43	3092	652	364	1826	49
Shared Lane Traffic (%)												
Lane Group Flow (vph)	43	71	0	429	43	549	43	3092	652	364	1826	49
Turn Type	pm+pt	NA		pm+pt	NA	pm+ov	pm+pt	NA	Perm	pm+pt	NA	Perm
Protected Phases	7	4		3	8	1	5	2		1	6	
Permitted Phases	4			8		8	2		2	6		6
Total Split (s)	8.0	31.0		11.0	34.0	17.0	8.0	91.0	91.0	17.0	100.0	100.0
Total Lost Time (s)	4.0	4.0		4.0	4.0	4.0	4.0	7.0	7.0	4.0	7.0	7.0
Act Effct Green (s)	13.0	9.0		19.2	13.6	48.6	93.5	84.0	84.0	122.0	110.4	110.4
Actuated g/C Ratio	0.09	0.06		0.13	0.09	0.32	0.62	0.56	0.56	0.81	0.74	0.74
v/c Ratio	0.34	0.53		3.04	0.26	1.04	0.25	1.70	0.69	0.94	0.78	0.04
Control Delay	65.3	52.4		961.7	67.6	93.7	8.2	342.2	20.5	52.2	20.1	2.2
Queue Delay	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	65.3	52.4		961.7	67.6	93.7	8.2	342.2	20.5	52.2	20.1	2.2
LOS	E	D		F	E	F	A	F	C	D	C	A
Approach Delay		57.2			457.3			283.0			25.0	
Approach LOS		E			F			F			C	

Intersection Summary	
Cycle Length: 150	
Actuated Cycle Length: 150	
Offset: 0 (0%), Referenced to phase 2:NBTL and 6:SBTL, Start of Yellow	
Control Type: Actuated-Coordinated	
Maximum v/c Ratio: 3.04	
Intersection Signal Delay: 223.6	Intersection LOS: F
Intersection Capacity Utilization 138.3%	ICU Level of Service H
Analysis Period (min) 15	

Splits and Phases: 5: US 85 & Midway Dr./Town Center Dr.



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	110	20	25	345	30	710	30	2635	325	260	1485	25
Future Volume (vph)	110	20	25	345	30	710	30	2635	325	260	1485	25
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.95	1.00	0.97	0.95	1.00
Frt			0.850			0.850			0.850			0.850
Flt Protected	0.950			0.950			0.950			0.950		
Satd. Flow (prot)	1289	1610	1357	1752	1776	1262	1687	3282	1509	3152	3135	1344
Flt Permitted	0.736			0.526			0.950			0.950		
Satd. Flow (perm)	999	1610	1357	970	1776	1262	1687	3282	1509	3152	3135	1344
Satd. Flow (RTOR)			124			182			124			73
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Heavy Vehicles (%)	40%	18%	19%	3%	7%	28%	7%	10%	7%	10%	14%	19%
Adj. Flow (vph)	120	22	27	375	33	772	33	2864	353	283	1614	27
Shared Lane Traffic (%)												
Lane Group Flow (vph)	120	22	27	375	33	772	33	2864	353	283	1614	27
Turn Type	pm+pt	NA	Free	pm+pt	NA	Free	Prot	NA	Free	Prot	NA	Perm
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases	4		Free	8		Free			Free			6
Total Split (s)	9.0	32.0		9.0	32.0		9.0	96.0		13.0	100.0	100.0
Total Lost Time (s)	4.0	5.0		4.0	5.0		4.0	7.0		4.0	7.0	7.0
Act Effct Green (s)	11.4	8.1	150.0	13.7	8.2	150.0	8.6	92.2	150.0	26.7	112.2	112.2
Actuated g/C Ratio	0.08	0.05	1.00	0.09	0.05	1.00	0.06	0.61	1.00	0.18	0.75	0.75
v/c Ratio	1.41	0.25	0.02	2.95	0.34	0.61	0.34	1.42	0.23	0.51	0.69	0.03
Control Delay	288.2	74.0	0.0	922.7	76.8	2.2	76.7	218.8	0.4	57.6	10.0	0.0
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	288.2	74.0	0.0	922.7	76.8	2.2	76.7	218.8	0.4	57.6	10.0	0.0
LOS	F	E	A	F	E	A	E	F	A	E	A	A
Approach Delay		214.3			296.8			193.6			16.9	
Approach LOS		F			F			F			B	

Intersection Summary	
Cycle Length: 150	
Actuated Cycle Length: 150	
Offset: 0 (0%), Referenced to phase 2:NBT and 6:SBT, Start of Yellow	
Control Type: Actuated-Coordinated	
Maximum v/c Ratio: 2.95	
Intersection Signal Delay: 160.7	Intersection LOS: F
Intersection Capacity Utilization 119.4%	ICU Level of Service H
Analysis Period (min) 15	

Splits and Phases: 6: US 85 & Dumont Way/HR Pkwy.

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	165	0	190	0	1	1	65	3370	1	2	2965	110
Future Volume (vph)	165	0	190	0	1	1	65	3370	1	2	2965	110
Lane Util. Factor	0.95	0.95	1.00	1.00	1.00	1.00	1.00	0.95	0.95	1.00	0.95	1.00
Frt			0.850		0.925							0.850
Flt Protected	0.950	0.950					0.950			0.950		
Satd. Flow (prot)	1603	1603	1482	1827	1690	0	1770	3471	0	1770	3505	1568
Flt Permitted	0.757	0.757					0.032			0.033		
Satd. Flow (perm)	1277	1277	1482	1827	1690	0	60	3471	0	61	3505	1568
Satd. Flow (RTOR)			58		1							100
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Heavy Vehicles (%)	7%	4%	9%	4%	4%	4%	2%	4%	4%	2%	3%	3%
Adj. Flow (vph)	179	0	207	0	1	1	71	3663	1	2	3223	120
Shared Lane Traffic (%)	50%											
Lane Group Flow (vph)	89	90	207	0	2	0	71	3664	0	2	3223	120
Turn Type	Perm	NA	Perm	Perm	NA		pm+pt	NA		pm+pt	NA	Perm
Protected Phases		4			8		5	2		1	6	
Permitted Phases	4		4	8			2	2		6		6
Total Split (s)	14.0	14.0	14.0	14.0	14.0		8.0	127.0		9.0	128.0	128.0
Total Lost Time (s)	5.0	5.0	5.0	5.0	5.0		5.0	6.0		5.0	6.0	6.0
Act Effct Green (s)	9.0	9.0	9.0		9.0		129.8	128.2		127.0	122.0	122.0
Actuated g/C Ratio	0.06	0.06	0.06		0.06		0.87	0.85		0.85	0.81	0.81
v/c Ratio	1.17	1.18	1.45		0.02		0.83	1.24		0.02	1.13	0.09
Control Delay	214.1	218.0	268.7		56.5		38.6	138.2		1.5	81.0	0.9
Queue Delay	0.0	0.0	0.0		0.0		0.0	0.0		0.0	0.0	0.0
Total Delay	214.1	218.0	268.7		56.5		38.6	138.2		1.5	81.0	0.9
LOS	F	F	F		E		D	F		A	F	A
Approach Delay		244.3			56.5			136.3			78.1	
Approach LOS		F			E			F			E	

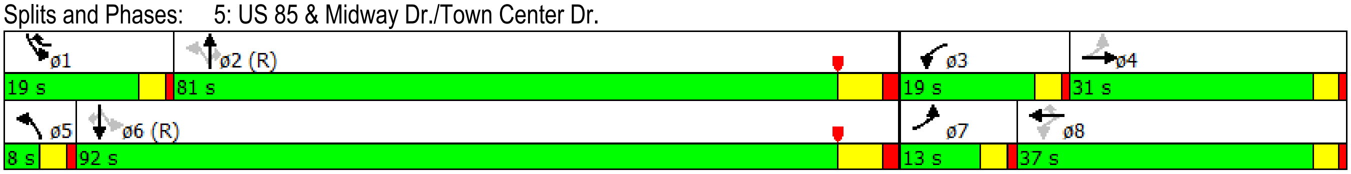
Intersection Summary	
Cycle Length: 150	
Actuated Cycle Length: 150	
Offset: 0 (0%), Referenced to phase 2:NBTL, Start of Yellow	
Control Type: Actuated-Coordinated	
Maximum v/c Ratio: 1.45	
Intersection Signal Delay: 115.8	Intersection LOS: F
Intersection Capacity Utilization 113.6%	ICU Level of Service H
Analysis Period (min) 15	

Splits and Phases: 4: US 85 & Blakeland Dr.

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	140	50	45	680	40	405	20	2750	400	435	2700	20
Future Volume (vph)	140	50	45	680	40	405	20	2750	400	435	2700	20
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.95	1.00	1.00	0.95	1.00
Frt		0.929				0.850			0.850			0.850
Flt Protected	0.950			0.950			0.950			0.950		
Satd. Flow (prot)	1770	1730	0	1703	1827	1509	1735	3372	1552	1660	3229	1485
Flt Permitted	0.729			0.377			0.055			0.052		
Satd. Flow (perm)	1358	1730	0	676	1827	1509	100	3372	1552	91	3229	1485
Satd. Flow (RTOR)		27				58			152			95
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Heavy Vehicles (%)	2%	2%	2%	6%	4%	7%	3%	6%	3%	6%	9%	6%
Adj. Flow (vph)	152	54	49	739	43	440	22	2989	435	473	2935	22
Shared Lane Traffic (%)												
Lane Group Flow (vph)	152	103	0	739	43	440	22	2989	435	473	2935	22
Turn Type	pm+pt	NA		pm+pt	NA	pm+ov	pm+pt	NA	Perm	pm+pt	NA	Perm
Protected Phases	7	4		3	8	1	5	2		1	6	
Permitted Phases	4			8		8	2		2	6		6
Total Split (s)	13.0	31.0		19.0	37.0	19.0	8.0	81.0	81.0	19.0	92.0	92.0
Total Lost Time (s)	4.0	4.0		4.0	4.0	4.0	4.0	7.0	7.0	4.0	7.0	7.0
Act Effct Green (s)	23.0	12.0		28.9	16.7	48.7	83.1	74.0	74.0	111.0	101.7	101.7
Actuated g/C Ratio	0.15	0.08		0.19	0.11	0.32	0.55	0.49	0.49	0.74	0.68	0.68
v/c Ratio	0.63	0.63		3.17	0.21	0.83	0.18	1.80	0.52	1.24	1.34	0.02
Control Delay	65.8	65.3		1009.4	60.2	54.4	12.5	389.2	30.0	145.5	179.5	0.0
Queue Delay	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	65.8	65.3		1009.4	60.2	54.4	12.5	389.2	30.0	145.5	179.5	0.0
LOS	E	E		F	E	D	B	F	C	F	F	A
Approach Delay		65.6			632.2			341.5			173.6	
Approach LOS		E			F			F			F	

Intersection Summary	
Cycle Length: 150	
Actuated Cycle Length: 150	
Offset: 0 (0%), Referenced to phase 2:NBTL and 6:SBTL, Start of Yellow	
Control Type: Actuated-Coordinated	
Maximum v/c Ratio: 3.17	
Intersection Signal Delay: 306.7	Intersection LOS: F
Intersection Capacity Utilization 157.0%	ICU Level of Service H
Analysis Period (min) 15	

Splits and Phases: 5: US 85 & Midway Dr./Town Center Dr.



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	150	50	105	555	40	395	30	2405	615	650	2665	60
Future Volume (vph)	150	50	105	555	40	395	30	2405	615	650	2665	60
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.95	1.00	0.97	0.95	1.00
Frt			0.850			0.850			0.850			0.850
Flt Protected	0.950			0.950			0.950			0.950		
Satd. Flow (prot)	1770	1863	1583	1752	1863	1553	1770	3406	1583	3399	3404	1552
Flt Permitted	0.729			0.722			0.950			0.950		
Satd. Flow (perm)	1358	1863	1583	1332	1863	1553	1770	3406	1583	3399	3404	1552
Satd. Flow (RTOR)			153			262			203			73
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Heavy Vehicles (%)	2%	2%	2%	3%	2%	4%	2%	6%	2%	2%	5%	3%
Adj. Flow (vph)	163	54	114	603	43	429	33	2614	668	707	2897	65
Shared Lane Traffic (%)												
Lane Group Flow (vph)	163	54	114	603	43	429	33	2614	668	707	2897	65
Turn Type	pm+pt	NA	Free	pm+pt	NA	Free	Prot	NA	Free	Prot	NA	Perm
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases	4		Free	8		Free			Free			6
Total Split (s)	14.0	32.0		14.0	32.0		9.0	82.0		22.0	95.0	95.0
Total Lost Time (s)	4.0	5.0		4.0	5.0		4.0	7.0		4.0	7.0	7.0
Act Effct Green (s)	19.3	9.7	150.0	19.3	9.6	150.0	8.4	75.0	150.0	37.5	106.0	106.0
Actuated g/C Ratio	0.13	0.06	1.00	0.13	0.06	1.00	0.06	0.50	1.00	0.25	0.71	0.71
v/c Ratio	0.81	0.45	0.07	3.03	0.36	0.28	0.33	1.53	0.42	0.83	1.20	0.06
Control Delay	88.2	78.5	0.1	948.3	74.6	0.4	76.3	273.3	0.8	49.5	117.1	3.5
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	88.2	78.5	0.1	948.3	74.6	0.4	76.3	273.3	0.8	49.5	117.1	3.5
LOS	F	E	A	F	E	A	E	F	A	D	F	A
Approach Delay		56.3			535.1			216.4			102.1	
Approach LOS		E			F			F			F	

Intersection Summary	
Cycle Length: 150	
Actuated Cycle Length: 150	
Offset: 0 (0%), Referenced to phase 2:NBT and 6:SBT, Start of Yellow	
Control Type: Actuated-Coordinated	
Maximum v/c Ratio: 3.03	
Intersection Signal Delay: 200.9	Intersection LOS: F
Intersection Capacity Utilization 135.8%	ICU Level of Service H
Analysis Period (min) 15	

Splits and Phases: 6: US 85 & Dumont Way/HR Pkwy.

2040 AM Peak Hour - VISSIM Signalized Intersection Results

Intersection	Movement	Volume (veh/h)	Vehicle Delay (s)	LOS
US85 / Blakeland Drive	SBL	0	0.0	A
	SBT	3076	4.0	A
	SBR	222	4.8	A
	EBL	117	81.3	F
	EBT	0	0.0	A
	EBR	135	7.3	A
	NBL	128	95.2	F
	NBT	490	9.0	A
	NBT (to C-470)	1074	47.4	D
	NBR	0	0.0	A
	WBL	0	0.0	A
	WBT	0	0.0	A
	WBR	0	0.0	A
	INTERSECTION	**5242**	**17.1**	**B**
US85 / Town Center Drive CFI Crossover	CFI NB	4031	3.7	A
	CFI SB	651	77.5	E
	INTERSECTION	**4682**	**14.0**	**B**
US85 / Town Center Drive Main Intersection	SBL	651	13.5	B
	SBT	2294	17.6	B
	SBR	61	5.8	A
	EBL	38	74.6	E
	EBT	31	82.1	F
	EBR	55	12.4	B
	NBL	77	136.9	F
	NBT	3535	32.8	C
	NBR	613	9.0	A
	WBL	435	68.2	E
	WBT	39	63.8	E
	WBR	459	1.7	A
	INTERSECTION	**8288**	**26.6**	**C**
Total US85 / Town Center Drive Crossover plus Main Intersection	**COMBINED**		**40.6**	**D**
US85 / Highlands Ranch Parkway CFI Crossover	CFI NB	4226	2.5	A
	CFI SB	447	73.7	E
	INTERSECTION	**4673**	**9.3**	**A**
US85 / Highlands Ranch Parkway Main Intersection	SBL	447	2.6	A
	SBT	2073	20.5	C
	SBR	40	3.2	A
	EBL	198	74.4	E
	EBT	19	71.1	E
	EBR	20	6.3	A
	NBL	60	147.8	F
	NBT	3257	28.2	C
	NBR	336	15.3	B
	WBL	268	104.6	F
	WBT	27	109.9	F
	WBR	774	3.0	A
	INTERSECTION	**7519**	**26.5**	**C**
Total US85 / Highlands Ranch Parkway Crossover plus Main Intersection	**COMBINED**		**35.8**	**D**

Final Design 3-lane NB @ HRP - 10 Model Runs

2040 PM Peak Hour - VISSIM Signalized Intersection Results

Intersection	Movement	Volume (veh/h)	Vehicle Delay (s)	LOS
US85 / Blakeland Drive	SBL	0	0.0	A
	SBT	3443	4.0	A
	SBR	114	4.7	A
	EBL	163	81.0	F
	EBT	0	0.0	A
	EBR	179	8.1	A
	NBL	169	96.5	F
	NBT	2703	7.0	A
	NBT (to C-470)	895	36.2	D
	NBR	0	0.0	A
	WBL	0	0.0	A
	WBT	0	0.0	A
	WBR	0	0.0	A
	INTERSECTION	**7666**	**12.6**	**B**
US85 / Town Center Drive CFI Crossover	CFI NB	3674	2.8	A
	CFI SB	582	76.3	E
	INTERSECTION	**4256**	**12.9**	**B**
US85 / Town Center Drive Main Intersection	SBL	582	12.6	B
	SBT	3094	24.8	C
	SBR	32	7.0	A
	EBL	197	80.7	F
	EBT	57	80.6	F
	EBR	50	26.8	C
	NBL	33	88.4	F
	NBT	3115	40.3	D
	NBR	398	6.8	A
	WBL	458	77.0	E
	WBT	37	68.2	E
	WBR	361	1.4	A
	INTERSECTION	**8414**	**32.8**	**C**
Total US85 / Town Center Drive Crossover plus Main Intersection	**COMBINED**		**45.6**	**D**
US85 / Highlands Ranch Parkway CFI Crossover	CFI NB	3551	2.5	A
	CFI SB	728	82.2	F
	INTERSECTION	**4279**	**16.1**	**B**
US85 / Highlands Ranch Parkway Main Intersection	SBL	728	8.6	A
	SBT	2736	27.1	C
	SBR	58	6.7	A
	EBL	345	76.7	E
	EBT	49	75.5	E
	EBR	89	26.0	C
	NBL	36	106.1	F
	NBT	2777	37.2	D
	NBR	586	17.2	B
	WBL	479	95.4	F
	WBT	37	101.1	F
	WBR	432	2.7	A
	INTERSECTION	**8352**	**33.7**	**C**
Total US85 / Highlands Ranch Parkway Crossover plus Main Intersection	**COMBINED**		**49.8**	**D**

Final Design 3-lane NB @ HRP - 10 Model Runs

Appendix C.
Access Management

US85 NEPA Reevaluation Access Management Summary

Location	Initial Access/FEIS Access		NEPA Refinement Options	
	Existing Conditions	FEIS Selected Alternative	Conventional Alternative	CFI Refined Selected Alternative
CDOT Maintenance Facility				
Diamond Shamrock Corner Store		#		
Blakeland Drive				
Mill Vista Rd.				
Norwood Drive				
Old Java				
Jensen Sales Co.				
Center Rental & Sales Inc./ Store Rite (Shared Driveway)				
My Pets Place N				
My Pets Place S				
* Carder Ct.				
Midway - Town Center Drive				
Brandon Dr. - Spring Gulch Equestrian Area				Combined access to Spring Gulch Equestrian and Grace Presbyterian Church
Grace Presbyterian Church	No Detail Provided (Church constructed 2012)			
Highlands Ranch Pkwy. - Dumont Way				

*** US85 Access Management Plan 2001 states:**
A traffic signal will not be installed at Carder Ct. for safety reasons. If the intersection deteriorates to poor operating conditions the access may be adjusted to prohibit certain turning movements. The restricted traffic may access US85 using Town Center Drive traffic signal.

#Right turn out of service station in Access Management Plan but not in design

Note: N/S through movements assumed for all intersections

Appendix D.
Comparison of Conventional Intersection to a Continuous Flow Intersection

US 85 Intersection Options at Highlands Ranch Parkway and Town Center Drive

The intersections along US 85 at Highlands Ranch Parkway (HRP) and at Town Center Drive (TCD) are currently conventionally configured, signalized intersections. Through the NEPA reevaluation process an alternative design is being considered. A Continuous Flow Intersection (CFI) configuration has many traffic operational advantages with relatively few minor disadvantages. This memo summarizes the relative differences and similarities between the intersection types.

Advantages of the Continuous Flow Intersections

The primary, significant advantages of the CFI intersections in comparison to a conventional intersection are:

Capacity – The CFIs will accommodate 2,000 to 3,000 more vehicles per hour at capacity than the conventional intersections.

Level of Service – at similar levels of traffic demand, such as forecasted for 2025, the overall LOS at the CFIs will be C while the LOS will be F for the conventional intersections.

Life Span – the CFI intersections expected to operate acceptably until at least 2040. Conventional intersections are expected to fail by 2025.

Value – although slightly more expensive than conventional intersections, the value of reduced delay and increased mobility far exceeds the additional cost.

Advantages of Conventional Intersections

The advantages of the conventional intersection in comparison to CFI intersections are relatively minor:

Cost – The CFIs will add about six percent to the cost of the project over the conventional intersections. This is approximately $700,000.

U-Turns – The conventional intersections can accommodate the southbound to northbound U-Turn movement. The CFIs could only accommodate this movement if the design were altered to provide a wider, more costly, center median. Lack of a U-Turn movement will impact access Grace Presbyterian Church and Spring Gulch Reservoir, requiring a slightly longer (0.13 mile) indirect route for those traveling southbound along US 85.

Other comparisons

Many aspects of the two options are indistinguishable. In some aspects there are differences, but those aspects do not present a clear advantage to one option or the other.

Access – The access to streets and driveways along the corridor in the vicinity of the intersections are the same for the two options. Per the access management plan, all access points except for Blakeland Drive, HRP, and TCD will be right-in, right-out.

Safety – Based on several years' data from the Utah DOT, which has built and operates at least 11 CFIs, there has been no observable difference in crash rates at CFI intersections compared to similar conventional intersections. The CFIs here are expected to be as safe as conventional intersections. This includes pedestrian safety as well.

Shared Use Paths – Both design options can accommodate the full path design, albeit with slightly different alignments in the vicinity of the intersections.

Driver Expectancy – The CFIs will require public outreach to ensure drivers are not caught unaware when they are first opened. However, after an initial period of adjustment drivers quickly adapt to the new configuration.

Environmental Impacts – The CFIs have a slightly larger footprint which requires additional land acquisitions. Most environmental impacts are negligibly different. Air quality may improve with the CFI due to reduced congestion.

Pedestrian Convenience – Crossing the north and west legs will be identical for the CFI and conventional intersections The CFI will have a 10’ shorter distance to cross the east leg, and a 30’ shorter distance to cross the south leg. The north leg of the CFI will have traffic traveling in multiple directions simultaneously, which might create some confusion. However, when crossing, pedestrians will be fully protected as they are in the conventional configuration.

INTERSECTION REFINEMENT OPTIONS
HIGHLANDS RANCH PKWY TO C-470 PROJECT
DRAFT (12/9/15)

Evaluation Criteria	Conventional Signalized Intersection	Continuous Flow Intersection (CFI)
Mobility ▪ LOS ▪ Delay ▪ Queue Length	▪ At the LOS E/F threshold the Highlands Ranch Parkway intersection can process approximately ***6,200*** vehicles per hour. At the LOS E/F threshold the Town Center Drive intersection can process approximately ***5,800*** vehicles per hour. ▪ Assuming 6,200 vph, the average delay at Highlands Ranch Parkway is **83 seconds/vehicle**. Assuming ***5,800*** vph, the average delay at Town Center Drive is **82 seconds/vehicle**. ▪ Side streets and driveways are accessible with at least right-in-right-out movements.	▪ At the LOS E/F threshold the Highlands Ranch Parkway intersection can process approximately ***8,200*** vehicles per hour. At the LOS E/F threshold the Town Center Drive intersection can process approximately ***8,400*** vehicles per hour. ▪ Assuming 6,200 vph, the average delay at Highlands Ranch Parkway is **35 seconds/ vehicle**. Assuming ***5,800*** vph, the average delay at Town Center Drive is **24 seconds/vehicle**. ▪ Side streets and driveways are accessible with at least right-in-right-out movements.
Safety ▪ Qualitative Assessment of Safety Characteristics	▪ High speed conflicts between mainline through traffic and opposing left turn traffic represents the highest risk for severe crashes. This is unmitigated. ▪ Overall, UDOT studies show similar safety characteristics as CFI intersections.	▪ Displaced southbound left turns reduce high speed left turn vs through vehicle conflict. ▪ Overall, UDOT studies show similar safety characteristics as conventional intersections.
Environmental (in spite of quantitative measures listed, use qualitative assessment) ▪ Section 4(f) property used (acres) ▪ Wetlands impacted (acres) ▪ Water Quality—meets new requirements ▪ Riparian vegetation impacted (acres) ▪ Waters of the US impacted (acres) ▪ Air quality (based on intersection LOS, VMT) ▪ Wildlife (accommodates wildlife crossing needs) ▪ PMJM habitat impacted (acres) ▪ Prairie dog town impacts (acres) ▪ Hazardous waste (# and type of hazmat sites) ▪ Cultural resources (historic/archeo/paleo) - # and acres of impacted NRHP eligible properties or archaeological sites and paleontological sites ▪ Floodplains (acres in 100 year floodplains) ▪ Recreation (# of parks or trails impacted) ▪ Right-of-way (# of affected ownerships categorized by land use type)	▪ The two intersection concepts appear to have identical effects to Chatfield State Park, the riparian and wetland resources at Marcy Gulch, Section 4(f) and riparian resources at the High Line Canal, and the wetlands, riparian and 4(f) resources at Spring Gulch. ▪ At Town Center Drive, the CFI requires larger partial acquisitions from the three commercial properties in the northeast quadrant of the interchange than the conventional intersection concept. The additional partial acquisition areas are minimal and slightly larger than the partial acquisitions documented in the FEIS. ▪ At Highlands Ranch Parkway, the CFI requires larger partial acquisitions from the open space property in the immediate northeast quadrant of the interchange, and from the property used as a church immediately north of that property, than the conventional intersection concept. The additional partial acquisition areas are minimal and slightly larger than the partial acquisitions documented in the FEIS. ▪ The CFI requires reconfiguring the Highland Ranch Metro District trail, which is protected by Section 4(f). This could likely be covered as a temporary occupancy of the trail, which is not a Section 4(f) use. The CFI also moves travel lanes closer to residential areas. The primary advantage of the CFI at Highlands Ranch Parkway is that it is less congested, so has fewer AQ impacts for the pollutants that are associated with congestion. It also can process more traffic (7500 vehicles per hour compared to approximately 6000 with a conventional intersection.	▪ The two intersection concepts appear to have identical effects to Chatfield State Park, the riparian and wetland resources at Marcy Gulch, Section 4(f) and riparian resources at the High Line Canal, and the wetlands, riparian and 4(f) resources at Spring Gulch. ▪ At Town Center Drive, the CFI requires larger partial acquisitions from the three commercial properties in the northeast quadrant of the interchange than the conventional intersection concept. The additional partial acquisition areas are minimal and slightly larger than the partial acquisitions documented in the FEIS. ▪ At Highlands Ranch Parkway, the CFI requires larger partial acquisitions from the open space property in the immediate northeast quadrant of the interchange, and from the property used as a church immediately north of that property, than the conventional intersection concept. The additional partial acquisition areas are minimal and slightly larger than the partial acquisitions documented in the FEIS. ▪ The CFI requires reconfiguring the Highland Ranch Metro District trail, which is protected by Section 4(f). This could likely be covered as a temporary occupancy of the trail, which is not a Section 4(f) use. The CFI also moves travel lanes closer to residential areas. The primary advantage of the CFI at Highlands Ranch Parkway is that it is less congested, so has fewer AQ impacts for the pollutants that are associated with congestion. It also can process more traffic (7500 vehicles per hour compared to approximately 6000 with a conventional intersection.

INTERSECTION REFINEMENT OPTIONS

HIGHLANDS RANCH PKWY TO C-470 PROJECT

DRAFT (12/9/15)

Evaluation Criteria	Conventional Signalized Intersection	Continuous Flow Intersection (CFI)
Implementation 1. Capital cost 2. Operation/maintenance costs 3. Institutional challenges (CDOT approvals, USACE, etc.) 4. Value of investment considering life-cycle costs (e.g., MOT, phasing, minimize “throw-away” costs) 5. Impacts of access changes on property owners 6. Public education and acceptance of intersection use and functionality 7. Right-of-Way Impacts	1. Anticipated to be the least capital investment compared to the CFI. 2. Typical Operations and maintenance. 3. None anticipated 4. Reduced life-cycle and capacity compared to the CFI configuration 5. All Access remains as described in the Access Management Plan with the following exceptions: a) Grace Presbyterian Church is converted from a full-movement to RI/RO b) Brandon Dr. Carder Ct. and Norwood Dr. are converted to RI/RO c) Existing full-movement Intersections spacing: i) HRP to Brandon = 2000’ (0.38 mile) ii) Brandon to Town Center = 1460’ (0.28 mile) iii) Town Center to Carder = 1095’ (0.21 mile) iv) Carder to Norwood = 1688’ (0.32 mile) d) Colorado State Parks RI Access just north of Blakeland Drive is eliminated 6. Conventional signalized intersections are familiar and no education for acceptance is anticipated.	1. CFI is estimated to be a 6% increase in cost over conventional signalized intersection at approx. $700k. 2. Operations: a) Additional traffic signal equipment is required to operate and maintain. b) Snow removal requires extra planning but minimal extra effort. 3. CFI is unfamiliar to community. 4. Life cycle is much improved over the conventional signal. Additional 30% capacity will significantly extend the life of this configuration. 5. All access is the same as the revised Conventional Signalized Intersection, except Grace Presbyterian Church / Spring Gulch Equestrian Area which has a southbound left turn entry provided 6. Public Involvement and communication of why a CFI is needed; what to expect during and after construction.
Community Values ▪ Communities/agencies support ▪ Out-of-direction travel	▪ Conventional signalized intersections are familiar and no education for support is anticipated. ▪ Some out of direction travel is anticipated where existing full movement access points will change to right-in-right-out (e.g., Carder Ct., Norwood, Brandon).	▪ Outreach to agencies is required to garner support. ▪ Some out of direction travel is anticipated where existing full movement access points will change to right-in-right-out (Carder Ct., Norwood, Brandon)
Multi-Modal 1. Shared-use Path 2. Bus Stops 3. Pedestrian Comfort	▪ Pedestrian Crossing is provided but crossing a highway as large as US 85 won’t be pleasant. All four legs can be crossed.	1. Shared-use Path is the same except around the CFI intersection area. 2. RTD’s preferred bus stop location is along HRP just before US85 and this location is anticipated to have impacts to 4(f) property. If shifted back onto US85 where it currently exists, careful consideration should be applied so that there is not an interference with the HRP WB to NB movement onto US85. 3. Pedestrian Comfort a) There is a more regional movement that crosses north/south on the east side of the HRP intersection. 4. Pedestrian Crossing is provided but crossing a highway as large as US 85 won’t be pleasant. All four legs can be crossed. Crossing distance is reduced for the east and north legs.

Appendix E.
Traffic Volumes

For each approach movement at the intersection, Level of Service (LOS) is defined as the average stopped delay per vehicle. Intersection LOS is defined as the average total vehicle delay for all movements through an intersection and may be calculated from movement delay using the following formula:

$$\frac{\sum(vehicles\ by\ movement * movement\ delay)}{total\ vehicles}$$

Air quality hot-spot analysis is warranted where an individual intersection performs at LOS D or worse. For comparison of alternatives, traffic operations analysis considers the cumulative delay of both the crossover and main intersection components of the Continuous Flow Intersection (CFI). Intersection LOS presented in the *Transportation Technical Report, US 85 Corridor Improvements, Highlands Ranch Parkway to C-470 Reevaluation* (HDR 2016) is total CFI LOS, not individual intersection LOS; therefore there is a discrepancy between the way in which results are discussed within the *Air Quality Technical Report* (HDR 2016) and the *Transportation Technical Report* (HDR 2016).

Table 1 presents the 2040 AM Peak Hour VISSIM Signalized Intersection LOS Results for each approach movement and the intersection as a whole. Table 2 presents the 2040 PM Peak Hour VISSIM Signalized Intersection LOS Results for US 85 and Blakeland Drive and an example of how the formula was used to derive the intersection LOS at the US 85/Blakeland Drive intersection.

Table 1. 2040 AM Peak Hour—VISSIM Signalized Intersection Results

2040 AM Peak Hour - VISSIM Signalized Intersection Results

Intersection	Movement	Volume (veh/h)	Vehicle Delay (s)	LOS
US85 / Blakeland Drive	SBL	0	0.0	A
	SBT	3076	4.0	A
	SBR	222	4.8	A
	EBL	117	81.3	F
	EBT	0	0.0	A
	EBR	135	7.3	A
	NBL	128	95.2	F
	NBT	490	9.0	A
	NBT (to C-470)	1074	47.4	D
	NBR	0	0.0	A
	WBL	0	0.0	A
	WBT	0	0.0	A
	WBR	0	0.0	A
	INTERSECTION	**5242**	**17.1**	**B**
US85 / Town Center Drive CFI Crossover	CFI NB	4031	3.7	A
	CFI SB	651	77.5	E
	INTERSECTION	**4682**	**14.0**	**B**
US85 / Town Center Drive Main Intersection	SBL	651	13.5	B
	SBT	2294	17.6	B
	SBR	61	5.8	A
	EBL	38	74.6	E
	EBT	31	82.1	F
	EBR	55	12.4	B
	NBL	77	136.9	F
	NBT	3535	32.8	C
	NBR	613	9.0	A
	WBL	435	68.2	E
	WBT	39	63.8	E
	WBR	459	1.7	A
	INTERSECTION	**8288**	**26.6**	**C**
Total US85 / Town Center Drive Crossover plus Main Intersection	**COMBINED**		**40.6**	**D**
US85 / Highlands Ranch Parkway CFI Crossover	CFI NB	4226	2.5	A
	CFI SB	447	73.7	E
	INTERSECTION	**4673**	**9.3**	**A**
US85 / Highlands Ranch Parkway Main Intersection	SBL	447	2.6	A
	SBT	2073	20.5	C
	SBR	40	3.2	A
	EBL	198	74.4	E
	EBT	19	71.1	E
	EBR	20	6.3	A
	NBL	60	147.8	F
	NBT	3257	28.2	C
	NBR	336	15.3	B
	WBL	268	104.6	F
	WBT	27	109.9	F
	WBR	774	3.0	A
	INTERSECTION	**7519**	**26.5**	**C**
Total US85 / Highlands Ranch Parkway Crossover plus Main Intersection	**COMBINED**		**35.8**	**D**

Final Design 3-lane NB @ HRP - 10 Model Runs

Table 2. 2040 PM Peak Hour—VISSIM Signalized Intersection Results (US 85/Blakeland Drive) and Mathematical Derivation

2040 PM Peak Hour—VISSIM Signalized Intersection Results

Intersection	Movement	Volume (veh/h)	Vehicle Delay (s)	LOS
US85 / Blakeland Drive	SBL	0	0.0	A
	SBT	3443	4.0	A
	SBR	114	4.7	A
	EBL	163	81.0	F
	EBT	0	0.0	A
	EBR	179	8.1	A
	NBL	169	96.5	F
	NBT	2703	7.0	A
	NBT (to C-470)	895	36.2	D
	NBR	0	0.0	A
	WBL	0	0.0	A
	WBT	0	0.0	A
	WBR	0	0.0	A
	INTERSECTION	**7666**	**12.6**	**B**

Mathematic Derivation

US85 / Blakeland Drive	Movement	Traffic Volume		Per Vehicle Delay		Total Delay (seconds)
Formula	SBL	0	x	0.0	=	0
	SBT	3443	x	4.0	=	13806.43
	SBR	114	x	4.7	=	532.38
	EBL	163	x	81.0	=	13203
	EBT	0	x	0.0	=	0
	EBR	179	x	8.1	=	1446.32
	NBL	169	x	96.5	=	16308.5
	NBT	2703	x	7.0	=	18812.88
	NBT (to C-470)	895	x	36.2	=	32399
	NBR	0	x	0.0	=	0
	WBL	0	x	0.0	=	0
	WBT	0	x	0.0	=	0
	WBR	0	x	0.0	=	0
Total	**INTERSECTION**	**7666**				**96508.51**
Average Delay =		**Total Delay**	**/**	**Total Traffic Volume**	=	**12.58916123**