Engineering Summary Report

FM 1960 Access Management Study

Houston, Texas

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1 EXECUTIVE SUMMARY

Farm-To-Market Road 1960 (FM 1960) is a major urban arterial maintained by the Texas Department of Transportation (TxDOT) that spans east-west across Harris and Liberty Counties in Texas. The project study area includes an 11-mile segment of the corridor from East Gatewick to Business FM 1960A (BF 1960A). The corridor currently experiences recurring congestion during weekday and weekend peak periods due to bottlenecks at several critical signalized intersections as well as from off-corridor congestion and queues that spill back into the study area. The corridor also features a continuous two-way left-turn lane (TWLTL) throughout and a high density of driveways along certain segments, which contribute to a high number of conflict points and potential for crashes to occur. For the corridor, left turn and angle crashes accounted for 34 percent of all segment crashes from 2015 to 2017, indicating safety issues with existing access connections. TxDOT conducted the FM 1960 Access Management Study to assess the operational and safety needs of the corridor, and to identify short-, medium-, and long-range improvements that aim to improve safety and mobility, enhance multi-modal access, and support existing and future development.

An existing traffic operations analysis was conducted using calibrated microsimulation VISSIM models. Calibrated models were developed for the AM, PM, and Saturday peak hours using the collected traffic volumes, travel times, and peak hour queue and congestion observations to ensure that the models effectively replicated field conditions.

Safety and operational needs of the corridor were identified through traffic and safety analyses of existing conditions and an extensive public-involvement process. Identified corridor issues and improvement needs are summarized below:

- Weekday and weekend peak-period congestion along the corridor.
- Lane utilization issues near I-69.
- Higher-than-posted travel speeds along the corridor.
- Safety concerns associated with the TWLTL and closely spaced driveways.
- Lack of continuous bicycle and pedestrian facilities.
- Rear-end and angle crashes along segments and at intersections.
- Localized congestion near the Deerbook Mall from on- and off-corridor traffic.
- Localized congestion near Treaschwig Road, Lee Road, and I-69 frontage road intersections.

The following short-range, medium-range, and long-range improvements were developed to address identified needs of the corridor.

- Short-range improvements include replacement of the existing continuous TWLTL with a raised median to reduce conflict points along the corridor. Additional short-range improvements include signal equipment upgrades and timing optimization, signing and striping enhancements, buffered bike lanes and improved delineation through intersections, sidewalk installation in high-pedestrian areas, intersection turn-lane and storage-length improvements, continuous-lighting installation, and Intelligent Transportation Systems (ITS) incorporation to enhance and maximize operational benefits.

- Medium-range improvements include driveway consolidation to reduce conflict points and improvements to side-street approaches that require right-of-way. These are considered medium-range improvements as they involve coordination with local agencies and property owners prior to implementation.
- Long-range improvements include significant infrastructure upgrades that are either high cost, require substantial right-of-way, or need further study. Proposed long-range improvements include innovative intersection and interchange concepts at Lee Road and I-69 frontage road intersections to address major capacity needs, a connector road between Deerbrook Mall and Townsen Boulevard West, and external network improvements that benefit operations along FM 1960 such as capacity improvements at the interchange of BF 1960A and I-69 frontage roads.

It is anticipated that short-range improvements can be implemented within 5 years, medium-range improvements within 5 to 10 years, and long-range improvements within 10 or more years. Estimated construction costs are approximately $36.5 million for short-range improvements and approximately $52.5 million combined for medium-range and long-range improvements.

Operational benefits of proposed short-range improvements were quantified using travel time results from VISSIM models. For all build VISSIM models, signal timings were optimized in Synchro prior to being imported into VISSIM. Safety benefits of proposed improvements were quantified by applying the Federal Highway Administration's (FHWA's) Highway Safety Manual methodology. Monetary benefits of proposed improvements were calculated using the Texas Transportation Institute's (TTI's) 2019 road-user cost estimates and FHWA's 2018 Crash Costs for Highway Safety Analysis. Proposed short-range improvements are expected to result in a 19 percent reduction in total crashes per year and an 8 percent reduction in travel times, which equates to savings of approximately $20 million per year ($17.7 million in safety benefits and $2.2 million in operational benefits).

2 INTRODUCTION

2.1 Project Purpose

The purpose of the study is to assess the operational and safety needs of FM 1960 from East Gatewick to BF 1960A (the corridor) and to identify short-, medium-, and long-range improvements to reduce crashes, alleviate traffic congestion, improve traffic flow, enhance multi-modal access, and improve access for existing and future development. Proposed improvements are divided into short-range (0 to 5 years), medium-range (5 to 10 years), and long-range (10+years) categories to expedite the implementation of low-cost and high-impact short-range improvements and maximize project benefits over time. Improvement strategies also focus on enhancing safety and connectivity for pedestrians and bicyclists along segments of the corridor that warrant such consideration. A summary of the study purpose is provided as Figure 1.

Figure 1: Study Purpose

2.2 Study Goals

The overall goal of the study is to develop a plan that identifies short- to medium-term solutions to improve traffic safety and mobility while providing more travel choices to the public. The plan will also offer opportunities to enhance and streamline business access in order to preserve and enhance economic development in the area and will engage the public and relevant stakeholders throughout the study duration to shape the solutions with their input. Study goals are provided in summary as Figure 2.

Figure 2: Study Goals

2.3 Study Area

The project study area includes an 11-mile segment of FM 1960 from East Gatewick (just east of I-45) to BF 1960A (on the east side of the city of Humble) in Harris County. The segment from East Gatewick to Hardy Toll Road has nine 12-foot lanes across FM 1960, a 14-foot continuous TWLTL, and 10-foot shoulders on either side of FM 1960. The segment from Hardy Toll Road to BF 1960A has seven 12-foot lanes across FM 1960, a 17-foot continuous TWLTL, and 10-foot shoulders on either side of FM 1960. A total of 27 signalized intersections located within the project limits are being evaluated for the purpose of this study. The posted speed limit along the corridor is 55 mph from East Gatewick to Lee Road, 50 mph from Lee Road to Mall Entrance (Ent) 2, 35 mph from Mall Ent 2 across I-69, and 50 mph to the east of I-69 up to BF 1960A. The study area is illustrated on Figure 3.

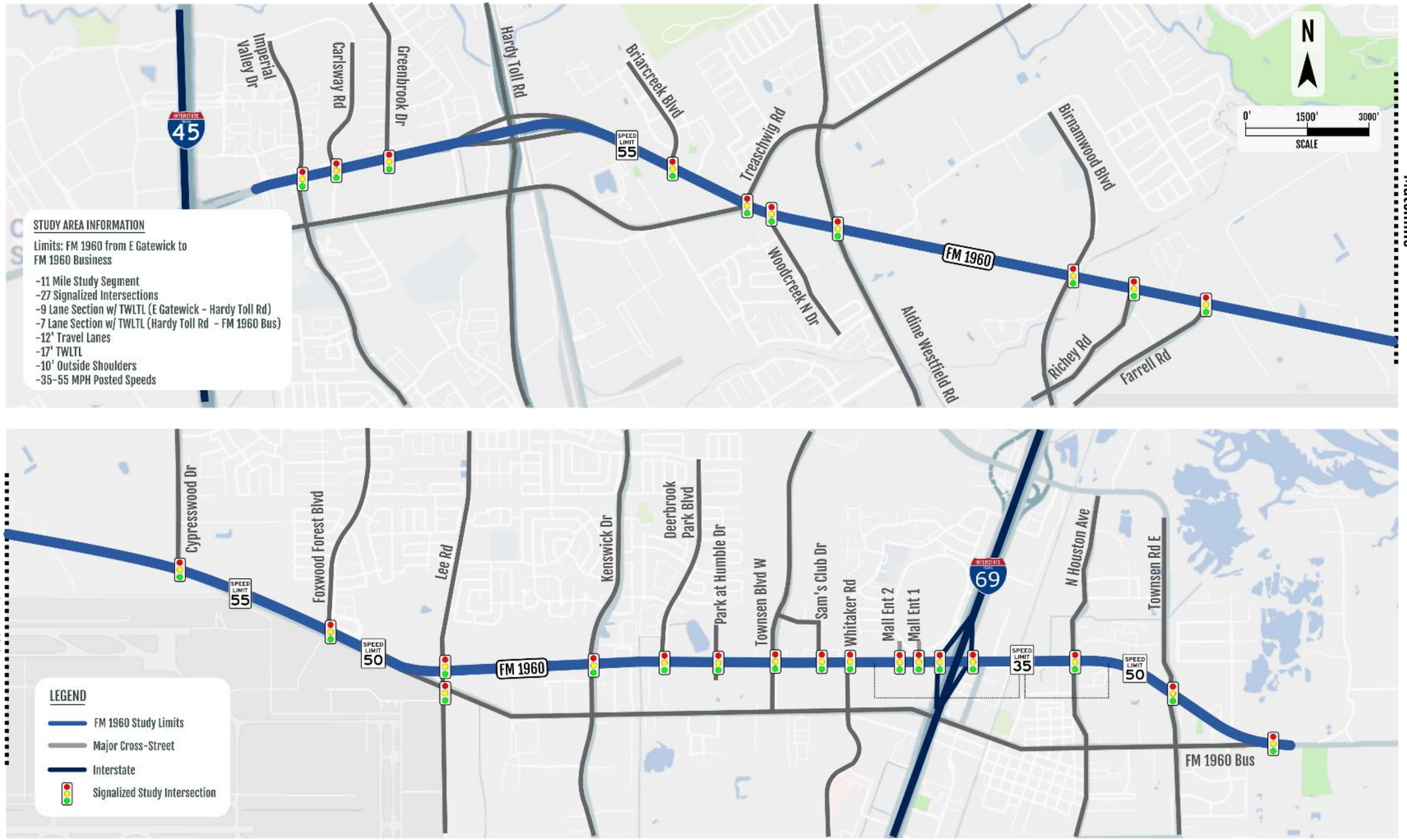


Figure 3: Study Area Map

2.4 Study Methodology

The study methodology for the project is presented in relation to the four main project tasks: Assembly & Review of Data, Evaluation of Existing Corridor, Analysis of Short-, Medium-, and Long-Range Solutions, and Development of Study Documentation. A detailed description of the study methodology for each task is provided in the previously submitted Study Methodology Memo, which is included as Appendix A to this report. A detailed description of project administration and project management plans is provided in a previously submitted Project Management Plan, which is included as Appendix B to this report.

The public and stakeholders were engaged throughout the study duration to obtain input and guide the development of improvement alternatives. A detailed description of public- and agency-involvement strategies and activities is provided in the previously submitted Public Involvement Plan, which is included as Appendix C to this report. A summary of study methodology is provided in Figure 4.

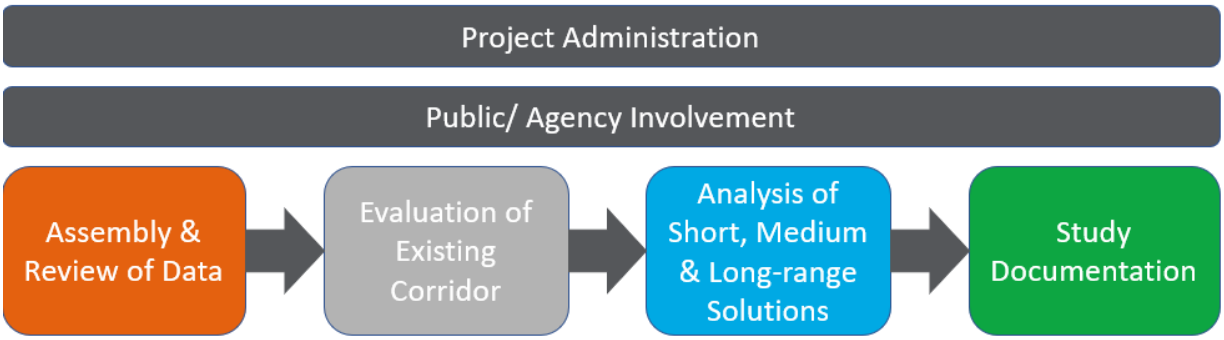


Figure 4: Study Methodology

3 EXISTING ROADWAY CHARACTERISTICS

3.1 Existing Typical Sections

The FM 1960 corridor is comprised of two district typical sections as shown on Figure 5. Typical Section 1 represents a 2-mile segment between East Gatewick and Treaschwig Road. This segment includes four 12-foot travel lanes in each direction, a continuous 14-foot TWLTL in the middle, and 5-foot bike lanes and 5-foot sidewalks in each direction. Typical Section 2 represents the remainder of the corridor, an approximately 9-mile segment between Treaschwig Road and BF 1960A. This segment includes three 12-foot travel lanes in each direction, a continuous 17-foot TWLTL in the middle, and 10-foot shared-use shoulders in each direction.

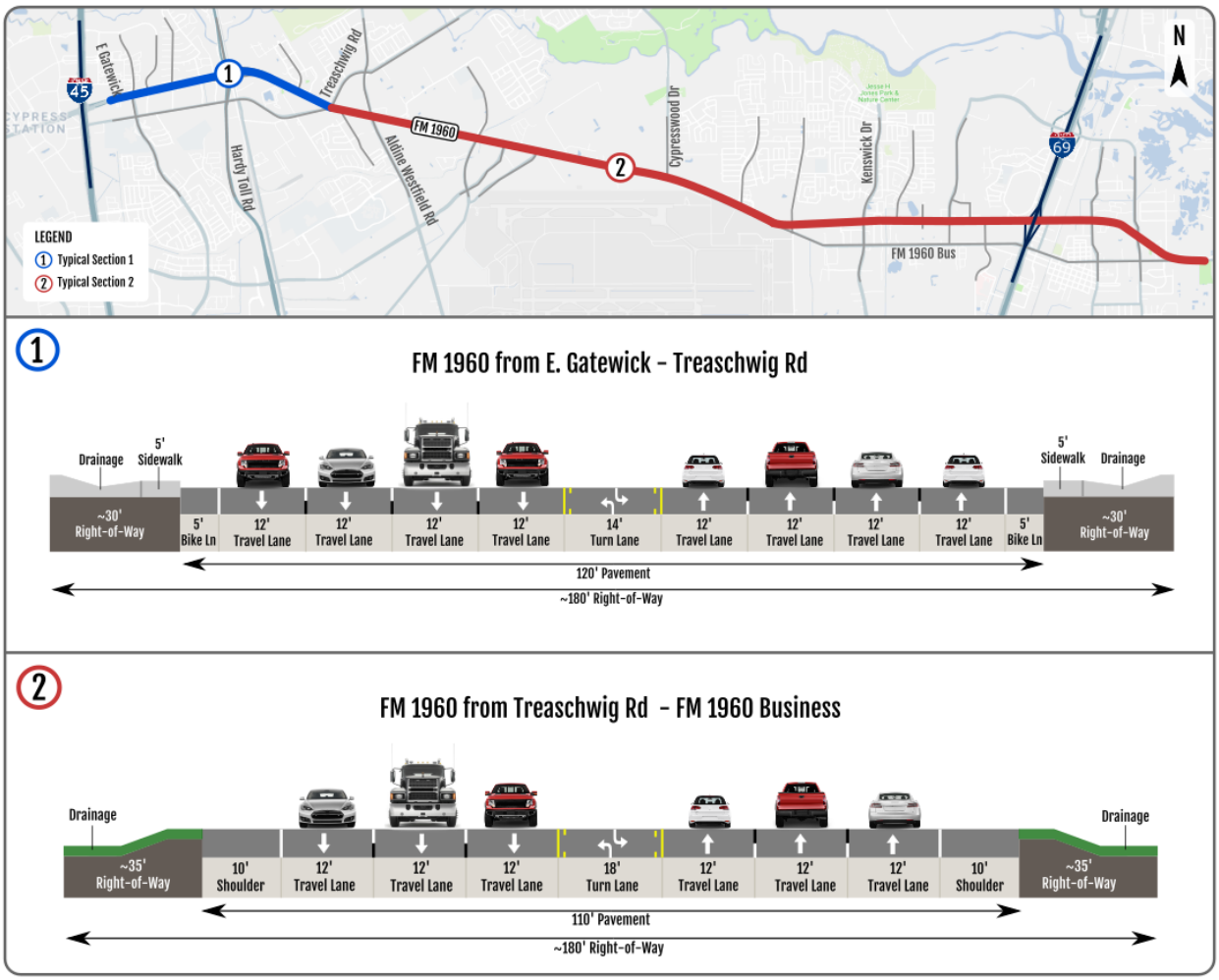


Figure 5: FM 1960 Existing Typical Sections

3.2 Land Use

3.2.1 Existing Land Use

Houston Galveston Area Council (H-GAC) maintains a detailed database of existing and proposed land use within the Houston-Galveston region. Land-use data within a 1-mile radius of the corridor were collected and evaluated to identify population, employment, and growth trends along the corridor. Understanding these trends helps with the development of corridor improvements that complement existing and future land use. As illustrated on Figure 6, FM 1960 is surrounded by various land-use types, with the majority of parcels falling into Commercial (42.4 percent) or Residential (12.7 percent) land-use classifications. There is a large area of undevelopable land (9.6 percent) in the vicinity of the George Bush Intercontinental Airport, which is located near the midpoint of the project limits.

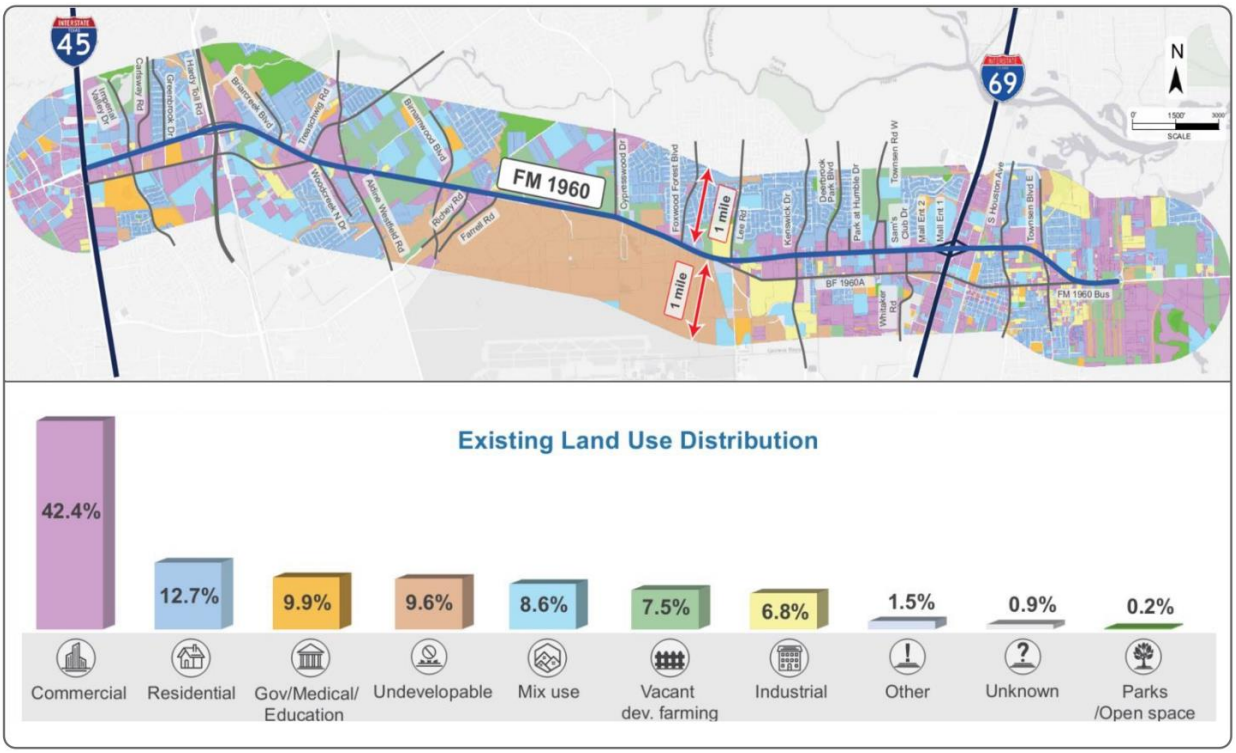


Figure 6: Existing Land-Use Distribution

3.2.2 Announced Land-Use Changes

A review of H-GAC-announced land-use changes (Figure 7) showed that several existing commercial parcels on the west side of the corridor are being reclassified as Industrial. Additionally, a large industrial parcel near Lee Road is being reclassified as Mix Use. Land-use changes for parcels not directly adjacent to FM 1960 were also noted. Most land-use changes include reclassifying parcels to Commercial, Residential, or Mix Use.

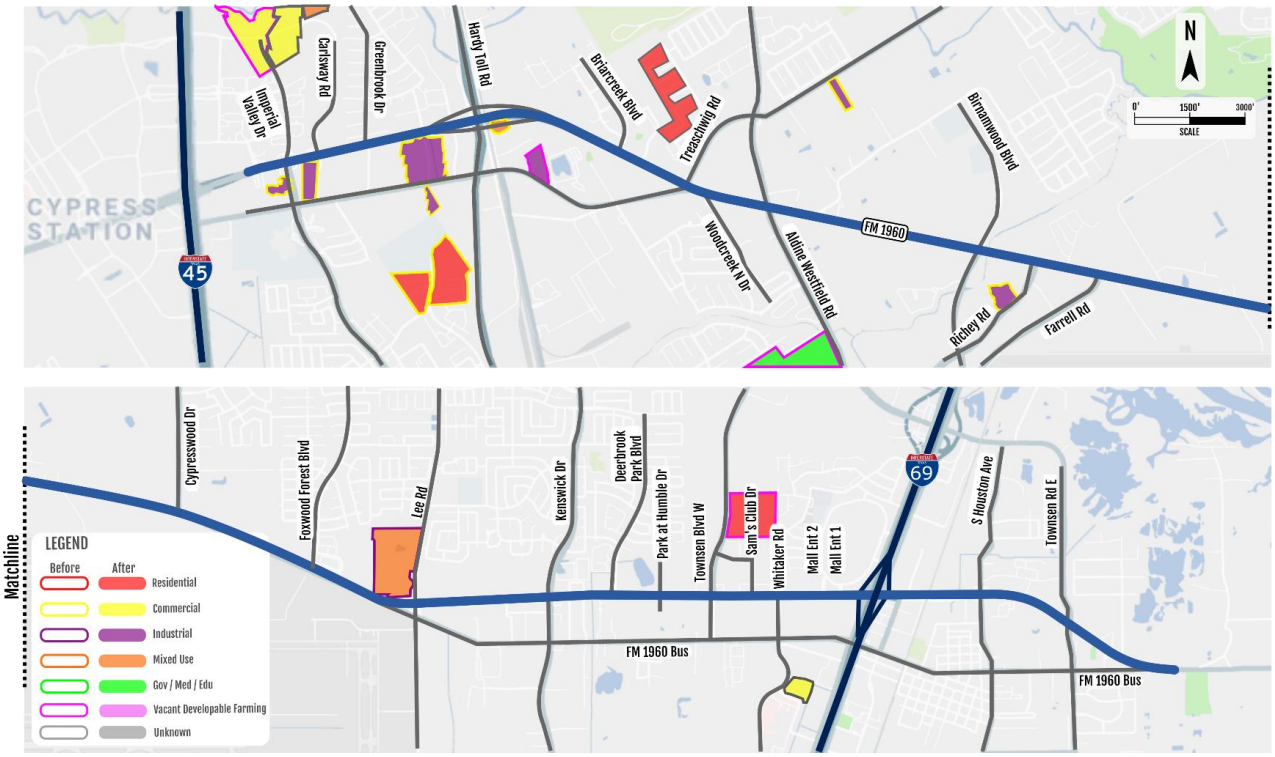


Figure 7: Announced Land-Use Changes

3.3 Multi-Modal Facilities

An overview of multi-model facilities along FM 1960 is provided on Figure 8. Transit service is available along FM 1960 from East Gatewick to Aldine Westfield Road, which includes several bus routes and a park-n-ride facility to the south of the corridor near Carlsway Road. There are currently no transit stops or service along FM 1960 between Aldine Westfield Road and BF 1960A.

As shown on Figure 8, most signalized intersections along FM 1960 have pedestrian accommodations, including pedestrian signals, crosswalks, and Americans with Disabilities Act (ADA) curb ramps. However, there are six intersections located along the east side of the corridor that do not have pedestrian signal heads. Similar to transit services, existing bike lanes and sidewalks are concentrated on the west side of the corridor between East Gatewick and Aldine Westfield Road.

To better understand bicycle activity and determine the need for bicycle facilities, Strava Metro data from Year 2018 were evaluated. Annual cyclist counts for segments of the corridor are shown on Figure 9. It is important to note that these data only represent cyclists using the app, and therefore, these data only represent a sample of the population of cyclists. Results show that the highest concentration of bicycle activity occurs between Cypresswood Drive and Park at Humble Driveway.

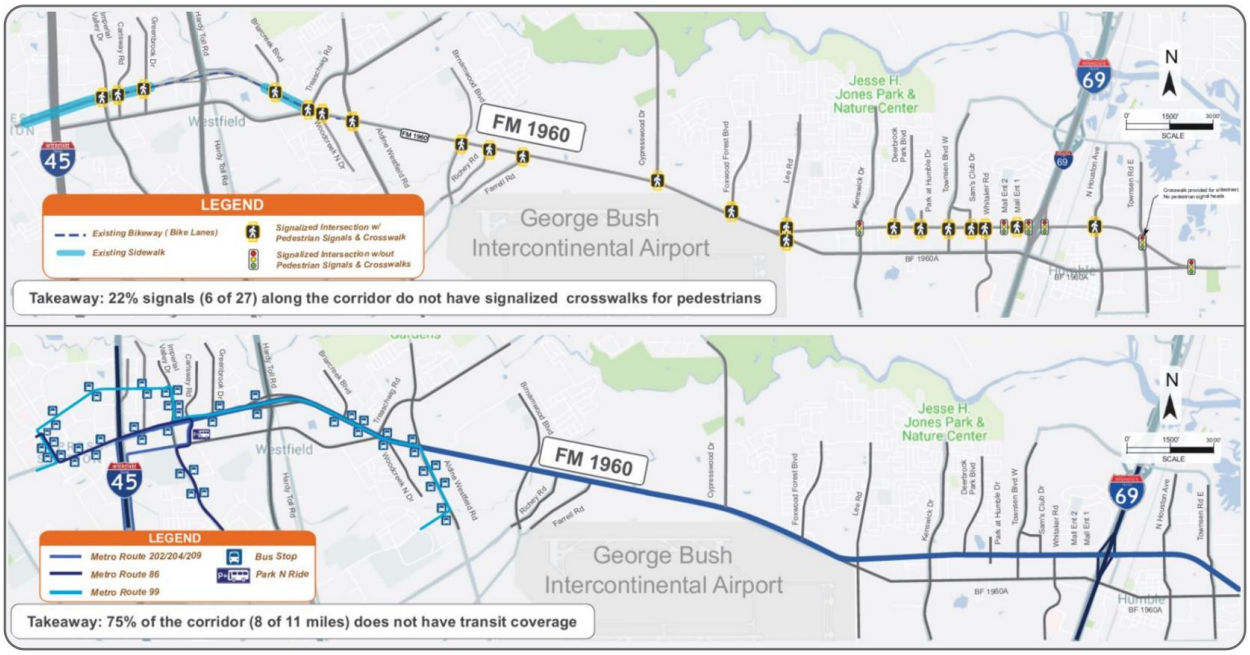


Figure 8: Existing Multi-Modal Network

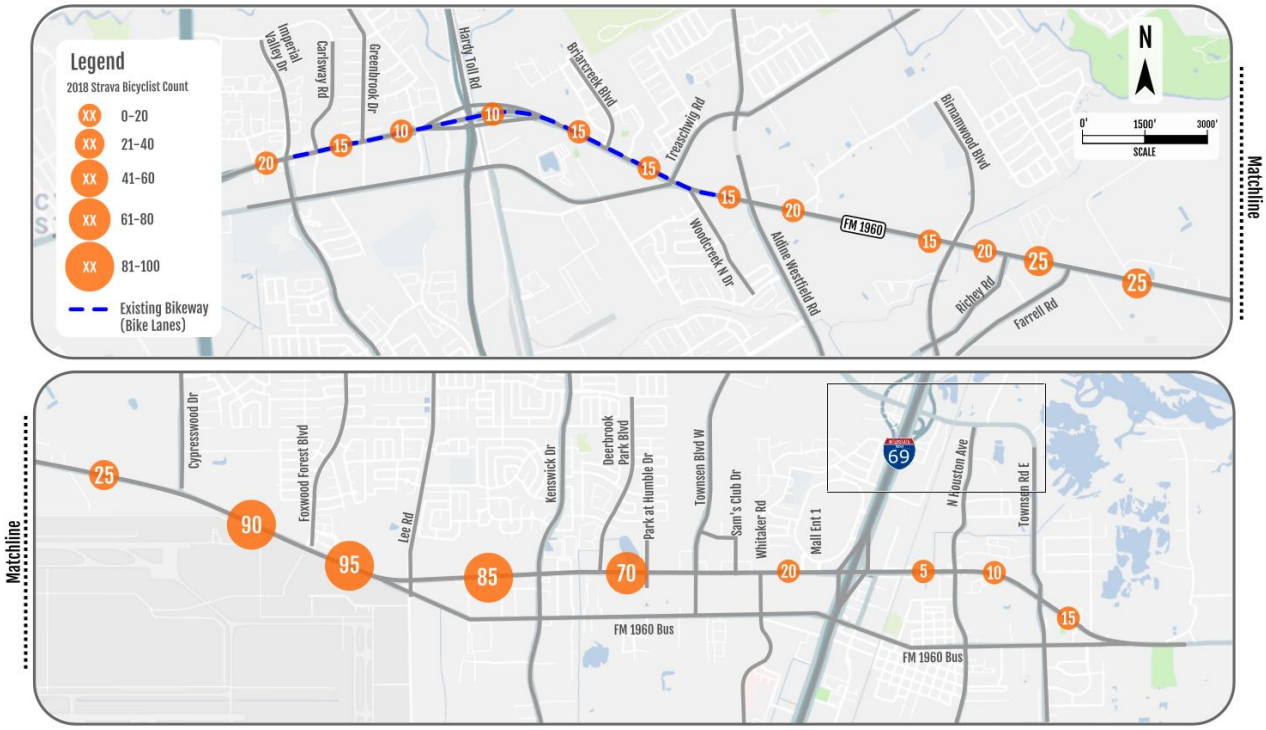


Figure 9: Cyclist Concentration Map

3.4 Access Point Density

An inventory of existing driveway and intersection access points was developed based on aerial imagery and confirmed through field verification. Based on the inventory data, access point density (the number of access points per mile) was calculated for distinct segments of the corridor as illustrated on Figure 10. The corridor access point density varies from seven access points per mile (Birnamwood Boulevard to Richey Road) to 60 access points per mile (Briarcreek Boulevard to Treaschwig Road).

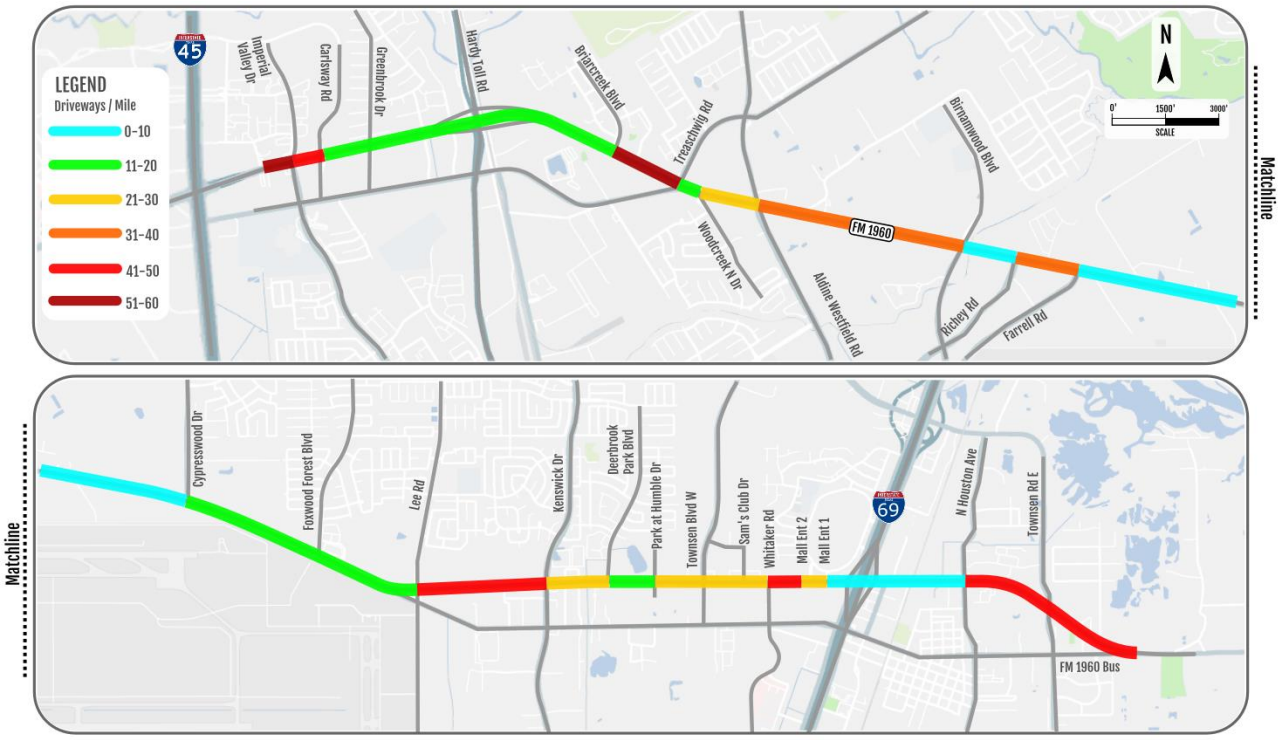


Figure 10: Driveway Density per Mile

3.5 Future Planned Projects

Future planned projects along the FM 1960 study corridor and along FM 1960 segments adjacent to the study corridor are detailed on Figure 11. The planned improvements along the study corridor include traffic signal upgrades and access management improvements. Planned improvements along FM 1960 to the study corridor (west of I-45) include ITS improvements such as the installation of fiber optic cable, closed-circuit television (CCTV) cameras, and dynamic message signs (DMS). Planned improvements along FM 1960 to the east of the study corridor (east of BF 1960A) include widening of FM 1960 to six lanes with a median divider. Additionally, TxDOT has plans to add high-occupancy vehicle (HOV) lanes along I-69, which may influence future travel patterns. Future planned projects were considered during the development of access management improvements to ensure consistency with those infrastructure upgrades.

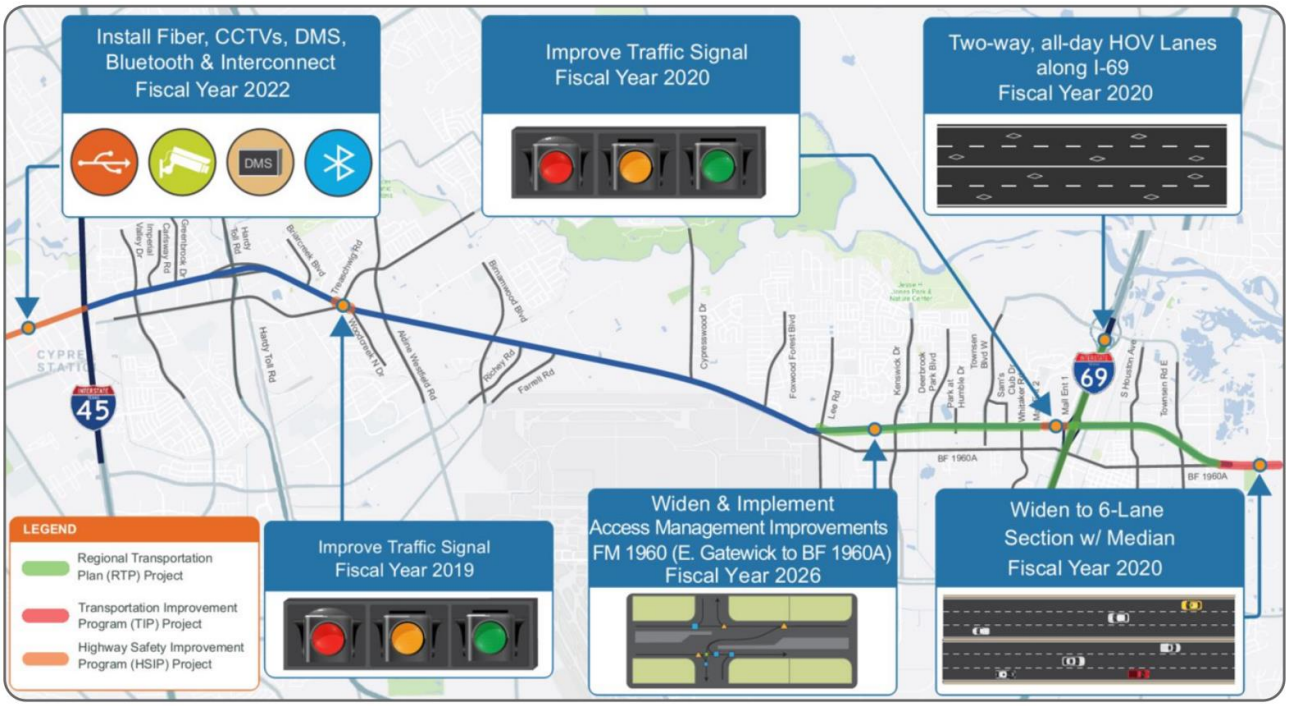


Figure 11: Future Planned Projects

4 TRAFFIC CHARACTERISTICS

4.1 Existing Traffic Volumes

A significant amount of volume data, including 7-day 24-hour tube counts, 24-hour classification counts (weekday and Saturday), and 2-hour turning movement counts (TMCs; AM, PM, and Saturday), were collected along the study corridor to support the traffic operations analysis. TMCs for intersections from Lee Road to BF 1960A were not included as part of the data collection for this study because TMCs for these intersections were available from a signal timing study conducted in 2017. Additionally, 24-hour counts from the previous signal timing study were obtained for use in this study.

Existing-Year (2019) Turning Movement Counts

The existing conditions 24-hour tube counts, classification counts, TMCs, and queue observations were utilized to develop the existing conditions demand volumes for the AM, PM, and Saturday peaks. The tube and classification counts were initially used to determine the durations over which TMCs were collected. Later, the tube and classification counts were compared with TMCs to assess the TMC accuracy and balancing strategy. The AM, PM, and Saturday peak-period TMCs along the corridor were analyzed to determine the peak-hour volumes during those peaks. Historical average annual daily traffic (AADT; 2013 to 2017), H-GAC travel demand model (TDM) projections (2017 to 2021), and historical (September 2017) and current (2019) annual daily traffic were compared to assess potential corridor volume growth over 2 years from 2017 to 2019. The TMCs from 2017 between Lee Road and BF 1960A were adjusted based on a factor developed from this comparison. The TMCs were then balanced along the corridor to develop the peak-hour model inputs for the traffic analysis. The balanced AM, PM, and Saturday TMCs are provided in volume diagrams under Appendix D.

A review of existing year TMCs and field observations during weekday and weekend peak periods showed that several intersections along the corridor currently experience high traffic volumes, resulting in congestion and queues near those intersections. Figure 12 shows the high volume intersections and roadway segments that experience recuring congestion and queues during one or more peak periods. During AM peak period, sever congestion and queues occur along mainline and side street approaches of Treaschwig Road, Aldine Westfield Road, and Lee Road intersections. During PM peak period, severe congestion and queues occur along FM 1960 between Lee Road and Kenswick Drive, and between Townsen Boulevard West and North Houston Avenue. PM peak period congestion and queues also occur along FM 1960 near Cypresswood Dr and Imperial Valley Dr, and along side-street approaches to Kenswick Drive, Townsen Boulevard West, and Townsen Road intersections. During the Saturday peak period, congestion occurs along FM 1960 primarily between Townsen Boulevard West and North Houston Avenue.

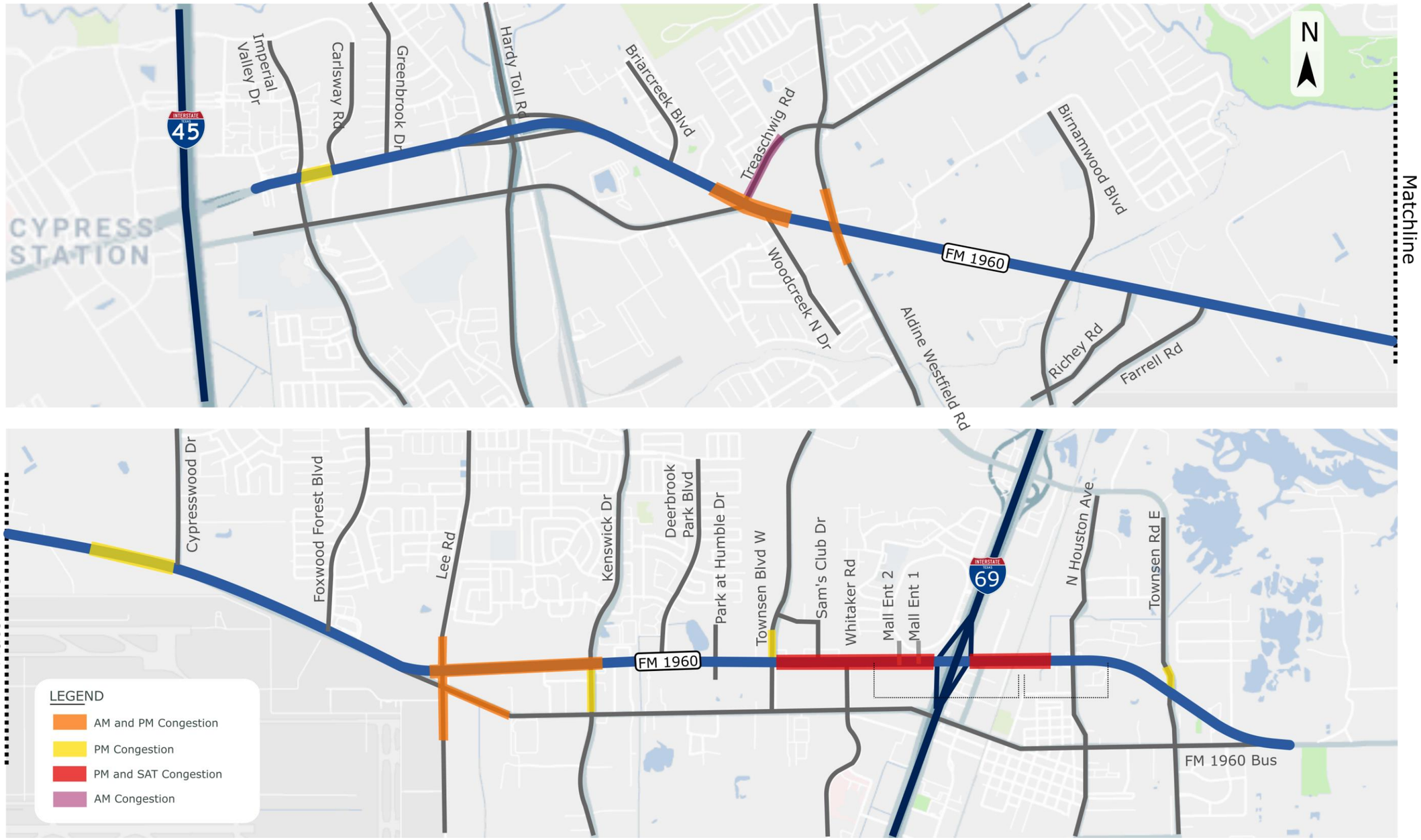


Figure 12: Existing Congestion and Bottlenecks during the AM, PM, and Saturday Peak Periods

4.2 Origin-Destination Analysis

Origin-destination (O-D) data for the project were gathered from 10 Bluetooth devices deployed along FM 1960 between Foxwood Forest Boulevard and BF 1960A to identify travel patterns in the most congested areas of the corridor. Results of the O-D study are provided on Figure 13 for the combined trends that cover AM, PM, and Saturday peak periods. The O-D results for AM, PM, and Saturday periods were similar; therefore, trip percentages on the figure represent all peak periods.

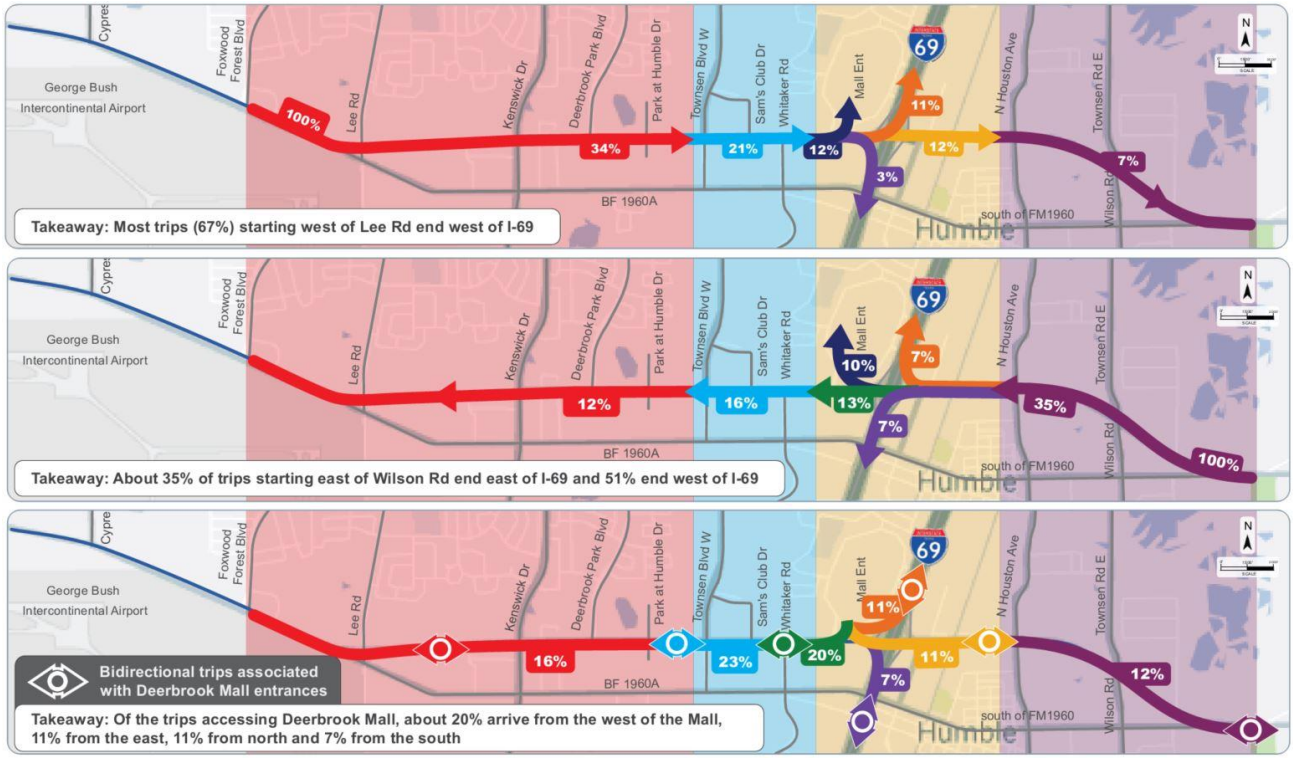


Figure 13: Origin-Destination Travel Patterns

4.3 Growth Rate Determination

Average annual growth rates for the corridor were estimated using the historical traffic count data and the H-GAC TDM. Historical growth rates were calculated using a linear regression analysis of historical counts obtained from permanent count stations located along the corridor. Model growth rates were calculated by comparing daily link flows between 2017 and 2025 TDMs at locations similar to the permanent count station locations. Unique historical and model growth rates were calculated and averaged for three distinct segments of the corridor to capture varying degrees of growth and development. Recommended average annual growth rates for the three roadway segments are presented in Table 1.

Table 1: Recommended Average Annual Growth Rates

FM 1960 Roadway Segment	Historical Growth Rate	TDM Growth Rate	Recommended Growth Rate
East Gatewick to Aldine Westfield Road	3.1%	2.0%	2.6%
Aldine Westfield Road to I-69	3.2%	1.3%	2.2%
I-69 to BF 1960A	3.8%	4.0%	3.9%

TDM = Travel demand model.

Year 2024 Turning Movement Counts

As mentioned previously, it takes up to 5 years for the short-range improvements to be implemented. To ensure the study's short-range improvements will perform adequately when implemented, 5-year-horizon TMCs for year 2024 were developed. The purpose of developing future year volumes is to estimate future travel demand within the study area, evaluate the operational performance of short-range improvements, and determine if additional improvements are needed to achieve acceptable operations in the implementation year.

The AM, PM, and Saturday peak-hour TMCs for Year 2024 were developed by applying the average annual growth rates determined under Section 4.3 to the existing-year (2019) AM, PM, and Saturday peak-hour TMCs, respectively. Because unique growth rates were applied to distinct segments of the corridor, volume balancing was performed between segments to achieve a balanced network. Balanced peak-hour TMCs for year 2024 are provided in Appendix E.

4.4 Historical Crash Analysis

A safety analysis of the FM 1960 study corridor was performed based on the latest 3-year (2015 to 2017) historical crash data obtained from TxDOT's Crash Records Information System database. Crash data for all segments and intersections along the corridor were collected and analyzed. A summary of the safety analysis results is provided below, and the detailed Safety Analysis Report is provided in Appendix F.

Figure 14 illustrates an overview of the 3-year crash history for the corridor along segments and intersections. A total of 2,909 crashes occurred within the study limits, with 1,883 crashes (65 percent) attributed to roadway segments and 1,026 crashes (35 percent) attributed to intersections. There have been 17 crashes (less than 1 percent) resulting in fatalities over the 3-year period.

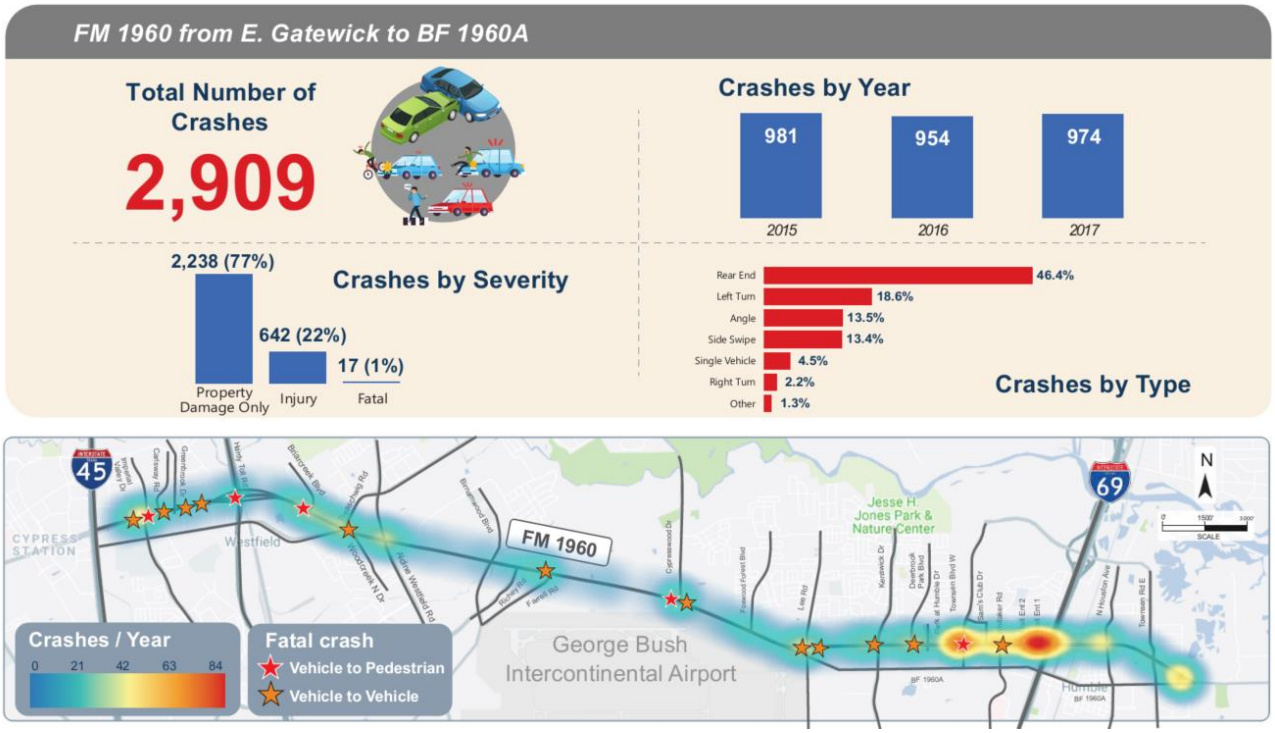
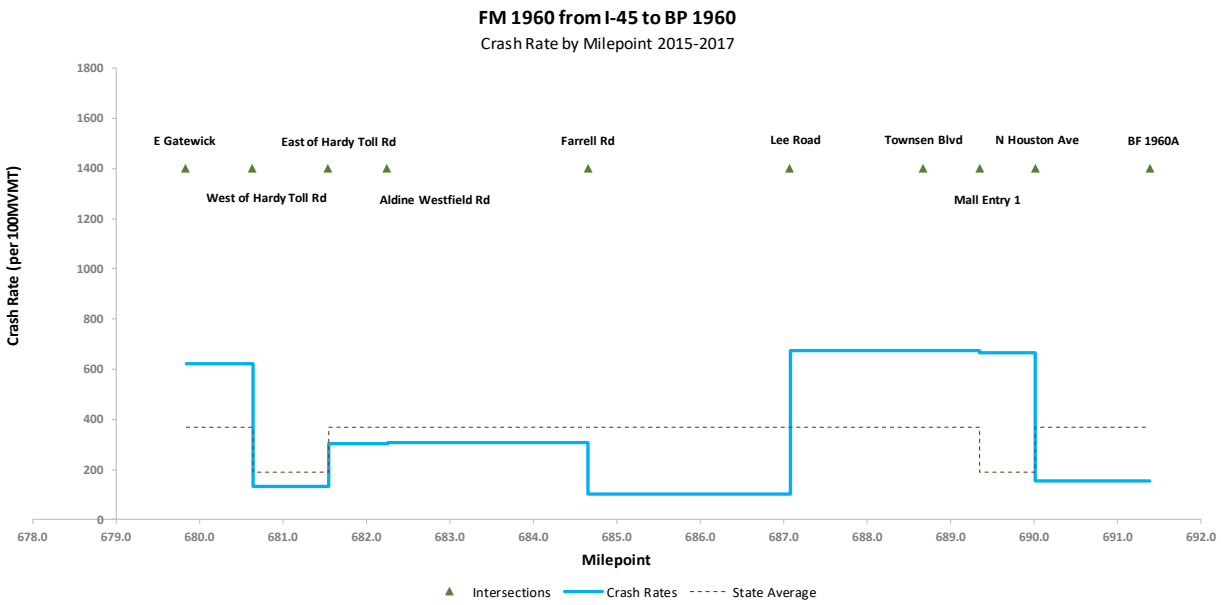


Figure 14: Corridor-Level Crash Summary (2015-2017)

4.4.1 Segment Crashes

A total of 1,883 segment-related crashes were reported along the corridor during the 3-year analysis period (2015 to 2017). Of the 1,883 segment crashes, rear-end crashes were the predominant crash type on roadway segments and accounted for 40 percent of the crashes. Additionally, left-turn and angle crashes accounted for 34 percent of total crashes on roadway segments, suggesting potential access management issues. Reducing the number of driveways and medians accessed and implementing other median-related treatments could alleviate these issues. A total of 13 fatal crashes (less than 1 percent) occurred along the corridor segments during the 3-year period, with 12 of those crashes occurring between 8 PM and 8 AM. This equates to a fatality rate of 2.33 for the corridor (calculated as crashes per 100 million vehicle miles traveled [MVMT]).

The study corridor was divided into eight homogenous segments based on functional classification, AADT, and intersecting locations. Figure 15 provides a visual comparison of segment crash rates (calculated as crashed per 100 million vehicle miles traveled [MVMT]) to statewide average crash rates. Crash rates are based on the 2017 crash rates published by TxDOT for divided or undivided urban highways with 4 or more lanes. These roadway types were used for crash rate comparisons because they are more applicable to the typical sections and urban conditions that exist along the FM 1960 corridor, whereas the general Farm-to-Market classification considers a wide range of roadway typical sections and conditions that may not be as applicable. Segment crash analysis results indicated that multiple segments such as segments from East Gatewick to west of Hardy Toll Road and Lee Road to North Houston Avenue were found to have crash rates significantly greater than statewide averages. In general, west and east ends of the study corridor, where many of the residential and commercial developments are located, experienced much higher crash rates.



Note: Crash rates are based on the 2017 crash rates published by TxDOT for divided or undivided urban highways with 4 or more lanes.

Figure 15: Segment Crash Rates (2015-2017)

4.4.2 *Intersection Crashes*

A total of 1,026 intersection-related crashes were reported along the corridor during the 3-year analysis period (2015 to 2017). Of the 1,026 intersection-related crashes, 58 percent were rear-end crashes and 30 percent were left-turn and angle crashes. The intersections of FM 1960 at Imperial Valley Drive, Treaschwig Road, Aldine Westfield Road, Lee Road, Kenswick Drive, Townsen Boulevard West, Mall Ent 1, and the US 69 interchange experienced the highest crash frequencies (close to the top 25 percent of all intersections). Also, the intersections of FM 1960 at East Gatewick, Imperial Valley Drive, Treaschwig Road, Aldine Westfield Road, Lee Road, Kenswick Drive, Townsen Boulevard West, and Mall Ent 1 showed a significantly high number of left-turn/angle crashes (close to the top 25 percent of all intersections). A total of four fatal crashes occurred at corridor intersections during the 3-year period, with all of them occurring between 8 PM and 8 AM Intersections that experienced a fatal crash include Imperial Valley Drive, Treaschwig Road, and Kenswick Drive. Also, the corridor intersections between Kenswick Drive and North Houston Avenue experienced the majority (close to the top 20 percent of all intersections) of crashes with incapacitating injury.

4.4.3 *Pedestrian and Bicycle Crashes*

A total of 24 pedestrian- and bicyclist-related crashes occurred during the 3-year analysis period. Sixteen crashes were pedestrian related, 10 of which involved a pedestrian injury and five of which involved a pedestrian fatality. Eight crashes were bicyclist related, half of which involved a bicyclist injury. Most of the pedestrian- and bicyclist-related crashes occurred under dark conditions and when vehicles were going straight. Strategies including illumination enhancements and ADA-compliant sidewalks will be evaluated to address pedestrian-/bicyclist-related crashes along the corridor segments. Also, intersection-level

countermeasures, including pedestrian signal timing and high-visibility crosswalks in high-crossing-activity locations, could slow down vehicles and provide higher visibility for pedestrians.

4.5 Field Observations

Field visits were conducted in March and April 2019 to visually assess traffic operations within the study area. Operational features such as vehicle queue lengths, queue spillback locations, areas of congestion, bottlenecks, and signal operations were noted to aid in development of microsimulation models for the study area. Existing roadway characteristics such as number of lanes, length of turn bays, lane widths, and sight distances were also observed and verified. A detailed description of field observations is provided in Appendix G.

5 EXISTING CONDITIONS TRAFFIC OPERATIONS ANALYSIS

Existing conditions (2019) traffic operations analysis was conducted using the calibrated AM, PM, and Saturday peak-hour VISSIM microsimulation models. Detailed descriptions of data and model inputs, model coding, calibration criteria and process, and results are provided in the Existing Conditions Traffic Analysis Report (Appendix H). Existing conditions capacity analysis results are discussed in the section below, with intersection approach delays and levels of service (LOS) provided in Tables 2 through 4.

The majority of mainline (eastbound and westbound) approaches to the study intersections operate at LOS D or better during the AM peak hour, except at Woodcreek North Drive and Lee Road. Woodcreek North Drive experiences longer mainline delays due to a recurring bottleneck along FM 1960 at Treaschwig Road. Approaches at the Lee Road intersection perform at LOS E or F due to congestion and bottlenecks during the AM peak hour, when there is heavy side-street traffic competing with the heavy mainline traffic for green time. Side-street approaches at approximately 50 percent of the study intersections perform at LOS E or F due to congestion, including approaches to Imperial Valley Drive, Woodcreek Drive, Aldine Westfield Road, Lee Road, Kenswick Drive, Deerbrook Park Boulevard, Park at Humble Driveway, Townsen Boulevard West, Whitaker Road, Mall Ent 1, North Houston Avenue, and Wilson Road intersections.

Table 2: Intersection Approach Delay and LOS – Existing Conditions – AM Peak Hour

Intersection	Approach			
	Eastbound LOS (Delay)	Westbound LOS (Delay)	Northbound LOS (Delay)	Southbound LOS (Delay)
FM 1960 at Imperial Valley Dr	C (26)	B (16.5)	**E (77.1)**	D (51.2)
FM 1960 at Carlsway Rd	A (1.4)	A (3.6)	D (50.6)	D (53.8)
FM 1960 at Greenbrook Dr	A (5.1)	A (5.5)	D (37.5)	C (34.6)
FM 1960 at Briarcreek Blvd	A (4.2)	A (3)	--	D (54)
FM 1960 at Treaschwig Rd	C (21.6)	D (47.2)	C (28.7)	C (22.8)
FM 1960 at Woodcreek N Dr	A (2.8)	**E (55.6)**	**E (63.1)**	**F (131)**
FM 1960 at Aldine Westfield Rd	B (20)	C (25)	**E (69)**	**E (63.2)**
FM 1960 at Birnamwood Blvd	A (8.1)	A (5.6)	D (42.7)	D (43.1)
FM 1960 at Richey Rd	A (5.1)	A (9.4)	B (11.6)	--
FM 1960 at Farrell Rd	A (5.5)	B (15)	B (12.7)	--

Intersection	Approach			
	Eastbound LOS (Delay)	Westbound LOS (Delay)	Northbound LOS (Delay)	Southbound LOS (Delay)
FM 1960 at Cypresswood Dr	C (22.1)	C (28.7)	--	D (39.7)
FM 1960 at Foxwood Forest Blvd	B (18.9)	C (31.6)	--	D (41.2)
FM 1960 at Lee Rd	**E (55.6)**	**E (63.8)**	**E (56.4)**	**F (93.8)**
FM 1960 at Kenswick Dr	D (43.7)	C (20.2)	**E (77.6)**	D (37.8)
FM 1960 at Deerbrook Park Blvd	A (9.3)	A (5)	--	**E (69.2)**
FM 1960 at Park at Humble Dwy	A (3.5)	A (5.8)	D (46.4)	**E (72.5)**
FM 1960 at Townsen Blvd W	B (17.9)	B (19.1)	**E (65.9)**	D (35.9)
FM 1960 at Sam's Club Dwy	A (4.4)	A (2.3)	A (0)	D (47.7)
FM 1960 at Whitaker Rd	A (6.2)	A (5.5)	**E (55.4)**	A (0)
FM 1960 at Mall Entrance 2	A (1.5)	A (0.4)	--	D (49.2)
FM 1960 at Mall Entrance 1	A (3.1)	A (1.8)	D (52.3)	**E (63)**
FM 1960 at I-69 SB Frontage Rd	D (39.2)	A (4.8)	--	C (28.7)
FM 1960 at I-69 NB Frontage Rd	A (1.9)	D (47.3)	D (38.6)	--
FM 1960 at N. Houston Ave	B (14.4)	B (15.1)	**E (65.6)**	**E (60.3)**
FM 1960 at Wilson Rd	B (15.3)	B (14.4)	**E (58.9)**	**E (73.9)**
FM 1960 at BF 1960A	A (6.5)	C (25.4)	A (8.4)	--

Delay units in seconds per vehicle.
LOS = Level of Service.
NB = Northbound.
SB = Southbound.

The majority of mainline approaches operate at LOS D or better during the PM peak hour, except at Treaschwig Road, Lee Road, Kenswick Drive, Townsen Boulevard West, and the I-69 Northbound Frontage Road, where one or more of the mainline approaches operate at LOS E or F. This is due to recurring congestion and bottlenecks along FM 1960 during the PM peak hour. Side-street approaches at approximately 70 percent of study intersections perform at LOS E or F due to congestion and bottlenecks, including at Imperial Valley Drive, Carlsway Road, Briarcreek Boulevard, Treaschwig Road, Woodcreek North Drive, Aldine Westfield Road, Lee Road, Kenswick Drive, Deerbrook Park Boulevard, Park at Humble Driveway, Townsen Boulevard West, Sam's Club Driveway, Whitaker Road, Mall Ent 2, Mall Ent 1, I-69 Northbound Frontage Road, North Houston Avenue, and Wilson Road intersections.

Table 3: Intersection Approach Delay and LOS – Existing Conditions – PM Peak Hour

Intersection	Approach			
	Eastbound LOS (Delay)	Westbound LOS (Delay)	Northbound LOS (Delay)	Southbound LOS (Delay)
FM 1960 at Imperial Valley Dr	C (30.8)	B (17)	**E (62.2)**	**E (61.7)**
FM 1960 at Carlsway Rd	A (2.2)	A (8.2)	**E (57.5)**	**E (57.3)**
FM 1960 at Greenbrook Dr	A (3.7)	A (4.6)	D (43.8)	C (34.8)
FM 1960 at Briarcreek Blvd	B (18)	A (4.8)		**E (59.5)**
FM 1960 at Treaschwig Rd	**E (74.7)**	D (44.6)	**F (97.6)**	C (28.5)
FM 1960 at Woodcreek N Dr	A (4.2)	B (19.3)	**E (55.5)**	C (31.2)
FM 1960 at Aldine Westfield Rd	D (38.4)	D (35.6)	D (48.5)	**F (80.4)**

Intersection	Approach			
	Eastbound LOS (Delay)	Westbound LOS (Delay)	Northbound LOS (Delay)	Southbound LOS (Delay)
FM 1960 at Birnamwood Blvd	A (5)	A (2.7)	D (39.5)	D (45)
FM 1960 at Richey Rd	A (9.3)	B (14.7)	B (19.3)	
FM 1960 at Farrell Rd	A (7.6)	A (7)	B (19.2)	
FM 1960 at Cypresswood Dr	B (17.7)	B (19.5)		D (43.2)
FM 1960 at Foxwood Forest Blvd	B (13.2)	C (26.5)		D (43.1)
FM 1960 at Lee Rd	**E (59.4)**	**F (96.9)**	D (41.3)	**E (66.8)**
FM 1960 at Kenswick Dr	**F (89.2)**	C (30.3)	**E (68.1)**	D (43.1)
FM 1960 at Deerbrook Park Blvd	A (6)	C (21.5)		**E (78.1)**
FM 1960 at Park at Humble Dwy	B (16.8)	B (12.8)	**E (58.8)**	**F (81.4)**
FM 1960 at Townsen Blvd W	D (42.4)	**F (87.2)**	**F (235.3)**	**F (85.9)**
FM 1960 at Sam's Club Dwy	B (14)	C (34.1)	**E (79.1)**	**E (62.1)**
FM 1960 at Whitaker Rd	B (10.8)	C (21.6)	**F (116.7)**	**F (86.3)**
FM 1960 at Mall Entrance 2	A (4.9)	A (1.2)		**E (59.1)**
FM 1960 at Mall Entrance 1	A (7.1)	A (6)	**E (56.7)**	**E (68.4)**
FM 1960 at I-69 SB Frontage Rd	C (25.5)	A (4.8)		D (39.3)
FM 1960 at I-69 NB Frontage Rd	A (1.1)	**E (59.9)**	**E (59.9)**	
FM 1960 at N. Houston Ave	B (17.5)	D (36.3)	**E (64.9)**	**E (75.1)**
FM 1960 at Wilson Rd	D (41.9)	B (18)	D (52.8)	**F (90.9)**
FM 1960 at BF 1960A	A (5.4)	B (15.4)	B (14.4)	D (37.9)

Delay units in seconds per vehicle.
LOS = Level of Service.
NB = Northbound.
SB = Southbound.

During the Saturday peak hour, the majority of operational issues are along the corridor between Lee Road and Wilson Road. Mainline approaches at Lee Road, Kenswick Drive, Townsen Boulevard West, and the I-69 Northbound Frontage Road perform at LOS E for at least one approach. Side-street approaches at approximately 50 percent of the study intersections perform at LOS E or F due to congestion, including Birnamwood Boulevard, Lee Road, Briarcreek Boulevard, Kenswick Drive, Deerbrook Park Boulevard, Park at Humble Driveway, Townsen Boulevard West, Sam's Club Driveway, Whitaker Road, Mall Ent 2, Mall Ent 1, I-69 Northbound Frontage Road, Houston Avenue, and Wilson Road intersections.

Table 4: Intersection Approach Delay and LOS – Existing Conditions - Saturday Peak Hour

Intersection	Approach			
	Eastbound LOS (Delay)	Westbound LOS (Delay)	Northbound LOS (Delay)	Southbound LOS (Delay)
FM 1960 at Imperial Valley Dr	C (26.2)	B (17.8)	D (51)	D (50.2)
FM 1960 at Carlsway Rd	A (0.8)	A (3)	D (50.5)	D (45.5)
FM 1960 at Greenbrook Dr	A (3.1)	A (3.5)	D (42.4)	C (31.5)
FM 1960 at Briarcreek Blvd	A (8.2)	A (3.8)		D (39)
FM 1960 at Treaschwig Rd	C (34.8)	B (18.1)	D (41.5)	C (23.9)
FM 1960 at Woodcreek N Dr	A (3.4)	A (4.3)	D (44.2)	C (23.4)

Intersection	Approach			
	Eastbound LOS (Delay)	Westbound LOS (Delay)	Northbound LOS (Delay)	Southbound LOS (Delay)
FM 1960 at Aldine Westfield Rd	B (15.7)	B (18.4)	D (40.3)	C (33.1)
FM 1960 at Birnamwood Blvd	A (2.2)	A (1.3)	C (34)	**E (55.8)**
FM 1960 at Richey Rd	A (3.1)	A (5.4)	A (9.1)	
FM 1960 at Farrell Rd	A (7.8)	A (5.9)	B (13)	
FM 1960 at Cypresswood Dr	A (5.4)	B (17.1)		D (43.9)
FM 1960 at Foxwood Forest Blvd	B (11.9)	C (23.2)		D (47.1)
FM 1960 at Lee Rd	D (39.9)	**E (70.4)**	D (39.5)	**F (208.4)**
FM 1960 at Kenswick Dr	**E (56.6)**	B (10.8)	**E (73.4)**	**E (70.3)**
FM 1960 at Deerbrook Park Blvd	A (6.8)	B (17.5)		**E (74.7)**
FM 1960 at Park at Humble Dwy	B (16.5)	B (12.2)	**E (71.7)**	**F (85)**
FM 1960 at Townsen Blvd W	**E (61.4)**	D (52.3)	**F (214.7)**	**F (102.2)**
FM 1960 at Sam's Club Dwy	B (14.4)	B (11.4)	**F (84.8)**	**F (112.4)**
FM 1960 at Whitaker Rd	B (10.4)	D (50.6)	**E (63.1)**	**E (77.8)**
FM 1960 at Mall Entrance 2	B (15.9)	B (14.3)		**F (87.6)**
FM 1960 at Mall Entrance 1	B (13.8)	B (18.5)	**E (74.5)**	**F (88.6)**
FM 1960 at I-69 SB Frontage Rd	C (33.8)	A (5.1)		**F (110)**
FM 1960 at I-69 NB Frontage Rd	A (1.5)	**E (56.9)**	**E (55)**	
FM 1960 at N. Houston Ave	B (10.8)	A (9.3)	**E (68.3)**	A (4.3)
FM 1960 at Wilson Rd	C (28.3)	B (13.8)	D (53.7)	**E (71.8)**
FM 1960 at BF 1960A	A (4.4)	B (17.4)	B (10.1)	B (17)

Delay units in seconds per vehicle.
LOS = Level of Service.
NB = Northbound.
SB = Southbound.

6 PROPOSED IMPROVEMENTS

Proposed improvements were developed for the corridor based on traffic operations and safety deficiencies identified through traffic and safety analyses, as well as consideration of input received during steering committee, stakeholder, and public meetings. Proposed improvements are divided into short-range (0 to 5 years), medium-range (5 to 10 years), and long-range (10+ years) categories to expedite the implementation of low-cost and high-impact short-range improvements and to maximize project benefits over time. Short-range improvements focus on low-cost solutions that maximize the efficiency of the existing transportation infrastructure and avoid the need for significant right-of-way acquisition. Medium-range improvements include improvements that may require further coordination with local agencies and property owners in addition to some right-of-way acquisition. Long-range improvements include significant infrastructure upgrades that are generally high cost, require substantial right-of-way and coordination, and require further study. Long-range improvements were developed for study area intersections and segments where significant improvements are warranted to address more severe and reoccurring bottlenecks, sometimes due to congestion outside the study area.

6.1 Design Criteria

The design criteria utilized during the development of the short-, medium-, and long-range improvements were developed in conjunction with TxDOT planning and design teams and by referencing the TxDOT Roadway Design Manual (RDM), Texas Manual on Uniform Traffic Control Devices, FHWA's Separated Bike Lane Planning and Design Guide, and National Association of City Transportation Officials' Urban Bikeway Design Guide. The design criteria are summarized in Table 5.

Table 5: Design Criteria

Item	Design Value	Reference
Functional Class	Urban Arterial	RDM
Roadway Elements		
Travel-Lane Width	11' - 12'	RDM Table 3-1
Turn-Lane Width	10' - 11'	RDM Table 3-1
Shoulder Width	9' - 10'	RDM Table 3-1
Offset to Face of Curb	1'	RDM Table 3-1
Bike-Lane Width	4'	NACTO
Striped-Buffer Width	2'	NACTO
Sidewalk Width	6'	RDM Table 3-1
Medians		
Median Width (based on existing roadway width)	14' - 16'	RDM Chapter 3, Section 2
Median Width at Turn Lane	2' - 8'	RDM Chapter 3, Section 2
Turn-Lane-Taper Length	50' - 100' for single left turn 150' dual left turn	RDM Table 3-3
Shifting Taper	Calculated	MUTCD Table 6C -4
Turn-Lane-Deceleration Length (55 mph)[1]	510'	RDM Table 3-3
Turn-Lane-Deceleration Length (50 mph) [1]	425'	RDM Table 3-3
Turn-Lane-Deceleration Length (35 mph) [1]	110'	RDM Table 3-3
Miscellaneous		
Design Vehicle for U-turns within Shoulder	Passenger	Calculated

[1]Deceleration lane lengths were reduced where geometric constraints would not allow for the full turn-lane length.
References: RDM: TxDOT Roadway Design Manual, April 26, 2018; MUTCD: Manual on Uniform Traffic Control Devices 2009; NACTO: National Association of City Transportation Officials, Urban Bikeway Design Guide.

6.2 Short-Range Improvements

Short-range improvements focus on low-cost solutions that require little to no additional right-of-way and maximize the efficiency of the existing transportation infrastructure. It is anticipated that proposed short-range improvements can be implemented within 5 years. A description of proposed short-range improvements is provided below. Corridor-wide and intersection-level short-range treatments are summarized on Figures 16 and 17. Conceptual drawings of short-range improvements are provided in Appendix I.

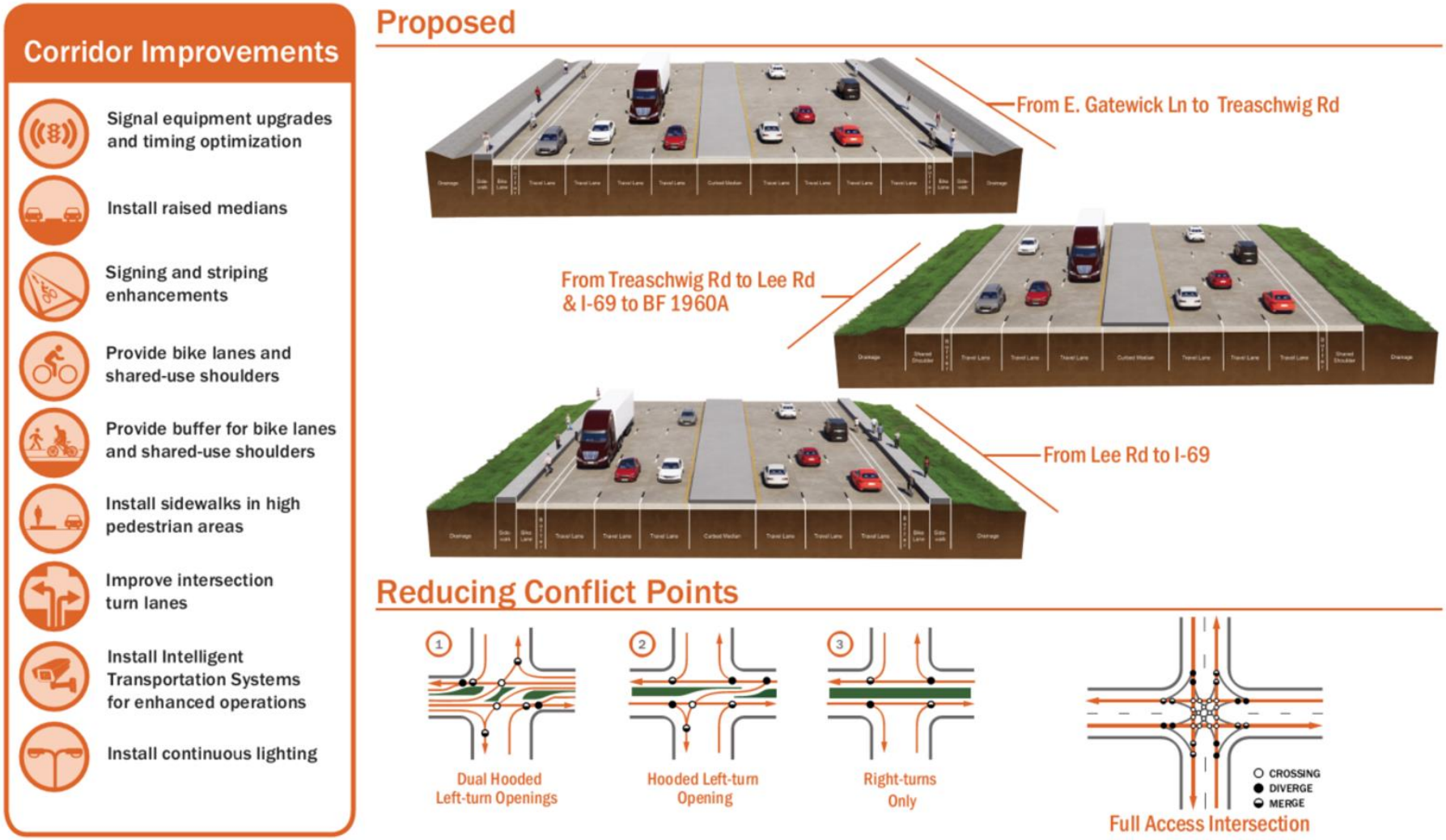


Figure 16: Short-Range Corridor-Wide Improvements Summary

Proposed Improvements

- Install turn lanes and improve storage lengths
- Improve bike lane delineation through intersections
- Install bike and pedestrian signage
- Perform vehicle detection upgrades
- Install Intelligent Transportation Systems for enhanced operations
- Provide raised medians
- Install sidewalk at intersections

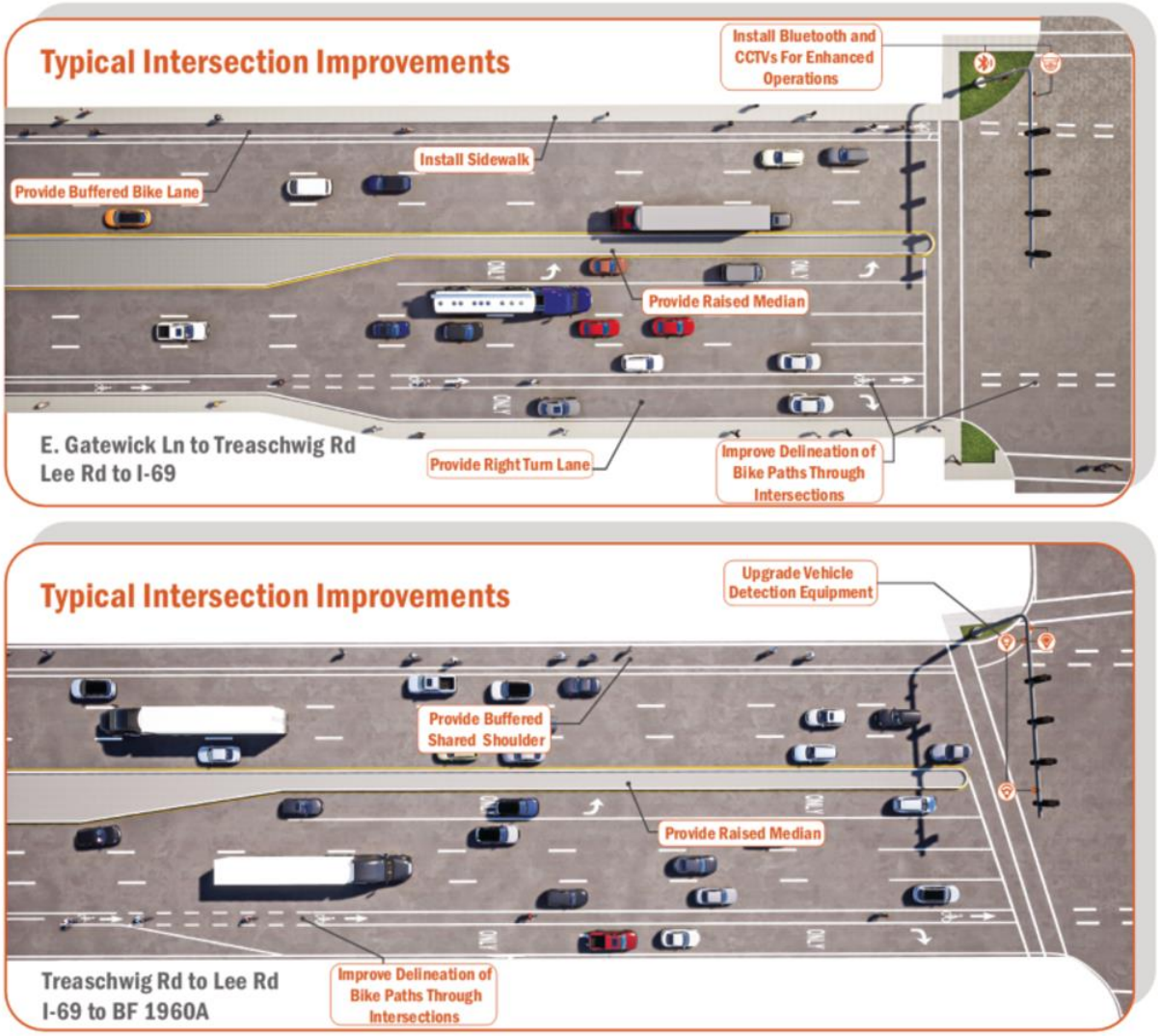


Figure 17: Short-Range Intersection Improvements Summary

Raised Median: The FM 1960 corridor currently has a continuous TWLTL across the entire corridor separating the eastbound and westbound lanes, except in the vicinity of I-45, Hardy Toll Road, and I-69. According to the TxDOT Access Management Manual (2011 edition), roadways with a non-traversable median have an average crash rate of approximately 30 percent less than roadways with a TWLTL. Therefore, a raised concrete median is proposed for the corridor to replace the existing TWLTL to reduce conflict points along the corridor and improve traffic operations and safety. Dedicated mid-block left-turn and U-turn lanes are strategically placed along the corridor to accommodate access to side streets and driveways. Median noses of the mid-block turn lanes will be configured to be traversable to accommodate emergency vehicles (e.g., fire trucks) and truck access.

Bike Lanes and Shared-Use Shoulders with Buffer: The existing bike lanes and sidewalks are concentrated on the west side of the corridor between East Gatewick and Aldine Westfield Road. To improve transportation mode choices and access to developments along the corridor, bike lanes and shared-use shoulders are proposed along the remainder of the corridor. Specifically, bike lanes are proposed along FM 1960 between Lee Road and I-69. Bike lanes are 4 feet wide, and a 2-foot striped buffer is provided between cyclists and vehicles traveling in adjacent lanes. A shared-use shoulder with a 2-foot striped buffer is proposed from Treaschwig Road to Lee Road and from I-69 to BF 1960A to separate pedestrians and bicyclists from vehicular traffic.

Sidewalks: Sidewalks currently exist along FM 1960 from East Gatewick to Treaschwig Road. Based on field observations of pedestrian activity and to improve accessibility to dense residential and commercial areas, 6-foot-wide sidewalks are proposed along FM 1960 from Lee Road to I-69.

Turn Lanes: The existing TWLTL provides storage capacity for left-turning vehicles at signalized intersections and other access points along the corridor. Because the TWLTL is being replaced by a raised median, specific turn-lane lengths must be calculated to accommodate peak traffic and prevent queue spillback into adjacent travel lanes. Turn-lane lengths for intersections were calculated using a combination of VISSIM analysis results and TxDOT RDM guidance. Single left-turn lanes are provided for all signalized intersection approaches where left-turn movements are allowed. Dual left-turn lanes are proposed for approaches with left-turn volumes of 300 vehicles per hour or more, or as determined necessary by VISSIM analysis. Right-turn lanes are proposed for approaches with right-turn volumes of 100 vehicles per hour or more. A summary of turn-lane improvements is provided in Table 6.

Table 6: Proposed Turn-Lane Improvements

Intersection	Add Turn Lane			Extend Turn Lane	
	Left	Right	Through	Left	Right
FM 1960 at Imperial Valley Dr		EB/WB		EB/WB	
FM 1960 at Carlsway Rd		EB/WB		EB/WB	
FM 1960 at Greenbrook Dr				EB/WB	
FM 1960 at Briarcreek Blvd				EB	
FM 1960 at Treaschwig Rd		WB		EB/WB	
FM 1960 at Woodcreek N Dr				EB/WB	
FM 1960 at Aldine Westfield Rd				EB/WB/SB	EB/WB
FM 1960 at Rayford Rd				EB/WB	
FM 1960 at Richey Rd				WB	
FM 1960 at Farrell Rd	EB			WB	
FM 1960 at Cypresswood Dr	WB			EB	WB
FM 1960 at Foxwood Forest Blvd				EB/WB	WB
FM 1960 at Lee Rd		EB**		EB/WB/SB	WB
FM 1960 at Kenswick Dr	NB	EB		EB/WB/SB	WB
FM 1960 at Deerbrook Park Blvd		WB		EB	
FM 1960 at Park at Humble Dwy		WB		EB/WB	
FM 1960 at Townsen Blvd W	EB*/NB	SB		EB/WB/NB/SB	
FM 1960 at Sam's Club Dwy		WB		EB/WB	
FM 1960 at Whitaker Rd		EB		EB/WB	
FM 1960 at Mall Entrance 2	EB*	WB*	EB	EB	
FM 1960 at Mall Entrance 1	EB*		WB/EB	EB/WB	
FM 1960 at I-69 SB Frontage Rd		SB*			
FM 1960 at I-69 NB Frontage Rd				WB	
FM 1960 at N. Houston Ave				WB	EB
FM 1960 at Wilson Rd	SB			EB/WB/SB	EB/WB
FM 1960 at BF 1960A				EB/WB	EB

*Dual turn lane.
**Off-ramp lane.
EB = Eastbound.
NB = Northbound.
SB = Southbound.
WB = Westbound.

Signing and Striping: Pavement markings and symbols within the study area will be improved to accommodate the proposed short-range improvements. A 2-foot striped buffer is proposed between travel lanes and bike lanes or shared-use shoulders to improve the spacing between pedestrians and vehicular traffic. Roadway signs will also be improved along the corridor to better inform the vehicular and pedestrian traffic of new traffic patterns. Enhancements to traffic signs and pavement markings are detailed in Appendix I.

Continuous Lighting: Corridor safety analysis indicated that a significant number of fatal crashes along the corridor occur between 8 PM and 8 AM Continuous street lighting is proposed along the corridor to improve

nighttime safety for all transportation modes. Lighting is proposed for all areas except from 350 feet east of Theiss Road to FM 1960 at Lee Road to avoid being in close proximity to the George Bush Intercontinental Airport.

Signal Equipment Upgrades and Timing Optimization: Detection upgrades to radar detection (stop bar and setback) are proposed at all signalized intersections within the study area that currently utilize video or loop detection to better detect and serve traffic. Signal equipment (e.g., signal heads and mast arm signs) is also being upgraded as necessary to accommodate additional turn lanes. The last signal timing optimization effort along the corridor was conducted in 2017. Because the corridor traffic volumes have increased since then, signal timing optimization is also recommended for the corridor to maximize operational efficiency.

Intelligent Transportation Systems (ITS): Proposed ITS strategies seek to maximize the efficiency of the existing roadway network by providing the equipment and communication infrastructure necessary to continuously monitor traffic operations and associated performance measures in real time. These systems are also able to provide valuable information to road users about roadway conditions, such as travel times or roadway incidents, and direct motorists to alternate routes if necessary. A description of proposed ITS devices and improvements is provided as follows:

- **CCTV Cameras:** CCTV cameras are proposed at all intersections within the study area where they do not currently exist. CCTVs provide overlapping and continuous coverage to visually monitor traffic conditions and aid in incident management.
- **Bluetooth:** Bluetooth devices are proposed at intersection and mid-block locations to provide point-to-point travel times along the FM 1960 corridor. Mid-block locations are proposed where signal spacing exceeds 3,000 feet unless the roadway segment has little to no traffic generators.
- **DMS:** DMS are proposed at three locations along the corridor to provide information to road users about upcoming roadway conditions.
    - Located 1 mile east of Hardy Toll Road ramp, facing east: DMS provided to notify travelers to take Hardy Toll Road to access I-45 as an alternate route if necessary due to a downstream incident.
    - Located 1 mile west of BF 1960A ramp, facing west: DMS provided to notify travelers to take BF 1960A as an alternate route if necessary due to a downstream incident.
    - Located 1 mile east of Townsen Road/Wilson Road, facing east: DMS provided to notify travelers to take Townsen Road/Wilson Road to FM 1960 as an alternate route if necessary due to a downstream incident.
- **High-Definition Radar:** High-definition-radar devices are proposed at mid-block locations for measurement of traffic counts and spot speeds. Mid-block locations are proposed where signal spacing exceeds 3,000 feet unless the roadway segment has little to no traffic generators.
- **Communication Fiber:** The existing 12 single-mode fiber between Lee Road and I-45 is being upgraded to 144 single-mode fiber to provide adequate communication bandwidth for proposed ITS devices and equipment.

Table 7 summarizes the type and location of the proposed signal and ITS equipment.

Table 7: Proposed Signal Equipment and ITS Devices and Locations

Location	Proposed Signal Equipment/ITS Devices						
	CCTV	Radar (Stop Bar)	Radar (Setback)	Pre-emption Devices	Bluetooth	HD Radar	DMS
Intersection							
FM 1960 @ Imperial Valley Dr				✓	✓		
FM 1960 @ Carlsway Rd		✓	✓	✓	✓		
FM 1960 @ Greenbrook Dr		✓	✓	✓	✓		
FM 1960 @ Briarcreek Blvd		✓	✓	✓	✓		
FM 1960 @ Treaschwig Rd		✓	✓	✓	✓		
FM 1960 @ Woodcreek N Dr				✓	✓		
FM 1960 @ Aldine Westfield		✓	✓	✓	✓		
FM 1960 @ Rayford Rd		✓	✓	✓	✓		
FM 1960 @ Richey Rd		✓	✓	✓	✓		
FM 1960 @ Farrell Rd		✓	✓	✓	✓		
FM 1960 @ Cypresswood Dr		✓	✓	✓	✓		
FM 1960 @ Foxwood Forrest Blvd		✓	✓	✓	✓		
FM 1960 @ Lee Rd				✓	✓		
BF 1960 @ Lee Rd				✓	✓		
FM 1960 @ Kenswick Dr	✓			✓	✓		
FM 1960 @ Deerbrook Park Blvd	✓			✓	✓		
FM 1960 @ Park at Humble	✓			✓	✓		
FM 1960 @ Townsen Blvd	✓				✓		
FM 1960 @ Whitaker Dr	✓				✓		
FM 1960 @ Mall Ent 2	✓				✓		
FM 1960 @ Mall Ent 1	✓				✓		
FM 1960 @ I-59		✓	✓		✓		
FM 1960 @ N Houston Ave	✓				✓		
FM 1960 @ Townsen Rd	✓				✓		
FM 1960 @ BF 1960	✓			✓	✓		
Mid-Block Location							
980' east of FM 1960 and Townsen Rd					✓	✓	
1250' east of FM 1960 and N Houston Ave.					✓	✓	
1840' west of FM 1960 and Kenswick Dr.					✓	✓	
800' west of FM 1960 and Lee Rd					✓	✓	
2970' east of FM 1960 and Aldine Westfield Rd					✓	✓	

Location	Proposed Signal Equipment/ITS Devices						
	CCTV	Radar (Stop Bar)	Radar (Setback)	Pre-emption Devices	Bluetooth	HD Radar	DMS
1410' east of FM 1960 and Greenbrook Dr					✓	✓	
DMS Location							
1 mile from Hardy Toll Rd ramp, facing east							✓
1 mile from BF 1960A ramp, facing west							✓
1 mile from Townsen Rd, facing east							✓

HD = High definition.

6.3 Medium-Range and Long-Range Opportunities (Further Analysis Required)

Medium-range improvements require more coordination with local agencies and property owners, may require some right-of-way acquisition, and can typically be implemented within 5 to 10 years. Long-range improvements include more significant upgrades to the network that are more costly and can typically be implemented in 10 or more years. The proposed long-range improvements are developed at a conceptual level based on identified needs of the corridor and surrounding network, and further study will be required to refine the improvements before they are designed. Medium-range and long-range improvements are described below. Conceptual drawings of the medium-range improvements are provided in Appendix I, and conceptual drawings of long-range improvements are provided in Appendix J.

1. Side-Street-Approach Improvements (Medium-Range)

Side-street improvements requiring coordination with local agencies and potentially requiring right-of-way are considered medium-range improvements. These improvements include extending and adding turn lanes to reduce approach delay, providing sufficient storage capacity, and improving lane utilization. Medium-range side-street improvements are proposed at the following intersections:

- Wilson Road – Provide two southbound left-turn lanes to accommodate peak-period traffic demands.
- Townsen Boulevard West – Provide additional turn storage for southbound left turn, a southbound right-turn lane, and a northbound left-turn lane.
- Kenswick Drive – Provide additional southbound left-turn storage and an additional northbound left-turn lane.
- Lee Road - Provide additional southbound left-turn and right-turn storage to accommodate peak-period traffic demands.

- Aldine Westfield Road – Provide additional southbound left-turn storage to accommodate peak-period traffic demands.
- Treaschwig Road – Modify southbound approach lane configuration to a shared left-turn/through lane and two right-turn lanes. Additionally, provide right-turn overlap for the southbound right-turn lanes.

2. Driveway Consolidation (Medium-Range)

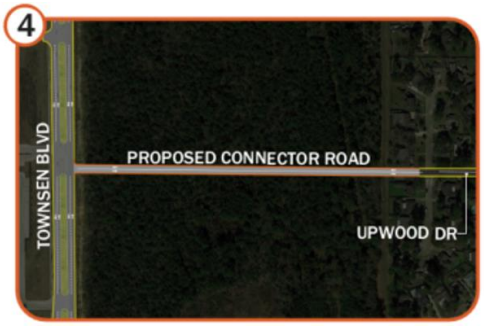
Driveway consolidation involves the relocation, removal, or sharing of existing driveways to reduce the number of conflict points and improve safety along the corridor. Proposed driveway consolidation along FM 1960 focused on the application of TxDOT Access Management Manual (2011) guidance to driveways in close proximity to intersections and developments with multiple driveways that are not necessarily based on traffic volumes, development type, or apparent parking-lot circulation patterns.

3. Innovative Intersection and Interchange Concepts (Long-Range)

Innovative intersections and interchanges are recommended to be evaluated at two locations on FM 1960.

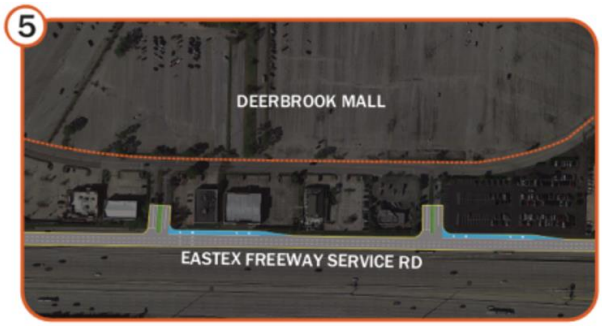
- **FM 1960 and BF 1960A at Lee Road:** A quadrant intersection (sketch below) is proposed at the intersections of FM 1960 and BF 1960A at Lee Road. The proposed intersection will address operational deficiencies due to close proximity of the two intersections and provide adequate storage for turning vehicles.
- **FM 1960 at I-69 Frontage Roads:** An echelon interchange is proposed at the interchange of FM 1960 at I-69. The echelon concept provides capacity for heavy left-turn and through traffic by grade-separating frontage road intersections such that the number of signal phases at each intersection can be reduced to two. As part of this improvement, the Northbound Frontage Road approach may be reconfigured to provide a direct access ramp to the Deerbrook Mall, which eliminates associated weaving movements along FM 1960 between I-69 and Deerbrook Mall.

4. Network Connectivity Improvements (Long-Range)



The most direct access to FM 1960 for the residents of the neighborhood directly to the west of the Deerbrook Mall currently is through the mall ring road. A new connector roadway is proposed between Townsen Boulevard West and the neighborhood to provide direct alternate access to FM 1960 for residents of the neighborhood. This roadway will alleviate congestion along the mall ring road, reduce travel delays for neighborhood residents, and improve response times for emergency responders who need access to the neighborhood.

5. Network Improvements to Benefit FM 1960 (Long-Range)



The following improvements are proposed at locations outside the FM 1960 study area to address bottlenecks that affect operations along FM 1960.

- **Deerbrook Mall:** Right-turn lanes are proposed at Deerbrook Mall accesses along the I-69 Southbound Frontage Road. This improvement aims to increase the utilization of these accesses and reduce demand at mall accesses along FM 1960.
- **BF 1960A at I-69 Frontage Roads:** Capacity challenges at this interchange often result in queue spillbacks onto the FM 1960 corridor. Capacity and configuration improvements are proposed at the interchange of BF 1960A at I-69 to alleviate congestion and improve traffic flows through the study area during peak traffic conditions.

7 EXISTING BUILD TRAFFIC OPERATIONS ANALYSIS

Build conditions are defined by the implementation of proposed short-range improvements detailed in Section 6.2 of this report and in Appendix I. The calibrated AM, PM, and Saturday VISSIM models for existing conditions were revised to incorporate the short-range improvements. Existing traffic volumes were redistributed as necessary based on allowable movements under the short-range build condition, and traffic signal timings were optimized for the entire corridor to maximize the operational benefits of the short-range improvements. The signal timings were optimized using Synchro software before being imported into VISSIM. The volume redistribution results in higher than existing turn volumes at several signalized intersections, limiting the operational benefits of short-range improvements. Capacity analysis results for the short-range build conditions are provided in Tables 8 to 10.

In the Mall Area, the Southbound Approach delay at Mall Ent 2 increases from 87.6s in existing conditions to 109s in short-range improvements scenario. This delay in the field can be lower if drivers choose to use alternative Mall entrances/exits on I-69 Southbound Frontage Road. This Study did not redistribute traffic to those driveways to allow apples-to-apples comparison between two scenarios, and since no traffic counts were collected for those Mall entrances/exits. Although it is true that the southbound approach delay at Mall Ent 2

increases, the overall intersection LOS stays C (with intersection delay increasing from 29.5s to 30.1s) and the travel times through this section (Foxwood Forest Drive to I-69) improve (11.9% and 8.8% travel time reduction in Eastbound and Westbound direction, respectively).

Capacity analysis results show a 9 percent reduction in total intersection peak hour delay with the short-range improvements compared to existing conditions. Additionally, 62 percent fewer mainline approaches perform at LOS E or F compared to existing conditions. Section 9, Project Benefits, summarizes the monetized benefits of the short-range solutions resulting from delay and safety improvements.

Table 8: Intersection Approach Delay and LOS – Short-Range Build Conditions – AM Peak Hour

Intersection	Approach			
	Eastbound LOS (Delay)	Westbound LOS (Delay)	Northbound LOS (Delay)	Southbound LOS (Delay)
FM 1960 at Imperial Valley Dr	C (22.6)	A (8.1)	F (80.6)	D (52.5)
FM 1960 at Carlsway Rd	A (1.6)	A (2.1)	D (50.7)	D (53.6)
FM 1960 at Greenbrook Dr	A (5.3)	A (6.1)	D (37.2)	C (33.3)
FM 1960 at Briarcreek Blvd	A (3)	A (3)		D (41.1)
FM 1960 at Treaschwig Rd	B (18.9)	D (41.4)	C (29.8)	C (25.7)
FM 1960 at Woodcreek N Dr	A (2.1)	C (28.3)	D (50.7)	D (51.1)
FM 1960 at Aldine Westfield Rd	B (15.3)	C (34.2)	E (68.1)	E (61.9)
FM 1960 at Birnamwood Blvd	A (9.7)	A (5.9)	D (43.6)	D (43.5)
FM 1960 at Richey Rd	A (3.6)	B (10.8)	B (12.3)	
FM 1960 at Farrell Rd	A (5.3)	B (10.3)	B (13.5)	
FM 1960 at Cypresswood Dr	A (8.7)	C (20.1)		D (40.6)
FM 1960 at Foxwood Forest Blvd	B (14.3)	D (37.8)		D (41.8)
FM 1960 at Lee Rd	D (46.3)	C (27.6)	E (56.5)	F (112.4)
FM 1960 at Kenswick Dr	B (17.4)	B (14.2)	E (66.4)	D (42.1)
FM 1960 at Deerbrook Park Blvd	B (12.1)	A (3.7)		E (76.5)
FM 1960 at Park at Humble Dwy	D (36.9)	A (5.6)	E (64.4)	F (88.5)
FM 1960 at Townsen Blvd W	E (75.6)	C (23.8)	E (64.3)	D (36.4)
FM 1960 at Sam's Club Dwy	A (3.7)	A (2.5)		D (49.7)
FM 1960 at Whitaker Rd	A (4.1)	A (6.5)	E (55.3)	
FM 1960 at Mall Entrance 2	A (1.4)	A (0.4)		D (49.9)
FM 1960 at Mall Entrance 1	A (4.6)	A (4.3)	D (52.3)	E (57.2)
FM 1960 at I-69 SB Frontage Rd	D (38.4)	A (1.9)		D (40.3)
FM 1960 at I-69 NB Frontage Rd	A (1.1)	C (34.1)	D (41)	
FM 1960 at N. Houston Ave	B (14.6)	B (14.8)	E (65.6)	E (60.5)
FM 1960 at Wilson Rd	B (14.3)	B (13.3)	E (61.8)	E (72)
FM 1960 at BF 1960A	A (8.5)	C (26.1)	A (8.4)	

Delay units in seconds per vehicle.
LOS = Level of Service.
NB = Northbound.
SB = Southbound.

Table 9: Intersection Approach Delay and LOS – Short-Range Build Conditions – PM Peak Hour

Intersection	Approach			
	Eastbound LOS (Delay)	Westbound LOS (Delay)	Northbound LOS (Delay)	Southbound LOS (Delay)
FM 1960 at Imperial Valley Dr	C (25.6)	B (14.7)	E (63.3)	E (61.7)
FM 1960 at Carlsway Rd	A (2.3)	A (6.1)	E (58)	E (57.5)
FM 1960 at Greenbrook Dr	A (3.4)	A (4.1)	D (43.7)	C (34.9)
FM 1960 at Briarcreek Blvd	B (13.4)	A (3.8)	-	D (44.2)
FM 1960 at Treaschwig Rd	D (50.9)	C (21.9)	F (99.8)	C (20.3)
FM 1960 at Woodcreek N Dr	A (4.6)	A (5.8)	E (55.3)	C (26.4)
FM 1960 at Aldine Westfield Rd	C (32.1)	D (44.3)	D (48.4)	F (80.7)
FM 1960 at Birnamwood Blvd	A (4.9)	A (2.7)	D (39.7)	D (44.7)
FM 1960 at Richey Rd	A (9.4)	B (15.2)	B (19.7)	-
FM 1960 at Farrell Rd	A (7.3)	A (5.1)	B (19.4)	-
FM 1960 at Cypresswood Dr	B (14.4)	C (20.6)	-	D (43.4)
FM 1960 at Foxwood Forest Blvd	B (12)	C (27)	-	D (43.3)
FM 1960 at Lee Rd	E (64.3)	E (71.2)	D (40.9)	E (69.9)
FM 1960 at Kenswick Dr	B (18.8)	A (7.7)	E (62.4)	D (43.3)
FM 1960 at Deerbrook Park Blvd	A (3.8)	C (23)	-	E (72)
FM 1960 at Park at Humble Dwy	B (10.6)	B (14.2)	E (75.5)	F (80.6)
FM 1960 at Townsen Blvd W	E (61.1)	D (54.4)	E (78.6)	F (83.5)
FM 1960 at Sam's Club Dwy	A (8.4)	B (12.4)	E (79.2)	E (59.4)
FM 1960 at Whitaker Rd	B (10.2)	B (16.7)	F (103.4)	F (81.5)
FM 1960 at Mall Entrance 2	A (3.6)	A (1.2)	-	E (57.6)
FM 1960 at Mall Entrance 1	A (6.1)	C (23)	E (56.8)	E (66.5)
FM 1960 at I-69 SB Frontage Rd	C (24.1)	A (1.1)	-	E (56.1)
FM 1960 at I-69 NB Frontage Rd	A (1.1)	D (39.4)	E (58)	-
FM 1960 at N. Houston Ave	B (17.2)	C (33.9)	E (65)	E (75.3)
FM 1960 at Wilson Rd	B (14)	B (15.3)	E (59.9)	E (68.1)
FM 1960 at BF 1960A	B (10.7)	B (13)	B (14.6)	D (36.5)

Delay units in seconds per vehicle.
LOS = Level of Service.
NB = Northbound.
SB = Southbound.

Table 10: Intersection Approach Delay and LOS – Short-Range Build Conditions - Saturday Peak Hour

Intersection	Approach			
	Eastbound LOS (Delay)	Westbound LOS (Delay)	Northbound LOS (Delay)	Southbound LOS (Delay)
FM 1960 at Imperial Valley Dr	C (21.7)	B (18.9)	D (51.3)	D (50.4)
FM 1960 at Carlsway Rd	A (0.8)	A (3.5)	D (50.7)	D (44.2)
FM 1960 at Greenbrook Dr	A (3.1)	A (4.5)	D (42.4)	C (31.6)
FM 1960 at Briarcreek Blvd	A (2.8)	A (4.9)	-	D (37.6)
FM 1960 at Treaschwig Rd	C (26.7)	B (12.9)	D (41.9)	B (16.3)
FM 1960 at Woodcreek N Dr	A (3.1)	A (4.2)	D (45.1)	C (24.7)

Intersection	Approach			
	Eastbound LOS (Delay)	Westbound LOS (Delay)	Northbound LOS (Delay)	Southbound LOS (Delay)
FM 1960 at Aldine Westfield Rd	B (19.6)	C (23.7)	D (50.5)	D (54.6)
FM 1960 at Birnamwood Blvd	A (2.4)	A (1.6)	C (34.5)	E (56)
FM 1960 at Richey Rd	A (2.7)	A (6.3)	A (9)	-
FM 1960 at Farrell Rd	A (7.6)	A (5)	B (13.2)	-
FM 1960 at Cypresswood Dr	A (5.4)	B (11)	-	D (44.8)
FM 1960 at Foxwood Forest Blvd	B (13.4)	C (24.5)	-	D (47)
FM 1960 at Lee Rd	D (40)	D (48.6)	D (40.6)	F (234.5)
FM 1960 at Kenswick Dr	B (15.4)	A (7.3)	E (69.2)	E (76.6)
FM 1960 at Deerbrook Park Blvd	A (4.6)	C (20.7)	-	E (74.3)
FM 1960 at Park at Humble Dwy	B (16.1)	B (16.5)	E (71.6)	F (84.7)
FM 1960 at Townsen Blvd W	E (71.4)	D (54.4)	E (75.3)	F (84.5)
FM 1960 at Sam's Club Dwy	B (12.8)	B (14.6)	F (91.3)	F (109.6)
FM 1960 at Whitaker Rd	B (11.2)	C (21.2)	E (63.9)	E (77.9)
FM 1960 at Mall Entrance 2	A (5.2)	A (3.9)	-	F (109)
FM 1960 at Mall Entrance 1	B (10.6)	D (40.9)	E (74)	F (88.2)
FM 1960 at I-69 SB Frontage Rd	C (30.7)	A (1.5)	-	E (71.8)
FM 1960 at I-69 NB Frontage Rd	A (1.5)	D (52.7)	D (48.5)	-
FM 1960 at N. Houston Ave	B (11.6)	B (13.5)	E (68.2)	A (4.6)
FM 1960 at Wilson Rd	C (20.6)	B (11)	E (61.4)	E (67.4)
FM 1960 at BF 1960A	A (3.2)	B (13.3)	B (10.1)	B (13.2)

Delay units in seconds per vehicle.
LOS = Level of Service.
NB = Northbound.
SB = Southbound.

8 YEAR 2024 TRAFFIC OPERATIONS ANALYSIS

It is anticipated that the proposed short-range improvements will be implemented within 5 years. Traffic operations analysis for 2024 was performed for no-build and build conditions to evaluate the performance of proposed short-range improvements and ensure that design features such as signal upgrades and phasing, U-turn locations, and turn-lane improvements perform acceptably upon their implementation.

The AM, PM, and Saturday peak-hour traffic operations analyses for 2024 no-build and build scenarios were performed using the calibrated VISSIM models. Projected 2024 traffic volumes were coded into the previously developed existing and existing build models, signal timings were optimized based on the projected traffic demands, and model runs were conducted to obtain analysis results. The signal timings for year 2024 scenarios were optimized using Synchro software before being imported into VISSIM. Traffic operations analysis results for Year 2024 scenarios are presented below.

8.1 Year 2024 No-Build

Capacity analysis results for 2024 no-build conditions show that traffic operations are expected to worsen as demand increases, particularly at intersection approaches that are already at/over-capacity in existing conditions. Most mainline approaches still perform at LOS D or better; however, several additional mainline intersection approaches operate at LOS E or F as existing bottlenecks intensify and cause queue spillbacks into adjacent intersections. Side-street approaches are expected to experience significant increases in delay as the side-street approaches compete with the congested mainline approaches for green time. Capacity analysis results for Year 2024 no-build conditions are presented in Tables 11 to 13. The results show a 91% percent increase in total intersection peak hour delay compared to existing conditions if no improvements are made.

As seen in the pictures, the southbound approach geometry for Treaschwig Road has changed since the existing conditions data were collected. The change in the southbound right turn movement configuration from dual right to right and a shared right coupled with the increase in AM peak hour southbound right turn demand from 1345 veh/hr to 1530 veh/hr results in the southbound approach LOS increasing from LOS C (existing) to LOS F (2024 no-build). Additionally, the eastbound left turn (375 veh/hr to 425 veh/hr) westbound through (1970 veh/hr to 2240 veh/hr) and eastbound through (1835 veh/hr to 2085 veh/hr) AM peak hour volumes also increased from existing to 2024 conditions. These volume increases result in the eastbound (LOS C to LOS F) and westbound (LOS D to LOS E) LOS to deteriorate significantly from existing to 2024 no-build conditions. The resulting queues spill back from Treaschwig Road into Briarcreek Boulevard and Woodcreek Drive North, deteriorating LOS at those intersections.

Table 11: Intersection Approach Delay and LOS – Year 2024 No-Build Conditions – AM Peak Hour

Intersection	Approach			
	Eastbound LOS (Delay)	Westbound LOS (Delay)	Northbound LOS (Delay)	Southbound LOS (Delay)
FM 1960 at Imperial Valley Dr	C (27.6)	B (16.4)	F (144.7)	D (54.4)
FM 1960 at Carlsway Rd	A (1.5)	A (4.3)	D (49.3)	E (55.4)
FM 1960 at Greenbrook Dr	A (6.1)	A (5.9)	D (39.6)	C (34.8)
FM 1960 at Briarcreek Blvd	C (26.7)	A (3.1)	-	F (111.8)
FM 1960 at Treaschwig Rd	F (180.8)	E (55.9)	C (27.1)	F (262.8)
FM 1960 at Woodcreek N Dr	A (3.4)	F (87.8)	F (256.2)	E (60.5)
FM 1960 at Aldine Westfield Rd	C (23.1)	D (54.1)	F (118.2)	E (78.6)
FM 1960 at Birnamwood Blvd	A (8.8)	A (7.8)	D (42.5)	D (43.8)
FM 1960 at Richey Rd	A (6.2)	A (9.4)	B (11.6)	-
FM 1960 at Farrell Rd	A (5.6)	B (18.7)	B (12.5)	-
FM 1960 at Cypresswood Dr	C (23.4)	D (41.6)	-	E (66.3)

Intersection	Approach			
	Eastbound LOS (Delay)	Westbound LOS (Delay)	Northbound LOS (Delay)	Southbound LOS (Delay)
FM 1960 at Foxwood Forest Blvd	E (62.9)	D (44)	-	E (56.5)
FM 1960 at Lee Rd	E (70.5)	F (88.8)	E (57.7)	F (121.7)
FM 1960 at Kenswick Dr	D (46.4)	D (40.9)	E (70.9)	F (193)
FM 1960 at Deerbrook Park Blvd	A (9)	A (5.4)	-	F (93.1)
FM 1960 at Park at Humble Dwy	A (4)	A (5.2)	D (46.5)	E (73.5)
FM 1960 at Townsen Blvd W	B (19.7)	B (16.8)	E (65.6)	D (38.5)
FM 1960 at Sam's Club Dwy	A (5.1)	A (2)	-	D (50.5)
FM 1960 at Whitaker Rd	A (6.9)	A (5.6)	E (57.7)	-
FM 1960 at Mall Entrance 2	A (1.8)	A (0.4)	-	D (52)
FM 1960 at Mall Entrance 1	A (3.9)	A (1.9)	D (48.8)	E (64.3)
FM 1960 at I-69 SB frontage Rd	D (41)	A (4)	-	D (40.3)
FM 1960 at I-69 NB frontage Rd	A (2)	E (69)	D (46.4)	-
FM 1960 at N. Houston Ave	B (17.1)	C (20.3)	E (72.3)	E (63.7)
FM 1960 at Wilson Rd	B (14.7)	B (17.3)	E (61.8)	F (97.6)
FM 1960 at BF 1960A	A (6.5)	B (15.8)	B (10.7)	-

Delay units in seconds per vehicle.
LOS = Level of Service.
NB = Northbound.
SB = Southbound.

Table 12: Intersection Approach Delay and LOS – Year 2024 No-Build Conditions – PM Peak Hour

Intersection	Approach			
	Eastbound LOS (Delay)	Westbound LOS (Delay)	Northbound LOS (Delay)	Southbound LOS (Delay)
FM 1960 at Imperial Valley Dr	D (35)	B (19.6)	F (96)	E (63.9)
FM 1960 at Carlsway Rd	A (2.5)	B (10.4)	E (56.7)	E (57.6)
FM 1960 at Greenbrook Dr	A (5.7)	A (5.5)	D (42.3)	D (36.2)
FM 1960 at Briarcreek Blvd	C (21)	A (4.7)	-	E (58.1)
FM 1960 at Treaschwig Rd	E (60.5)	D (45)	F (561.5)	F (147.5)
FM 1960 at Woodcreek N Dr	A (8)	F (105.7)	D (54.6)	D (50.8)
FM 1960 at Aldine Westfield Rd	D (35.1)	D (50.7)	F (97.9)	F (93.6)
FM 1960 at Birnamwood Blvd	A (6.8)	A (3.1)	D (38.9)	D (42.7)
FM 1960 at Richey Rd	B (12.3)	B (18.2)	C (23.9)	-
FM 1960 at Farrell Rd	B (10.5)	A (7.9)	C (27.1)	-
FM 1960 at Cypresswood Dr	C (34.2)	C (24)	-	D (43.6)
FM 1960 at Foxwood Forest Blvd	D (38.3)	C (33)	-	D (50)
FM 1960 at Lee Rd	F (121.9)	F (174.1)	D (42.1)	E (78)
FM 1960 at Kenswick Dr	F (155.6)	C (30)	F (160)	F (81.8)
FM 1960 at Deerbrook Park Blvd	B (16.1)	C (24.8)	-	F (89.4)
FM 1960 at Park at Humble Dwy	C (28.9)	B (14)	E (60.3)	F (82.5)
FM 1960 at Townsen Blvd W	E (59.2)	F (107.8)	F (725.5)	F (271.5)
FM 1960 at Sam's Club Dwy	A (0.8)	F (82.8)	F (86.2)	E (65.4)

Intersection	Approach			
	Eastbound LOS (Delay)	Westbound LOS (Delay)	Northbound LOS (Delay)	Southbound LOS (Delay)
FM 1960 at Whitaker Rd	B (12.2)	E (62.1)	F (544.8)	F (143)
FM 1960 at Mall Entrance 2	A (6.9)	B (19.3)	-	E (61.5)
FM 1960 at Mall Entrance 1	B (18.6)	B (19.6)	E (56.2)	E (71.7)
FM 1960 at I-69 SB Frontage Rd	E (57.7)	A (4.9)	-	E (61.6)
FM 1960 at I-69 NB Frontage Rd	A (1.2)	E (78.9)	F (314.8)	-
FM 1960 at N. Houston Ave	C (21.6)	D (46.4)	E (66)	F (84.8)
FM 1960 at Wilson Rd	B (17.2)	C (23.1)	D (50.9)	F (265)
FM 1960 at BF 1960A	A (4.1)	B (12.7)	D (53)	D (36.3)

Delay units in seconds per vehicle.
LOS = Level of Service.
NB = Northbound.
SB = Southbound.

Table 13: Intersection Approach Delay and LOS – Year 2024 No-Build Conditions - Saturday Peak Hour

Intersection	Approach			
	Eastbound LOS (Delay)	Westbound LOS (Delay)	Northbound LOS (Delay)	Southbound LOS (Delay)
FM 1960 at Imperial Valley Dr	C (27.9)	C (20.5)	E (57.3)	D (51.7)
FM 1960 at Carlsway Rd	A (0.8)	A (3.2)	D (54.3)	D (45)
FM 1960 at Greenbrook Dr	A (3.5)	A (3.3)	D (42.6)	C (29.5)
FM 1960 at Briarcreek Blvd	A (9.4)	A (4)	-	D (38.2)
FM 1960 at Treaschwig Rd	D (36.4)	C (20.1)	D (42.8)	C (26.3)
FM 1960 at Woodcreek N Dr	A (4.2)	A (6.9)	D (43.9)	C (24)
FM 1960 at Aldine Westfield Rd	B (18.3)	C (21.6)	D (48.1)	F (359.3)
FM 1960 at Birnamwood Blvd	A (2.7)	A (1.5)	C (32.1)	E (55.9)
FM 1960 at Richey Rd	A (3.6)	A (5.4)	A (10)	-
FM 1960 at Farrell Rd	A (9.4)	A (6.3)	B (14.5)	-
FM 1960 at Cypresswood Dr	A (6.1)	B (19.6)	-	D (44.8)
FM 1960 at Foxwood Forest Blvd	B (14)	C (27.4)	-	D (48.5)
FM 1960 at Lee Rd	D (42.7)	F (95.2)	D (39.4)	F (372.7)
FM 1960 at Kenswick Dr	F (109.7)	B (10.7)	F (83.2)	E (73.2)
FM 1960 at Deerbrook Park Blvd	F (94)	C (24.1)	-	F (719.1)
FM 1960 at Park at Humble Dwy	F (111.3)	B (14.3)	E (71.6)	F (98.3)
FM 1960 at Townsen Blvd W	F (105.6)	F (120.1)	F (931.2)	F (365.7)
FM 1960 at Sam's Club Dwy	C (34.4)	E (75.4)	F (128.3)	F (401.2)
FM 1960 at Whitaker Rd	C (25.9)	E (73.1)	E (75.8)	F (132.9)
FM 1960 at Mall Entrance 2	D (38.5)	D (49.9)	-	F (367.1)
FM 1960 at Mall Entrance 1	C (27.4)	D (42.6)	F (98.7)	F (422.4)
FM 1960 at I-69 SB Frontage Rd	D (45.9)	B (16.8)	-	F (909.9)
FM 1960 at I-69 NB Frontage Rd	A (1.4)	F (172)	F (351.9)	-
FM 1960 at N. Houston Ave	C (22.3)	E (76.8)	E (64.6)	E (76.6)
FM 1960 at Wilson Rd	C (22.7)	D (42.5)	D (52)	F (115.6)

Intersection	Approach			
	Eastbound LOS (Delay)	Westbound LOS (Delay)	Northbound LOS (Delay)	Southbound LOS (Delay)
FM 1960 at BF 1960A	A (2.3)	B (18.8)	C (21.4)	C (34.7)

Delay units in seconds per vehicle.
LOS = Level of Service.
NB = Northbound.
SB = Southbound.

8.2 2024 Build

Traffic operations analysis for 2024 build conditions was performed by coding future-year volume projections into Year 2019 build models and optimizing signal timings based on projected traffic demands. Signal timings were optimized using Synchro software prior to being imported into VISSIM. As stated previously, the purpose of the Year 2024 build analysis is to evaluate the performance of proposed short-range improvements and ensure that design features perform acceptably during the 5-year horizon.

Intersection approach delay and LOS results presented in Tables 14 to 16 show that proposed short-range improvements yield a 54 percent reduction in the number of mainline approaches that perform at LOS E or F, and a significant reduction in delay at many side-street approaches compared to the 2024 no-build results. Overall, analysis results show a 38 percent reduction in total peak hour intersection delay throughout the corridor with 2024 build conditions when compared to 2024 no-build conditions.

Table 14: Intersection Approach Delay and LOS – Year 2024 Build Conditions – AM Peak Hour

Intersection	Approach			
	Eastbound LOS (Delay)	Westbound LOS (Delay)	Northbound LOS (Delay)	Southbound LOS (Delay)
FM 1960 at Imperial Valley Dr	C (23.8)	B (10.4)	F (146.4)	E (55.3)
FM 1960 at Carlsway Rd	A (1.6)	A (2.3)	D (53.1)	E (56.3)
FM 1960 at Greenbrook Dr	A (6.2)	A (7)	D (37.3)	D (35.2)
FM 1960 at Briarcreek Blvd	A (3.5)	A (3.9)	-	D (39.8)
FM 1960 at Treaschwig Rd	B (19.9)	D (42.9)	C (26.3)	C (27.9)
FM 1960 at Woodcreek N Dr	A (2.8)	D (46.3)	E (72)	F (137.5)
FM 1960 at Aldine Westfield Rd	C (20.7)	D (38)	F (158.9)	E (58.8)
FM 1960 at Birnamwood Blvd	B (10)	A (8.4)	D (43.3)	D (43.4)
FM 1960 at Richey Rd	A (3.9)	B (10.6)	B (13.3)	-
FM 1960 at Farrell Rd	A (5.2)	B (16.7)	B (14.8)	-
FM 1960 at Cypresswood Dr	B (11.7)	C (30.7)	-	E (73.5)
FM 1960 at Foxwood Forest Blvd	B (14.5)	E (62)	-	D (51.2)
FM 1960 at Lee Rd	F (82.5)	E (67.8)	E (57.2)	F (138.9)
FM 1960 at Kenswick Dr	D (45.6)	C (24)	E (65.3)	F (187)
FM 1960 at Deerbrook Park Blvd	A (9.6)	A (4.7)		F (82.3)
FM 1960 at Park at Humble Dwy	A (5.4)	A (5.8)	D (46.6)	E (73.9)
FM 1960 at Townsen Blvd W	C (28.7)	C (31.3)	E (65.3)	D (52.5)
FM 1960 at Sam's Club Dwy	A (5.9)	A (2.9)	-	D (50.9)

Intersection	Approach			
	Eastbound LOS (Delay)	Westbound LOS (Delay)	Northbound LOS (Delay)	Southbound LOS (Delay)
FM 1960 at Whitaker Rd	A (5.4)	A (5.8)	E (63.1)	-
FM 1960 at Mall Entrance 2	A (1.8)	A (0.4)	-	D (48.3)
FM 1960 at Mall Entrance 1	A (4.8)	A (3.7)	D (48.9)	E (60.2)
FM 1960 at I-69 SB Frontage Rd	D (43.4)	A (3.2)	-	D (53)
FM 1960 at I-69 NB Frontage Rd	A (1.6)	C (28.2)	D (39.2)	-
FM 1960 at N. Houston Ave	B (17.4)	B (19.4)	E (72.4)	E (64.2)
FM 1960 at Wilson Rd	B (13.9)	B (17.3)	E (64.9)	E (73.7)
FM 1960 at BF 1960A	A (8.2)	B (14.8)	B (11.3)	-

Delay units in seconds per vehicle.
LOS = Level of Service.
NB = Northbound.
SB = Southbound.

Table 15: Intersection Approach Delay and LOS – Year 2024 Build Conditions – PM Peak Hour

Intersection	Approach			
	Eastbound LOS (Delay)	Westbound LOS (Delay)	Northbound LOS (Delay)	Southbound LOS (Delay)
FM 1960 at Imperial Valley Dr	C (27.8)	B (16.3)	F (103.2)	E (65.1)
FM 1960 at Carlsway Rd	A (2.8)	A (8.3)	E (57.4)	E (58)
FM 1960 at Greenbrook Dr	A (4.9)	A (5)	D (42.2)	D (36)
FM 1960 at Briarcreek Blvd	B (17.2)	A (4.3)	-	D (44.7)
FM 1960 at Treaschwig Rd	D (52.2)	D (37.3)	F (91)	C (27.3)
FM 1960 at Woodcreek N Dr	A (7)	D (52.3)	D (54.7)	D (39.5)
FM 1960 at Aldine Westfield Rd	D (37.8)	D (53.8)	F (94.2)	F (102.9)
FM 1960 at Birnamwood Blvd	A (6.3)	A (2.9)	D (39.2)	D (43)
FM 1960 at Richey Rd	B (12.9)	B (18.7)	C (24.4)	-
FM 1960 at Farrell Rd	A (10)	A (5.8)	C (26.4)	-
FM 1960 at Cypresswood Dr	C (31.6)	C (25)	-	D (43.3)
FM 1960 at Foxwood Forest Blvd	D (39.6)	C (34.1)	-	D (53.2)
FM 1960 at Lee Rd	F (115)	F (184.5)	D (41.7)	F (91.2)
FM 1960 at Kenswick Dr	C (28.7)	B (12.3)	E (65.6)	F (86)
FM 1960 at Deerbrook Park Blvd	A (4.1)	C (34.6)	-	E (75.9)
FM 1960 at Park at Humble Dwy	A (9.6)	A (9.7)	E (59.4)	F (82.4)
FM 1960 at Townsen Blvd W	D (52.6)	F (82.6)	F (287.1)	F (135.5)
FM 1960 at Sam's Club Dwy	B (12.2)	C (22.8)	F (90.6)	E (61.1)
FM 1960 at Whitaker Rd	B (13.7)	C (23.9)	F (118.1)	F (94.3)
FM 1960 at Mall Entrance 2	B (19.8)	A (1.2)	-	E (58.9)
FM 1960 at Mall Entrance 1	C (31.8)	C (20.5)	E (55.6)	E (67.7)
FM 1960 at I-69 SB Frontage Rd	E (67)	A (1.7)	-	E (61.5)
FM 1960 at I-69 NB Frontage Rd	A (1.3)	F (85.5)	E (61.4)	-
FM 1960 at N. Houston Ave	C (23.4)	D (46.6)	E (65.9)	F (84.2)
FM 1960 at Wilson Rd	B (12)	B (19)	E (60.9)	E (70)

Intersection	Approach			
	Eastbound LOS (Delay)	Westbound LOS (Delay)	Northbound LOS (Delay)	Southbound LOS (Delay)
FM 1960 at BF 1960A	A (5.8)	B (11.8)	E (55.1)	D (36)

Delay units in seconds per vehicle.
LOS = Level of Service.
NB = Northbound.
SB = Southbound.

Table 16: Intersection Approach Delay and LOS – Year 2024 Build Conditions –Saturday Peak Hour

Intersection	Approach			
	Eastbound LOS (Delay)	Westbound LOS (Delay)	Northbound LOS (Delay)	Southbound LOS (Delay)
FM 1960 at Imperial Valley Dr	C (22.7)	C (21.7)	E (57.8)	D (51.8)
FM 1960 at Carlsway Rd	A (0.8)	A (4.5)	D (53.9)	D (44)
FM 1960 at Greenbrook Dr	A (3.3)	A (5.4)	D (42.4)	C (29.4)
FM 1960 at Briarcreek Blvd	A (3.1)	A (5.2)	-	D (37.7)
FM 1960 at Treaschwig Rd	C (26.8)	B (16.6)	D (40.8)	B (15.9)
FM 1960 at Woodcreek N Dr	A (3.5)	A (5.3)	D (44.1)	C (24.2)
FM 1960 at Aldine Westfield Rd	D (45.1)	C (27.6)	D (51.7)	D (55)
FM 1960 at Birnamwood Blvd	A (2.6)	A (1.6)	C (34.7)	E (58.6)
FM 1960 at Richey Rd	A (3.2)	A (6)	A (9.8)	-
FM 1960 at Farrell Rd	A (8.4)	A (5.5)	B (14.5)	-
FM 1960 at Cypresswood Dr	A (5.9)	B (14.2)	-	D (45.5)
FM 1960 at Foxwood Forest Blvd	B (14.5)	C (29.5)	-	D (47.4)
FM 1960 at Lee Rd	E (59.6)	E (57.1)	D (43.4)	F (106.5)
FM 1960 at Kenswick Dr	B (16)	A (7.5)	E (72.4)	F (83.4)
FM 1960 at Deerbrook Park Blvd	A (5.1)	C (26)	-	E (75.4)
FM 1960 at Park at Humble Dwy	B (12.2)	B (18.5)	D (49.8)	F (90.8)
FM 1960 at Townsen Blvd W	E (60.6)	E (60.2)	F (355.6)	E (62)
FM 1960 at Sam's Club Dwy	B (17.1)	B (15.9)	F (105.8)	F (182.9)
FM 1960 at Whitaker Rd	B (14.4)	C (25.9)	E (76.6)	F (86.2)
FM 1960 at Mall Entrance 2	C (26.3)	A (6.3)	-	F (131.8)
FM 1960 at Mall Entrance 1	C (32.4)	D (43.6)	F (80.1)	F (81.3)
FM 1960 at I-69 SB Frontage Rd	D (40)	A (1.9)	-	F (365.8)
FM 1960 at I-69 NB Frontage Rd	A (1.4)	F (160.2)	F (81.4)	-
FM 1960 at N. Houston Ave	B (19.5)	C (28.6)	E (65.7)	E (72.8)
FM 1960 at Wilson Rd	B (16.2)	B (14.4)	E (59.9)	E (67.6)
FM 1960 at BF 1960A	A (2.4)	B (11.8)	C (23.5)	B (10.4)

Delay units in seconds per vehicle.
LOS = Level of Service.
NB = Northbound.
SB = Southbound.

9 PROJECT BENEFITS

Operational benefits of proposed short-range improvements were quantified using travel time results from existing conditions and existing-condition-build VISSIM models. Safety benefits of proposed improvements were quantified by using FHWA's Highway Safety Manual methodology through application of crash modification factors corresponding to short-range improvements. Table 17 shows the expected travel time savings, and Table 18 shows the crash reductions from implementation of the short-range solutions.

Table 17: Expected Peak-Hour Travel Time Savings Due to Short-Range Improvements

Scenario	AM Peak-Hour Travel Times (mm:ss)		PM Peak-Hour Travel Times (mm:ss)		Saturday Peak-Hour Travel Times (mm:ss)	
	EB	WB	EB	WB	EB	WB
Existing Conditions	18:39	20:25	20:52	23:20	18:58	20:27
Existing Build Conditions	17:42	18:25	18:58	20:51	17:28	19:41
Travel Time Savings	-5.1%	-9.8%	-9.1%	-10.6%	-7.9%	-3.7%

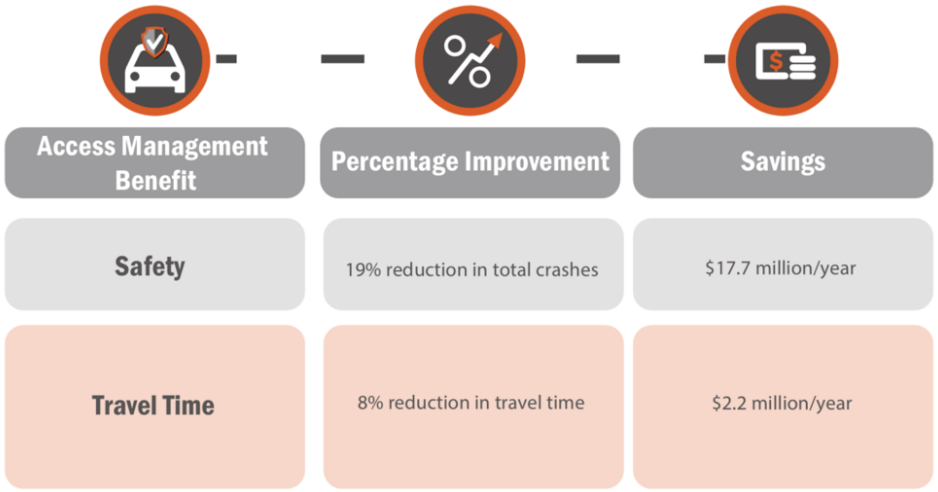
Delay units in seconds per vehicle.
EB = Eastbound.
mm:ss = Minutes:seconds.
WB = Westbound.

Table 18: Expected Yearly Crash Reductions Due to Short-Range Improvements

Type of Crash	Before	After	Reduction
Fatal	5.33	4.01	1.32
Incapacitating Injury	18.33	15.40	2.94
Non-incapacitating Injury	72.33	59.12	13.21
Possible Injury	110.33	90.34	19.99
Property Damage Only	720.33	582.47	137.86

Monetary benefits of proposed improvements were calculated using TTI's 2019 road user cost estimates and FHWA's 2018 Crash Costs for Highway Safety Analysis.

Project benefits are summarized on Figure 18. It should be noted that project benefits do not consider medium-range or long-range improvement opportunities.



1. Crash modification factors obtained from The Crash Modification Factors Clearinghouse.
2. Safety costs based on Crash Costs for Highway Safety Analysis, FHWA, 2018.
3. Travel time costs based on the Updated Estimate of Roadway User Cost for Personal Vehicles and Commercial Trucks memorandum, TTI, 2019.

Figure 18: Short-Range Improvement Benefits

10 PLANNING-LEVEL COST ESTIMATE

A planning-level cost estimate was prepared for the proposed short-range, medium-range, and long-range improvements, as shown on Figure 19. Estimated construction costs are segmented by state, county, and city based on ownership of the roadway. It is anticipated that improvements to mainline FM 1960 and side streets that are state routes will be funded by TxDOT, while side-street improvements on non-state routes will be funded by responsible local agencies including City of Houston, City of Humble, and Harris County. The total estimated construction cost is approximately 36.5 million for short-range and medium-range improvements, and approximately 52.5 million for long-range improvements.

COST OF SHORT-/ MEDIUM-RANGE IMPROVEMENTS

Improvements	Quantity	Unit	TxDOT	City of Houston	City of Humble	Harris County	Subtotal	Total
Install Sidewalk	5.0	Miles	$1,177,645	-	-	-	$1,177,645	$36,361,942
Provide Raised Median	9.5	Miles	$6,224,474	-	$22,518	-	$6,246,992	
Perform Drainage Enhancements *	36	EA	$10,796,142	-	$1,534	$4,294	$10,801,970	
Construct Additional Pavement	27	EA	$4,316,618	-	$576,909	$541,755	$5,435,282	
Provide Pavement Marking for Vehicles and Bicyclists (E.g. Bike Buffer and Bike Lane Marking)	11	Miles	$1,503,275	$50,000	$12,343	$10,601	$1,576,219	
Provide Intelligent Transportation Systems (E.g. Dynamic Message Signs, Bluetooth Sensors, Radars, Preemption Devices, CCTV Cameras)	1	Lump Sum	$6,962,915	-	-	-	$6,962,915	
Install Lighting	1	Lump Sum	$3,860,920	-	-	-	$3,860,920	
Perform Signal Timing Optimization	27	EA	$300,000	-	-	-	$300,000	
Subtotal			**$35,141,989**	**$50,000**	**$613,304**	**$556,649**		

NOTE: * Drainage enhancements will be necessary due to construction of additional pavement

COST OF LONG-RANGE IMPROVEMENTS

Improvements	Quantity	Unit	TxDOT	City of Houston	City of Humble	Harris County	Subtotal	Total
Construct Deceleration Lanes along I-69 Southbound Frontage Road	1	Lump Sum	$215,805	-	-	-	$215,805	$52,425,445
Construct an Echelon Interchange at FM 1960 and I-69	1	Lump Sum	$40,761,633	-	-	-	$40,761,633	
Construct a Quadrant Intersection at FM 1960 and Lee Rd	1	Lump Sum	-	$6,232,075	-	-	$6,232,075	
Construct a Connector Roadway between Townsen Blvd and Upwood Dr	1	Lump Sum	-	-	$3,378,136	-	$3,378,136	
Construct a Box Diamond at BF 1960A at I-69	1	Lump Sum	$1,837,796	-	-	-	$1,837,796	
Subtotal			**$42,815,234**	**$6,232,075**	**$3,378,136**	**$0**		

Notes:
1. Cost estimates are based on TxDOT unit costs as of January 2020 and other sources.
2. Contingencies of 10 percent have been included in all costs.

Figure 19: Planning-Level Construction Cost Estimate

11 SUMMARY OF PUBLIC INVOLVEMENT

A Public involvement Plan (PIP) was developed at the onset of the study and updated as necessary to adapt to the ever-evolving public involvement needs along the corridor. The PIP consisted of a range of goals and strategies centered on proactively engaging and informing the public, agencies with jurisdiction, and community stakeholders throughout the development of the study, as well as obtaining their input to inform decision making. The public involvement process for the study engaged stakeholders and the public to help TxDOT define the traffic mobility and safety issues, establish goals that will define success in addressing those issues, communicate solutions proposed by the project team, and solicit feedback to inform the final set of proposed solutions. Overall, the public involvement activities included four steering committee meetings, five stakeholder meetings, and two sets of public meetings.

The goals of the public involvement included:

- Employing an open communication process that encourages the public and stakeholders to stay informed on the progress of the study and offers opportunities for input into the decision-making process.
- Providing opportunities for the public to provide input into the study decision-making.
- Providing outreach to key agency representatives, elected officials, local businesses, first responders, schools and independent school districts, and community organizations; and maintaining communications with these entities throughout the study.
- Ensuring that underserved, limited English proficient (LEP) and Title VI populations are provided with an effective opportunity to participate in the study.

Detailed documentation of public involvement activities, outreach efforts, and outcomes are provided in Appendix K.

11.1 Contract Steering Committee

A steering committee composed of potentially impacted government entities and community representatives was established to guide the development of the study. The Contract Steering Committees' role was to:

- Identify project stakeholders
- Provide input on known issues to establish existing conditions
- Collaborate with the project team to develop study goals
- Provide input on proposed improvements
- Provide input on evaluation and screen criteria
- Provide input to refine and prioritize the proposed improvements
- Ideate funding opportunities to support medium and long-range improvements

The committee was composed of representatives from TxDOT, City of Houston, City of Humble, Harris County, H-GAC, METRO, Partnership Lake Houston (formerly Lake Houston Area Chamber of Commerce and Lake Houston area Economic Development Partnership), North Houston Association, Lake Houston Redevelopment Authority, and Brookfield Properties:

- Catherine McCreight (TxDOT)
- Qing Li (TxDOT)
- Ana Ramirez Huerta (TxDOT)
- Danny Perez (TxDOT)
- Jeffrey English (TxDOT)
- John Elam (TxDOT)
- Phillip Garlin (TxDOT)
- Amy Redmond (TxDOT)
- Seung Yoo (TxDOT)
- Yue Zhang (TXDOT)
- Austin Appleton (Harris County)
- Brannan Hicks (Harris County)
- Michael Turner (Harris County)
- Suzanna Set (Harris County)
- Khang Nguyen (City of Houston)
- Sharon Moses Burnside (City of Houston)
- Mark Arnold (City of Humble)
- Kenneth Brown (METRO)
- Ella Collins (METRO)
- Stephen Gage (H-GAC)
- Jenna Armstrong (Partnership Lake Houston)
- Mark Mitchel (Partnership Lake Houston)
- Marlisa Briggs (North Houston Association)
- Stan Sarman (Lake Houston Redevelopment Authority)
- Carlos Limontes (Brookfield Properties)

The project team met with the committee four times during the course of the study:

- Steering Committee Meeting #1 (June 17, 2019) – Input on corridor issues and challenges, selection of study stakeholders, and establishment of study goals and objectives.
- Steering Committee Meeting #2 (August 22, 2019) – Discussion of existing corridor conditions and analyses results; presentation of exhibits and roll plots for the first set of public meetings.
- Steering Committee Meeting #3 (March 26, 2020) – Discussion of results from the first set of public meetings; presentation of improvement concepts, exhibits and roll plots for the second set of public meetings.
- Steering Committee Meeting #4 (December 10, 2020) – Discussion of results from the second set of public meetings; presentation of final recommendations, and agency responsibilities and costs.

11.2 Stakeholder Meetings

The study stakeholders were identified with input from the Contract Steering Committee. The goal of stakeholder engagement was to provide opportunities for key organizations and businesses within the community to stay informed on the progress of the study, and to offer opportunities for input into the study decision-making process. The study stakeholders were engaged periodically to explain to them the study analysis results, seek their input on corridor issues and challenges, obtain their input during alternatives development and refinement, and build community support for the final proposed solutions of the study.

The project team met with the stakeholders five times during the course of the study:

- Stakeholder Meeting #1 (July 2, 2019) – Meeting with Deerbrook Mall representatives to understand existing corridor issues and challenges, especially around the Deerbrook Mall.
- Stakeholder Meeting #2 (March 2, 2020) – Meeting with Deerbrook Mall to discuss preliminary recommendations and seek input.
- Stakeholder Meeting #3 (March 2, 2020) – Meeting with Humble, Aldine and Spring Independent School Districts to discuss preliminary recommendations and seek input.
- Stakeholder Meeting #4 (March 3, 2020) – Meeting with Northwest Cycling Club to discuss preliminary recommendations and seek input.
- Stakeholder Meeting #4 (March 25, 2020) – Meeting with First Responders to discuss preliminary recommendations and seek input.

11.3 Public Meetings

The project team invited the steering committee, stakeholders and public to attend two rounds of public meetings near the FM 1960 corridor. These meetings provided the opportunity for community members to express concerns while engaging in the development of access management improvements. The first round of public meetings focused on discussing existing conditions along the corridor, obtaining public input of specific issues, and gauging interest on potential improvements. The second round of public meetings focused on presenting and obtaining input on proposed improvements that were selected to address the identified operational and safety needs of the corridor.

The first round of public meetings were held on the following dates:

- Open House Option #1 - October 1, 2019 – Humble High School
- Open House Option #2 - October 3, 2019 – Nimitz High School

The first round of public meetings were conducted in an open house format, with attendees allowed to view study exhibits freely and interact with the project team. Exhibits included poster boards with information on various aspects of the project, and roll plots showing detailed information on existing conditions of the corridor. Additionally, meeting attendees were encouraged to participate in an online MetroQuest survey to rank study goals, rank potential access management tools, and provide specific feedback on a map of the corridor.

The second round of public meetings were conducted virtually due to COVD-19 restrictions. The meeting materials were available online for review from August 25, 2020 to September 8, 2020. The study team was available online to answer public's questions through a chat function within a virtual meeting platform on following dates:

- Virtual Open House Option #1 – August 25, 2020; 6 PM - 8 PM
- Virtual Open House Option #2 – August 26, 2020; 6 PM - 8 PM
- Virtual Open House Option #3 – August 27, 2020; 6 PM - 8 PM

The virtual platform was developed to provide an environment similar to that of an open house public meeting. Participates were able to receive step-by-step instructions to sign-in, view an introductory video, view study

exhibits and roll plots, and provide feedback through a MetroQuest survey. The platform also provided the attendees the contact information (phone number, email) for the project team to provide feedback later.

12 H-GAC TRANSPORTATION IMPROVEMENT PLAN (TIP) APPLICATION

Funding for the proposed short-range improvements will be requested through H-GAC Call for Transportation Projects. A draft application has been prepared for the 2021 H-GAC Call for Transportation Projects based on requirements in the 2018 Call for Transportation Projects using the collected data, analysis results, and estimated construction costs for the project. It should be noted that proposed ITS improvements are included in a separate TIP application. Draft H-GAC TIP applications are provided in Appendix L.

13 ELECTRONIC FILES

Electronic files from the study, including raw traffic volume data, MicroStation files, Excel files for estimates and TIP applications are provided in Appendix M.

APPENDIX A

Study Methodology Memorandum

APPENDIX B

Project Management Plan

APPENDIX C

Public Involvement Plan

APPENDIX D

Existing-Year (2019) Peak Hour Volumes

APPENDIX E

Year 2024 Peak Hour Volumes

APPENDIX F

Crash Analysis Report

APPENDIX G

Field Observations

APPENDIX H

Existing Conditions Traffic Analysis Report

APPENDIX I

Short-/Medium-Range Improvement Concepts

APPENDIX J

Long-Range Improvement Concepts

APPENDIX K

Public Involvement Memorandum

APPENDIX L

H-GAC TIP Applications

APPENDIX M

Electronic Files (Provided Separately)