State Highway 6
Corridor Access Management Plan

February 2008

Kimley-Horn and Associates, Inc.

In association with:
Reynolds, Smith and Hills, Inc.
Parsons Brinkerhoff Quade & Douglass, Inc.
Community Awareness Services, Inc.
CJ Hensch & Associates, Inc.

Funding Partners:
City of Houston
City of Missouri City
City of Sugar Land
Fort Bend County
Harris County
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Texas Department of Transportation

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Chapter 1: Introduction

This study was commissioned by the Houston-Galveston Area Council (H-GAC), and funded through a partnership of H-GAC, TxDOT, Harris County, Fort Bend County, City of Houston, City of Sugar Land, and Missouri City. These agencies are all part of a voluntary association of local governments and local elected officials in the 8-county Gulf Coast State Planning Region — an area of 8,500 square miles with more than 5.4 million people (see **Figure 1-1**). H-GAC works to promote efficient and accountable use of local, state, and federal tax dollars; serves as a problem-solving and information forum for local governments; and helps local governments, businesses, and civic organizations analyze trends and conditions affecting the area in order to respond to their needs.

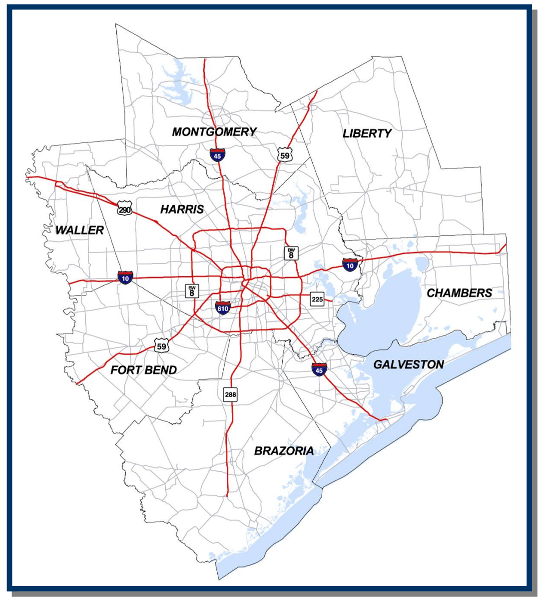


Figure 1-1: Metropolitan Planning Area

By 2035, the Houston-Galveston region's population is expected to reach 8.8 million. Employment forecasts reflect similar growth at an annual rate of 1.9%; reaching approximately 4 million by 2035 (source: HGAC 2035 RTP). This holds many opportunities for economic growth and diversification of the local economy. Such growth also presents many challenges to the natural and built environment. The regional transportation network is one such challenge. If it cannot provide an acceptable level of service (LOS) in the main travel corridors, the economy, community, and environment as a whole will suffer. This regional dilemma is being addressed by H-GAC's Transportation Department.

Figure 1-2: Corridor Study Area

H-GAC recognizes that a viable transportation network should include building roadways and transit connection, but also managing the existing network. One such way H-GAC is investing in the current network is through this study. "Access Management" is an optimal way of getting the most from your transportation system. Using strategies such as installing raised medians and providing adequately spaced driveways, access management will significantly improve the level of safety, efficiency, and effectiveness of the transportation system.

This study specifically targeted the SH 6 corridor from IH-10 to SH 521. As shown in **Figure 1-2**, the 23 miles of Texas Department of Transportation (TxDOT) roadway (under the H-GAC umbrella) bisects three cities and two counties. The 23-mile stretch of roadway varies from a high density urban commercial state highway to becoming a slightly undeveloped rural section. With connections to IH-10, Westheimer, Westpark Toll Road, 90A, US 59, Fort Bend Toll Way, and SH 521, it is obvious why SH 6 has quickly become a major thoroughfare for many local and regional travelers. It provides mobility and access to many retail, commercial, and residential developments. In addition, this corridor serves the main route for many commuters as well as an emergency evacuation route.

The purpose of this study is to provide agencies with a list of short-, medium-, and long-term solutions to relieve some of the current travel issues. This study will also examine alternative modes, including transit and pedestrians movements. Further, it will briefly look at the connections between land use and transportation and how future conditions can be better planned for today.

1.1. SH 6 Corridor Goals

Representatives from each city, county, and agency made up the Steering Committee that helped define the following five corridor goals:

- Improve Safety
- Identify Short-Term Transportation Solutions
- Improve Traffic Flow
- Reduce Motorist Delay
- Assess Long-Term Corridor Needs

The application of this study's access management recommendations and actions will move the involved communities toward these goals. The following details how these goals will be measured and achieved.

Goal 1: Improve Safety

Access management saves lives and reduces the frequency of injury and property damage crashes. The American Association of State Highway and Transportation Officials (AASHTO) indicate that 50% to 70% of all accidents are access related and could be relieved with proper access management strategies. As part of this report, each agency will be provided with the existing conditions and the project improvement to safety based on the recommendations of the consultant.

Goal 2: Identify Short-Term Transportation Solutions

This goal will be achieved by providing a list of projects that identifies the respective project limits, costs, and benefits. Again, a list and graphic of specific short-term improvements will be identified for each agency. These projects will include items that can be done within the current Right of Way such as raised medians, median opening closures, improved signal timing, intersection lane improvements, and driveway consolidation. These improvements when used concurrently have been known to reduce crashes by 50%.

Goal 3: Improve Traffic Flow

This measure will establish the improved traffic flow and the subsequent level of service, LOS, benefits from the improvements established in the previous goal. A current LOS will be evaluated based on available signal timing and traffic volumes. As improvements are developed their performance will be evaluated on their ability to improve the LOS within the intersection and along the corridor. Access Management strategies have been proven to increase the capacity of a roadway by 23% to 45% and can be demonstrated through an improved LOS.

Goal 4: Reduce Motorist Delay

Reducing the overall corridor delay as well as the individual intersection delay is a major issue along SH 6. The measures described herein will allow for the subsequent improvements to be evaluated and the benefits of each improvement documented. As computer models are developed to analyze the LOS based on volumes, signal timing, and lane configurations, these models can subsequently be used to estimate travel times for the current configurations versus the improved configuration. Each agency will be shown the predicted motorist delay improvement for their region while a total estimated improvement for the entire corridor will be presented. It will be delivered in two forms, a total delay and a per capita delay. The short term improvements discussed earlier have been known to reduce travel time within a corridor by up to 60%.

Goal 5: Assess Long-Term Corridor Needs

A list of medium- and long-range projects with estimated costs will be provided for each agency. These projects will focus on items that will take time, increased funds, or right of way to occur. By the nature of the time and costs associated, these projects are considered long-term improvements and are not necessary immediately to help reach the first four goals. These projects are focused on extensive driveway consolidation, back age roads, cross access, alternate mode plans, land use change, and policy implementation. The projects will use public private partnerships to make long range strides in the improvement of mobility, safety, and investment.

1.2. Study Process

- Extensive data collection
- Base map development
- Data analysis
- Public involvement
- Peer review
- Development of a final report

The first couple of months in the project focused primarily on data collection. This step of the process was directed toward receiving as much existing information from each agency to streamline the process. Specifically, the team worked toward a base condition; what are the current traffic volumes, signal timing, lane assignments, transit service, and access management policies. All of the information was summarized into map format and presented to the agencies as part of the steering committee meetings, (The steering committer is introduced in this chapter and further defined in Chapter 2). The agencies were given the opportunity to update information and to fill in gaps where needed. The result was a comprehensive database that was be used to develop and evaluate proposed improvements.

The next step of the process after the creation of the base condition was to initiate public and stakeholder meetings to help the team refine options and give overall guidance. The project steering committee played a crucial role in providing the team with insightful guidance as to who the major stakeholders were within each region. These meetings will be discussed further as part of the Chapter 2. Following the evaluation of the proposed improvements from the agencies, public, and stakeholders a final report was drafted, completing the project process. The graphic below (Figure 1-3) details the general process that was followed and corresponding month of completion.

Figure 1-3: Study Process

The following report sections details the SH 6 public involvement activities, discuss improvement options, and provides short-, medium-, and long-range improvements for each involved agency. One of the most important elements in a study of this nature is how the public is engaged. The following chapter discusses the pubic activities and associated comments and input.

1.3. EXISTING CORRIDOR ISSUES

The following section details the existing crash experiences and current traffic conditions from a corridor-wide perspective. For more detailed existing conditions data refer to **Chapters 4** through **6**.

Existing Collision Data

This section describes general crash trends and characteristics for the entire SH 6 project corridor. Currently, area agencies are in the process of updating the software used to archive collision information; therefore crash data from 1999 to 2001 was used to show overall trends within the corridor. The team was, however, able to pull current crash information in specific areas for detailed evaluation when needed. Throughout this report you will see the years analyzed clearly displayed.

The total number of crashes along the State Highway 6 project corridor increased steadily from 1999 through 2001, with a total of 2,096 crashes occurring over the three-year period. Compared to statewide and regional crash statistics, crash risk along SH 6 is higher than the statewide average but lower than the crash risk for the region as a whole, as seen in **Table 1-1**. Crash risk for the corridor is illustrated graphically in **Figure 1-4**, with bars showing crash rate within each of the jurisdictions included in the SH 6 project corridor.

	Total Crashes			Crashes per Million VMT
	1999	2000	2001	
Texas [1]	311,701	318,900	323,958	1.5
H-GAC Region (8 Counties) [1]	80,030	84,040	88,168	2.0
SH 6 Project Corridor [2]	638	686	772	1.9

Table 1-1: Statewide, Regional and Corridor Crash Statistics: 1999-2001

[1] Source: Dr. Ned Levine, Transportation Safety Coordinator, Houston-Galveston Area Council
[2] Source: Texas Department of Public Safety Crash Data: 1999-2001

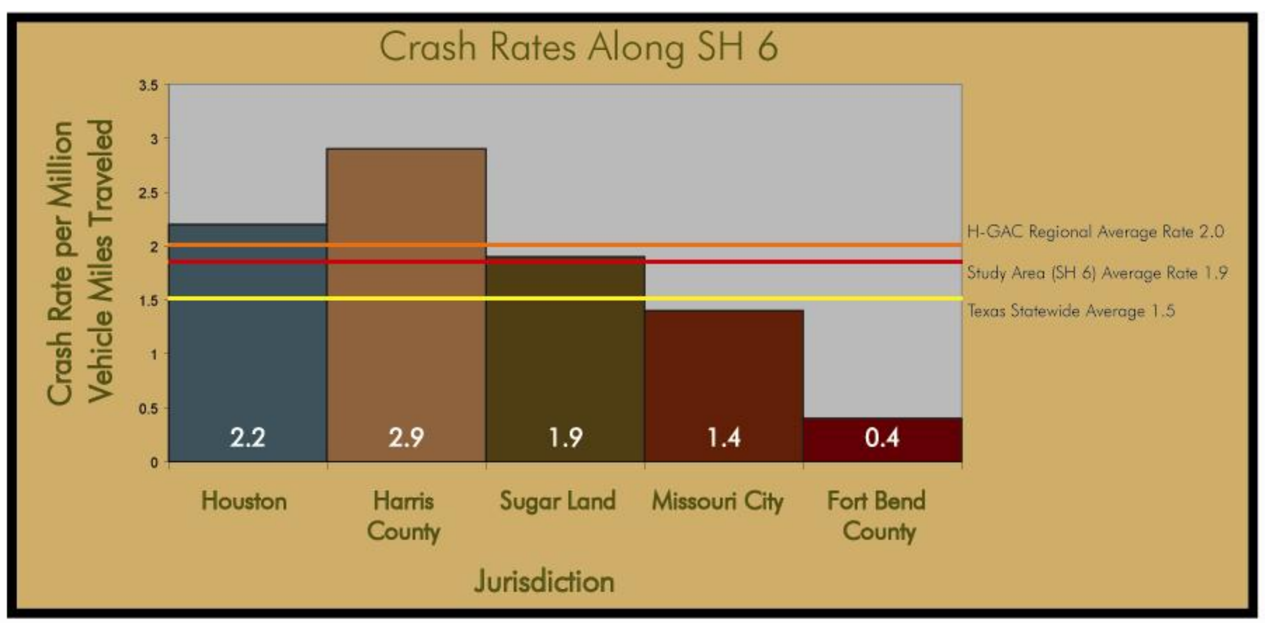


Figure 1-4: Crash Rate by Jurisdiction

Crash data from the years 1999, 2000, 2001 provided this study with a significant basis for analysis. The crash data was analyzed to determine the location, severity, and vehicle impacts. During the years 1999, 2000, 2001 a total of 2,096 crashes occurred along SH 6 including twenty fatalities and 298 incapacitating incidents. **Table 1-2** shows the crash data separated by severity for each City.

Cities	City of Houston	Harris County	City of Sugar Land	City of Missouri City	Fort Bend County	Total	% of Total
Fatality	4	7	5	4	0	20	1.0%
Type A - Incapacitating	20	30	35	24	2	111	5.3%
Type B -Non-Incapacitating	83	81	76	54	4	298	14.2%
Type C -Possible Injury	297	247	206	118	15	883	42.1%
No Injury /Not Reported	154	244	218	158	10	784	37.4%
Total	558	609	540	358	31	2096	100.0%

Table 1-2: Crash Data by Severity by Agency

The movements of the vehicles involved in the crashes were also analyzed. The 1999, 2000, 2001 crash data provided the direction of the crash along with the individual movements of each vehicle involved in the crash. The crash data were summarized to include the major crashes, categorized by the relative directions of the vehicles at time of impact. The serious impacts were determined to be: head-on, when multiple vehicles moving in a direction towards each other are involved in a crash; left-turn, when at least one of the vehicles involved in the crash was making a left-turn movement; right-turn, when at least one of the vehicles involved in the crash was making a right-turn movement; side impact, when at least one of the vehicles involved in the crash was struck perpendicular to the vehicle; and rear end, when at least one of the vehicles in the crash was struck from behind, either while driving or stopped, by another vehicle. The crashes that were categorized as "other" involve incidents including side-swipes and other non-major type collisions. The breakdown of these crashes can be seen in **Table 1-3.**

Movement Type	1999-2001 Crashes
Head-On	33
Side Impact	92
Rear End	1018
Right Angle	432
Driveway	343
Fixed Object	121
Other	57
Total	**2096**

Table 1-3: Crash Summary

Cost of Crashes

The National Safety Council was recently commissioned by the U.S. Congress to document and estimate the cost of motor vehicle crashes. Their estimates of cost per injury are listed in column two of **Table 1-4** below. These figures generate a total of $51 million worth of economic loss to the community over three years (1999 - 2001).

Severity	Cost per Injury	Total Crashes	Total Cost (rounded)
Fatality	$1,150,000	20	$23,000,000
Type A - Incapacitating	$60,500	111	$6,715,500
Type B - Non-Incapacitating	$19,600	298	$5,840,800
Type C - Possible Injury	$11,100	883	$9,801,300
No Injury / Not Reported	$7,500	784	$5,880,000
Total		2,096	$51,237,600

Table 1-4: Crash Cost Summary

The statistics shown above are appropriate for measuring the economic loss to the community resulting from past motor-vehicle crashes. They include the value of a person's natural desire to live longer or to protect the quality of one's life. That is, the economic loss estimates include what people are willing to pay for improved safety. Nevertheless, these estimates cannot fully represent the losses occurred when a person is involved in a serious motor vehicle crash.

Based on this data, five crash "hot spot" locations were defined. These locations experiences 60 or more crashes over a 3-year period and are identified as:

- IH-10 to Memorial Drive
- Piping Rock Lane to Richmond Avenue
- Westpark to Bissonnet
- US 90A to Brooks Street
- US 59 to Settlers Way

Table 1-8 summarizes crash statistics for each of the five "hot spot" locations. Crash risk was highest along the 0.8 mile segment from Piping Rock to Richmond, with a crash rate of 595 crashes per 100 million vehicle-miles traveled. The 2.9 mile segment from Westpark to Bissonnet experienced the highest number of total crashes, with 550 crashes occurring along this segment over the 3-year period.

Crash "Hot Spot"	Length (miles)	Jurisdiction	Crashes per Year			Total Crashes	Crashes per 100 Million VMT
1. IH-10 to Memorial Drive	0.6	Houston	64	65	70	199	503
2. Piping Rock to Richmond	0.8	Houston	92	96	58	246	595
3. Westpark to Bissonnet	2.9	Harris County	148	189	213	550	407
4. US 90A to Brooks Street	1.1	Sugar Land	39	45	38	122	259
5. US 59 to Settlers Way	1.7	Sugar Land	57	56	102	215	260

Table 1-5: Hot Spot Crash Statistics: 1999-2001

Source: Texas Department of Public Safety Crash Data: 1999-2001

The following sections will provide detailed crash data summaries for each intersection. However, further details on the "hot spot" crash locations including, recommendations for mitigation measures to improve safety along each segment, can be found as part of the appendix.

Existing Traffic Flows

Link Level of Service

Based on geographic location, three levels of capacity have been developed by H-GAC to better reflect travel patterns and roadway design characteristics. These capacities were further differentiated to reflect state standards for four facility types, as is shown below. These "evaluation" capacities include facility adjustments for signal green times, percent trucks, percent left turns, directional factors, etc. The following are 24-hours, per-lane capacities. For the SH 6 corridor the suburban arterial capacity of 6,250 was used to determine the link LOS. The calculated link LOS should be used for general information only. As with most urban and suburban facilities, the intersection LOS often determines the corridor's overall performance. Therefore, the following section "Intersection LOS / Delay" will play a major role in determining the final performance of the facility.

Facility Type	Urban	Suburban	Rural
Freeways	23,500	23,500	16,500
Tollways	18,000	18,000	---------
Expressways	11,000	11,000	---------
Arterials	7,500	6,250	5,000

Four levels of mobility (LOM), which are used to define congestion, were developed by the H-GAC Travel Modeling Committee in 1997 and approved by the Technical Advisory Committee (TAC). They are shown as follows:

LOM	Volume / Capacity	LOS
Tolerable	< 0.85	A, B, C, D
Moderate	>= 0.85 < 1.00	E
Serious	>= 1.00 < 1.25	F
Severe	>= 1.25	F

Roadways with a LOS of D were assumed to be the minimum acceptable mobility level for SH 6. Roadways with LOS of E or F (moderate, serious, severe) were identified as being congested. Roadways with a LOS of A through D (tolerable) were identified as not congested. Figure 1-6 demonstrates the average service levels along the corridor.

LOS was determined for SH 6 using Synchro™ software, which uses signalized intersection LOS to calculate LOS for sections on arterials. The different values for approach LOS are combined by Synchro™ to give an average LOS for the overall intersection. A detailed intersection by intersection diagram for both the AM and PM peak travel periods can be found in Chapter 4 through 6.

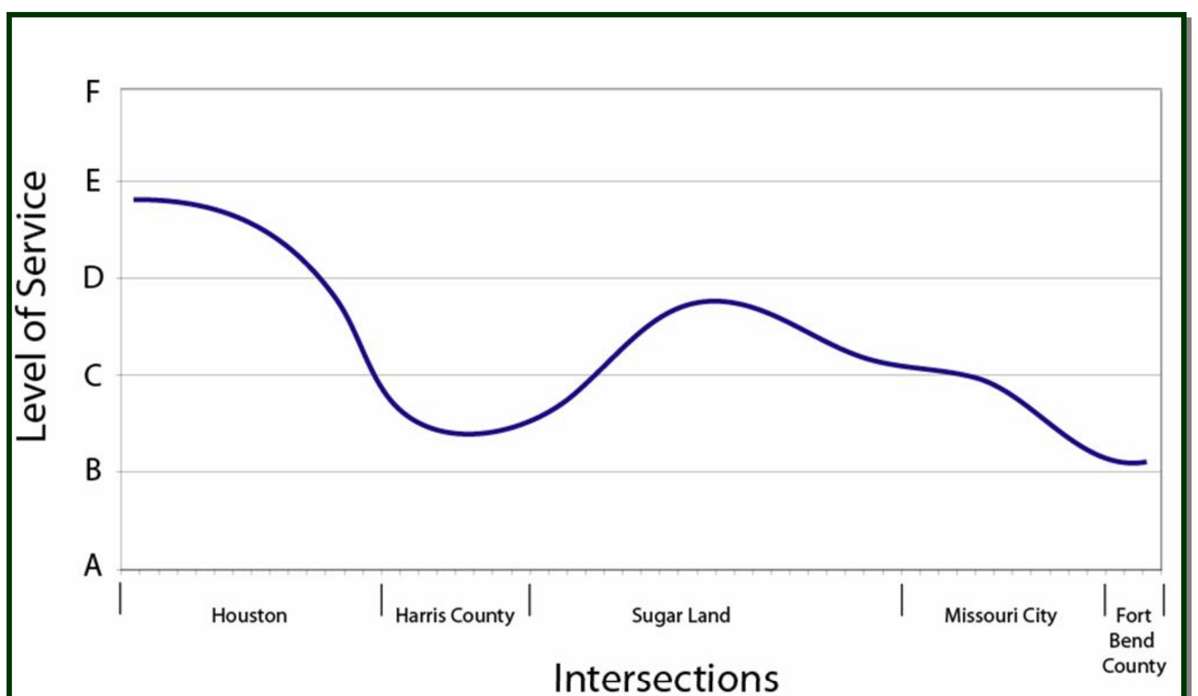


Figure 1-5: SH 6 Intersection Level of Service Summary

Conclusions

The base data shows clearly the need to improve the safety and mobility of this region. With average crash rates exceeding the region averages, there are clear problems within the corridor. Looking at the current level of service and signal operations, there are some changes that can be made to improve the mobility within the corridor. Last transit service is limited and there are some significant nodes within the corridor that could benefit from transit service, especially along the major corridors. The corridor does have some large problem areas and are highlighted in both our operational analysis and safety analysis. Moving forward these areas will become a focal point for our improvements.

Chapter 2. Public Involvement Process

2.1. INTRODUCTION

In accordance with H-GAC's commitment to "…ensuring an open transportation planning process that supports early and continued participation, provides complete information, timely public notice, and full public access to key decisions," each planning project will have a defined Public Participation Plan (PPP). This PPP is consistent with H-GAC's Transportation Public Participation Process adopted by the Transportation Policy Council in September 2003.

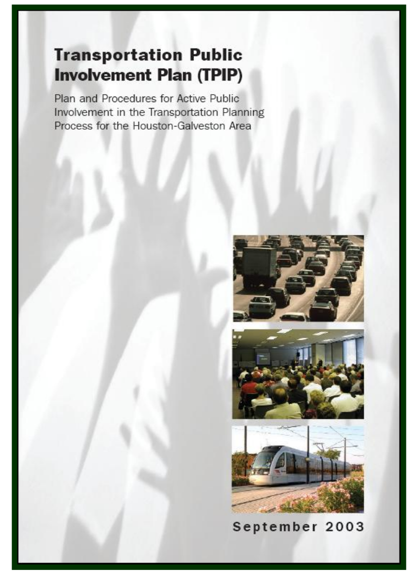


Figure 2-1: H-GAC's Public Participation Plan

The SH 6 Access Management Study public participation activities will address the need to have an ongoing information exchange during the study from beginning end. Arriving at consensus on the short- and long-range alternatives during the study process will enable the next phase of programming improvements and design to focus on implementation details rather than big-picture issues. This section describes the various public participation activities and techniques that were used during the development of the SH 6 Access Management Plan.

2.2. PURPOSE OF PUBLIC INVOLVEMENT PROGRAM

The purpose of this task is to finalize and implement an integrated group / stakeholder and PPP that supports development of the SH 6 Access Management Plan and is closely coordinated with other planning projects occurring in the Houston-Galveston Area. This PPP will support the decision-making role of the H-GAC, Transportation Policy Council (TPC), Technical Advisory Committee (TAC), the advisory role of the Task Force, and the participatory role of other identified stakeholders and citizens.

The PPP includes outreach and feedback to two closely related public participation groups:

1. A group of stakeholders
2. The general public within the study area

A schedule of meetings with these groups is detailed in Figure 2-2. The following guiding principles drove the study process:

- Initiation of citizen participation at the onset and throughout the process
- Intense efforts to solicit community views prior to major project decision points
- Public access to all relevant information
- Regular reports of study findings to the public
- Provision of orientation materials to accommodate new participants entering the process
- Two-way communication between the study team and community participants to freely exchange information, ideas, and values
- Presentation of transportation options in an objective manner
- Use of a variety of techniques and approaches to reach a diverse group of persons potentially affected by the proposed project
- Serious consideration of all suggestions from the community
- Timely response with answers and information to citizen inquiries
- Complete documentation of public participation activities
- Incorporation of small discussion groups to encourage a casual environment for discussions during public meetings
- Evaluation of the public participation program's effectiveness

	2006			2007									
	October	November	December	January	February	March	April	May	June	July	August	September	October	November
Steering Committee 1 (Goals)	2-Oct													
Steering Committee 2 (PPP)		13-Nov												
Steering Committee 3 (Problem Areas)					8-Feb									
Stakeholder Meeting 1-3					25-Feb									
Public Meeting 1 (Needs and Issues)							3-Apr							
Steering Committee 4 (Improvement Concepts)								31-May						
Steering Committee 5 (Improvement Results)											30-Aug			
Stakeholder 4-6												13-Sep		
Public Meeting 2												25-Sep		
Steering Committee 6 (Final Meeting)														9-Nov
Transportation Policy Committee Meeting														16-Nov

Figure 2-2: Meeting Schedule

2.3. STEERING COMMITTEE

H-GAC established the SH 6 Access Management Study Steering Committee to offer technical and policy decisions to guide the development of the study. The committee met during key milestones in the process to receive and assess reports on progress, comment on the schedule, coordinate with his or her respective agency, and provide oversight of major activities associated with the study. The Steering Committee is comprised of representatives from TxDOT; H-GAC; Cities of Sugar Land, Houston, and Missouri City; and Harris and Fort Bend Counties.

Generally, the Steering Committee met prior to public meetings and at benchmarks in the planning process (as outlined in Figure 2-2).

2.4. STAKEHOLDER GROUP

The SH 6 corridor has many stakeholders including residents, businesses, employees, commuters, environmental and historic preservation groups, civic and homeowner organizations, community planning groups and city councils, resource agencies, major landowners, and others affected by local transportation issues. The project team developed materials to educate the public specifically on access management and the study process in general. The project team was available during the project to meet with stakeholders, the general public, or elected officials in order to provide educational information as well as update interested parties on the study progress, alternatives under consideration, and key decision points. The main function of these meetings was to serve as a method to consider individual issues and potentially incorporate those issues into the study recommendations. These meetings were held on request and limited to six gatherings, each of which was scheduled around existing project meetings.

2.5. Information and Education Campaign

This PPP supports a cooperative planning process that includes an informational and educational campaign. The campaign described benefits of alternatives and activities in a concise, straightforward manner. The team developed materials to educate the public on the study process and transportation planning issues. In disseminating information to the public, the team used a variety of methods, including the following:

Presentation Materials

At each round of public meetings, a series of presentation boards were used to provide information about the study and describe the project. The boards included the study process, a project schedule, an overview of the corridor, the goals of the study, and the technical results at each stage of the study.

Website: www.SH6Mobility.com

As part of the effort to educate and inform the public about the study, the project team kept an up-to-date and informative project website. The website contained copies of the various presentation materials and study progress, as well as advertised upcoming public meetings. The website was continuously evolving as the study progressed. Responses to public questions were provided in a "FAQ"-type format.

Direct Mail

To conduct a public participation process touching as many affected parties as possible, the project team (in cooperation with H-GAC and the Cities of Houston, Missouri City, and Sugar Land) identified and assembled a comprehensive list of area residents, property owners and businesses, public officials, civic organizations, resource agencies, community groups, and media representatives who had interest in this project. Before each public meeting, direct mail notices were delivered to these parties within 30 days of each meeting. This provided adequate time to either attend the meeting or provide written comments to the appropriate party.

Media Coverage

One to three weeks prior to all public meetings, press releases were issued throughout the corridor to English- and Spanish-language newspapers, radio stations, and television stations. The press releases provided a wide range of coverage concerning upcoming public meetings and key decisions of the study. A number of key media contacts were also included on the general mailing list and received notice of all meetings. The following are the newspapers that were sent press releases:

- *Houston Chronicle*
- *La Voz de Houston*
- *Houston Defender*
- *Fort Bend Herald*

2.6. General Public

The public meeting component of the outreach effort was comprised of two series of meetings. These meetings relayed the purpose, process, and progress of the study, and were held in the evenings at municipal venues within each City. The public meetings were designed to maximize public convenience and allow discussions to focus in on sub-areas as well as whole-corridor issues.

At the meetings, poster-sized graphic displays providing information about the study were available for review. Displays staffed by team members who were knowledgeable about the project were available so attendees with questions could have them addressed and provide direct input regarding the project.

To ensure notification in English and Spanish, public notices were placed in local, community, and bilingual newspapers, such as the *Houston Chronicle*, *La Voz de Houston*, *Houston Defender*, and *Fort Bend Herald*. Public notices were published twice — at 30 and 10 days prior — for each round of meetings. Public meeting notices were also provided on the project and H-GAC websites.

Two series of public meetings were completed:

Public Meeting Series 1

Houston	Sugar Land and Missouri City
April 3, 2007	April 4, 2007
5:30 to 7:30 PM	5:30 to 7:30 PM
Wolf Elementary School Cafeteria	Elkins High School Cafeteria
502 Addicks-Howell Road	7007 Knights Court
Houston, Texas 77079	Missouri City, Texas 77459

Public Meeting Series 2

Houston	Sugar Land and Missouri City
September 25, 2007	September 27, 2007
5:30 to 7:30 PM	5:30 to 7:30 PM
Wolf Elementary School Cafeteria	Elkins High School Cafeteria
502 Addicks-Howell Road	7007 Knights Court
Houston, Texas 77079	Missouri City, Texas 77459

Series 1 Public Meeting Summary

During the first series of public meetings, attendees were encouraged to comment (using stickers and markers) on maps of the study area. Attendees of the public meeting ranged from local residents to business owners, land developers, and elected officials. Figures 2-3 through 2-5 demonstrate some of the participation during the initial meeting.

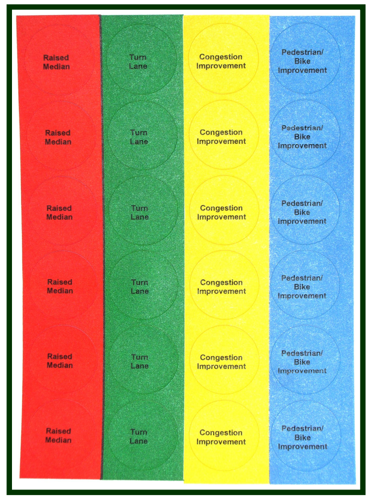


Figure 2-3: Example Sticker Sheet

Figure 2-4: Elkins HS Participants

Figure 2-5: Wolf Elementary Participants

Much of the information received during the initial public meetings concentrated on areas of concern and information that the consultants may not have captured as part of the typical data collection process.

In addition to writing their ideas and concern on the aerial maps, participants were also asked to participant in a short questionnaire. These questions focused on problem areas as well as different types of solutions that could occur as part of the final plan. The questionnaire included a section where respondents could enter specific comments for his or her region. The following questions are a summary of the preferences shown in the questionnaires.

Question 1. Respondents were asked to choose what types of improvements could fix the problems observed in the corridor. Although signal retiming was preferred, all improvement types received significant interest.

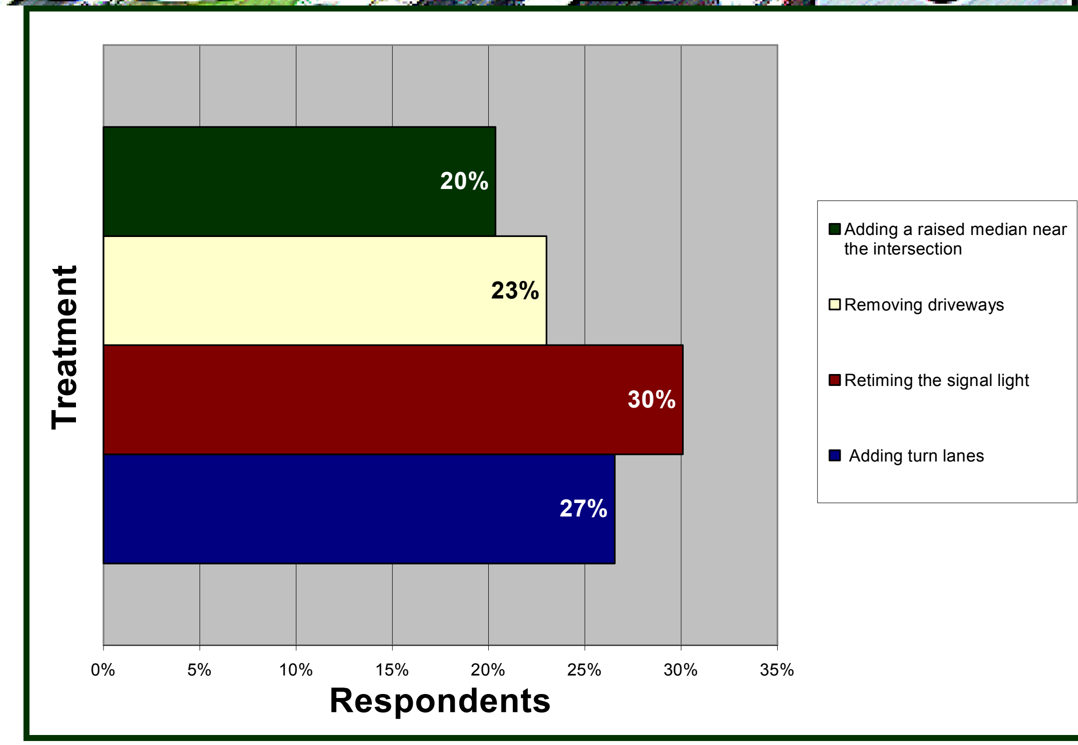


Figure 2-6: Question 1 — Improvement Type Summary

Question 2. Participants were asked what type of improvement would best resolve the safety problems within the corridor. In this case respondents felt that treatments should focus on medians, circulation, and driveway reduction rather than the addition of new traffic signals.

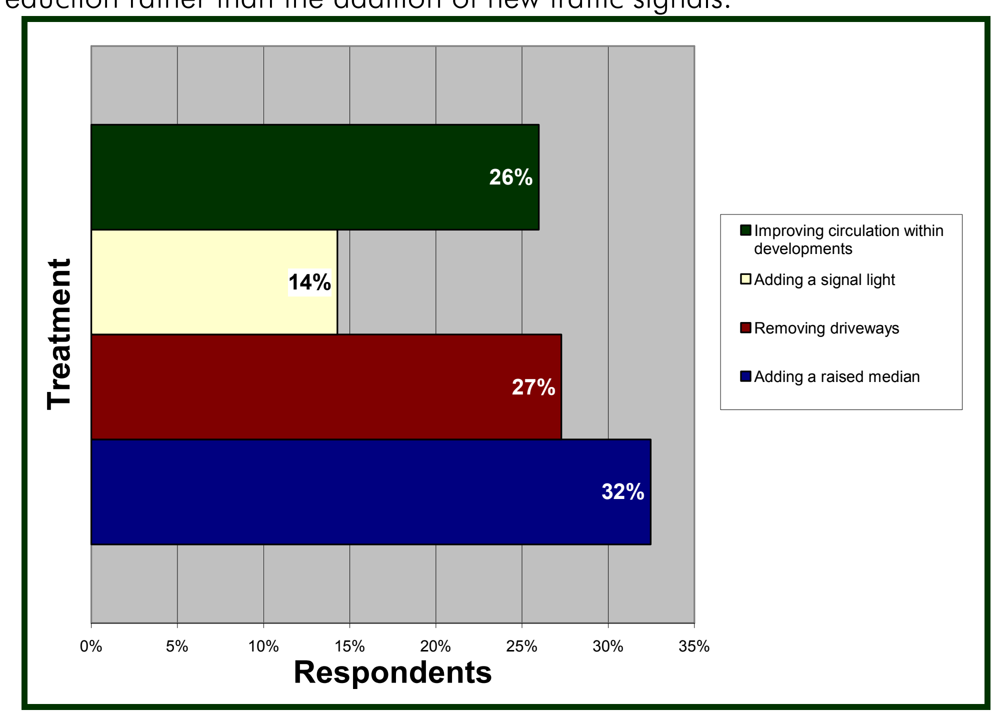


Figure 2-7: Question 2 — Safety Improvement Summary

The final three questions focused on alternative modes. Many respondents felt that sidewalks and bikeways should be connected across SH 6, but not built to share the existing right-of-way (ROW). Furthermore, 61% of the respondents felt that transit in any form was the best alternative mode for the corridor. Respondents expressed fear for the safety of those who may walk or bike for long distances on SH 6.

SERIES 2 PUBLIC MEETING SUMMARY

The second series of public meeting focused on the project recommendations. Specifically, attendees of the meeting were provided with aerial maps of the improvements drawn in and were again asked to adjust or add comment. Some respondents took the opportunity to praise specific improvements. These comments were considered to be edits and were directly incorporated into the final recommendations (found in later sections of this document). A summary of all the comments found on the maps has been included in the Appendix of the report.

Attendees again completed a short questionnaire. This form also focused on the improvements themselves. The initial question asked whom each respondent was representing by attending the public meeting: 21% was business owners within the study corridor, and 68% were residents from Houston, Sugar Land, or Missouri City. The following question asked if the respondents agreed with the construction of a raised median throughout the corridor, of which 71% responded "Yes."

The third question focused on what secondary improvements needed to be made in the corridor. The adjacent chart demonstrates that many respondents felt signal timing and additional turn lanes would help the issues within the corridor. However, the results show that many respondents were in favor of almost all the treatment types.

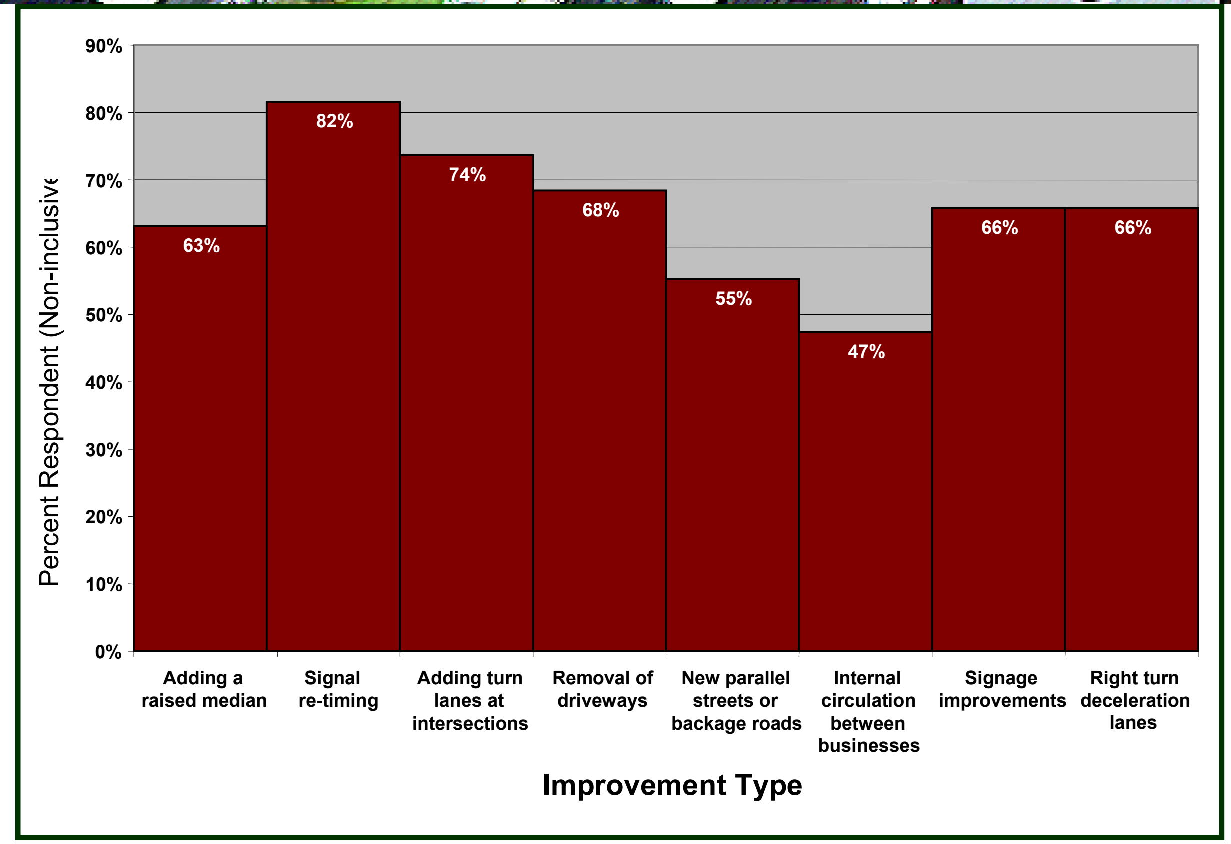


Figure 2-8: Secondary Improvement Type Preference

The questionnaire was completed by asking several questions concerning alternative modes. The first of these questions discussed improvements for pedestrians. Among respondents, 65% were in favor of pedestrian improvements at the intersections and off-street paths. Many respondents, as in the first questionnaire, express fear for sharing the ROW between pedestrians and vehicles. The questionnaire was completed by 67% of respondents agreeing with the long-term recommendation of local and rapid bus service along SH 6.

Chapter 3: Improvement Concepts

This chapter provides general guidance and criteria for the various improvement options that exist to improve mobility and safety in the SH 6 corridor. While many of the agencies involved in this study are well aware of these options, it nevertheless provides insight to people who are new to access management or safety projects. The improvement options for this corridor plan have several dimensions. For instance, there is short-term and long-term safety and operational improvement, and other improvements such as pedestrian and bicycle, and policy recommendations. The following five separate categories have been created to organize these improvements:

- Safety
- Operational/Intersections
- Policy
- Bicycle and pedestrian
- Transit
- Other

3.1. Safety

As noted in the goals of the study, safety in the corridor is a major concern. The need for safety improvements is even more apparent when looking at the numbers for the SH 6 corridor — more than 2,000 crashes each. Safety improvements are largely concepts derived from access management techniques. Below are two techniques that can be used for this study.

- Median Installation
- Driveway Consolidation

Raised Median Installation- short-term strategy

This technique involves adding a raised median barrier to restrict the movement of traffic, thereby reducing the number of conflicts in the corridor. Figure 3-1 illustrates that any of the 32 full-access locations creates potential conflict points. With the introduction of a raised median barrier to restrict the left-out maneuver, the conflict points are reduced by 50%.

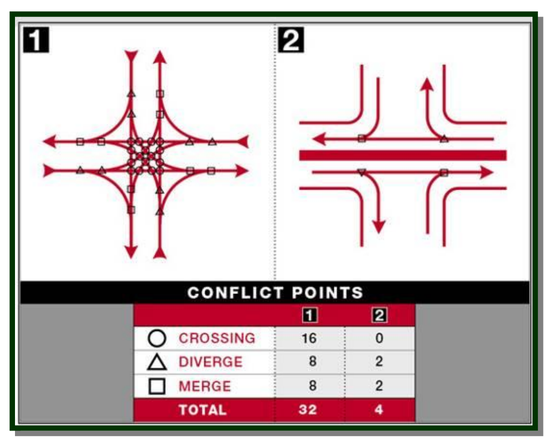


Figure 3-1: Conflict Points

Roadways with non-traversable medians are safer at higher speeds and higher traffic volumes than undivided roadways or those with continuous two-way left turn lanes (TWLTL). Numerous national studies have been conducted relating to undivided, TWLTL, and divided roadways with a non-traversable median. Based on these studies, roadways with a non-traversable median have an average crash rate about 30% lower than roadways with a TWLTL.

A raised median should be considered for locations where average daily traffic (ADT) exceeds 20,000 vehicles and the demand for mid-block turns is high. With raised medians, additional safety benefits are found for pedestrian and bicycle activity by providing a refuge area when crossing a thoroughfare.

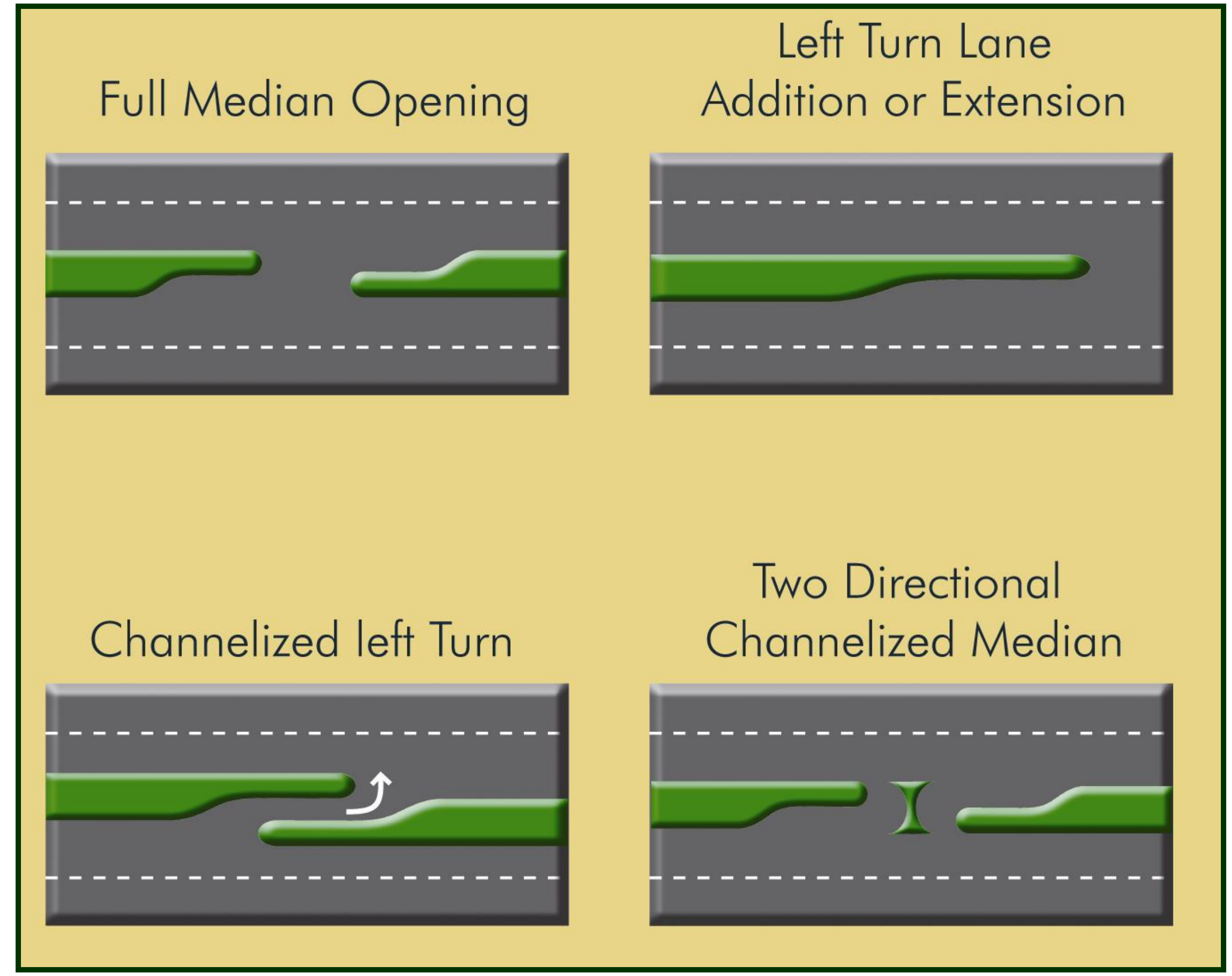


Figure 3-2: Raised Median Types

With a raised median, consideration of the median opening and opening type is necessary. The placement of the median opening first depends on the type of thoroughfare system. Priority should be given to those thoroughfares providing mobility and access throughout the community. Following that, other traffic generators along the corridor can be used when considering the opening. The median treatment can also take on many different forms. Figure 3-2 illustrates four variations available for median openings.

Driveway Consolidation- medium or long-term strategy

This technique involves removing or relocating existing access connections (driveways) for the sole purpose of improving safety. Research shows that driveways that are closely spaced have a direct impact on safety along a roadway. Moreover, research has found that a nexus exists between access connection density and crash rates, as indicated in **Figures 3-3 and 3-4.** Simply put, as the density of access connections increase, crash rates increase.

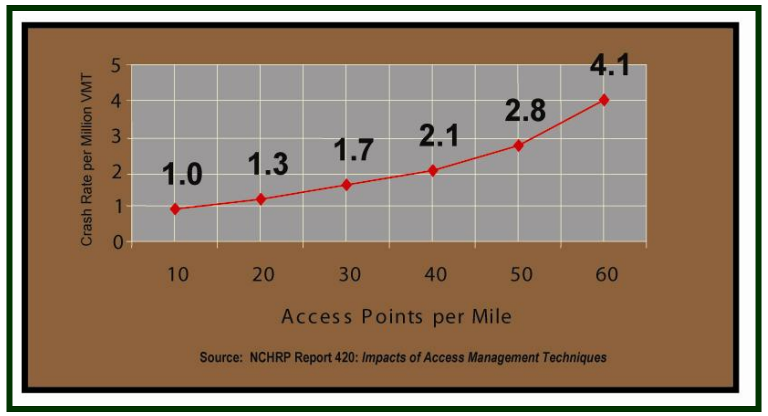


Figure 3-3: Effects of Driveway Spacing on Crash Rate

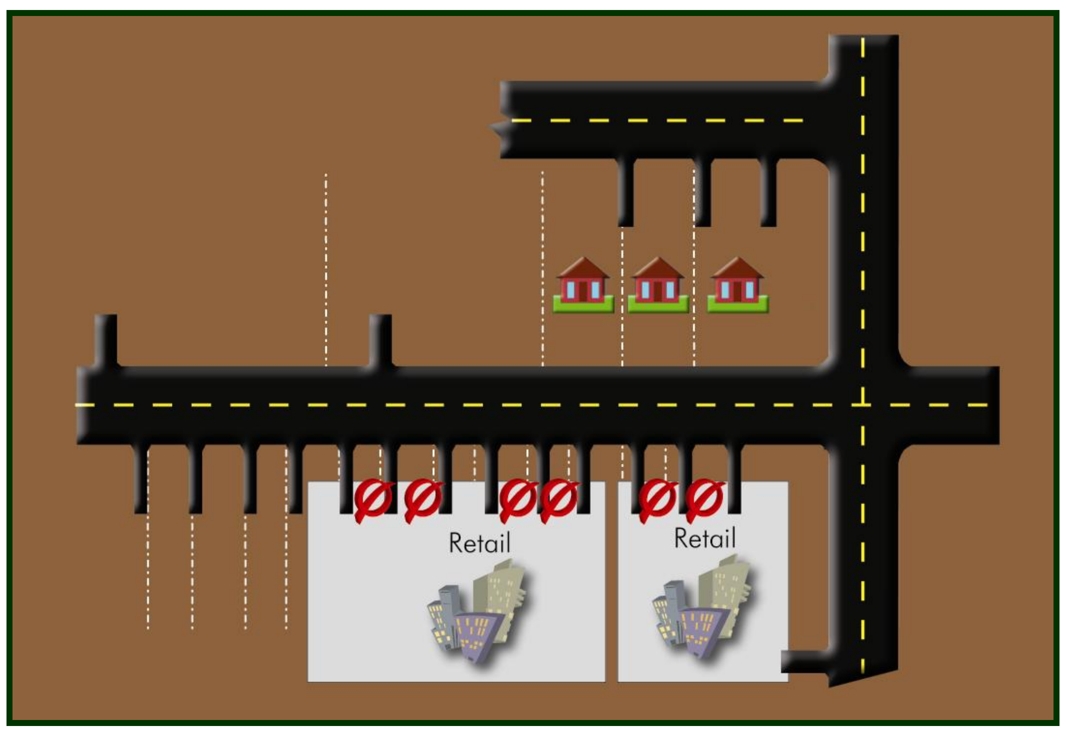


Figure 3-4: Demonstration of Driveway Consolidation

Driveway consolidation is only possible through a cooperative agreement between the property owner and the agency attempting to consolidate the driveway. Application of this technique will be focused on the greatest need. For instance, the areas in the corridor with the highest crash rates will be evaluated for possible consolidation. Each situation is unique and a great deal of negotiation will need to occur between all parties involves.

In addition to safety, improved operations in the corridor are another vital goal of the study. Operational improvements for this corridor can be broken down into several distinct intersection improvements:

- Right-Turn Lane
- Left-Turn Lane
- Signal Timing

3.2. Operations

Right-Turn Lane

The addition of acceleration and deceleration lanes can provide operational benefits throughout the corridor. These lanes allow turning vehicles to exit the roadway without affecting the through movement of traffic. This allows for a more efficient flow of traffic in the corridor and for vehicles to form "platoons" at the signalized intersections, thereby maximizing the flows each signal can handle.

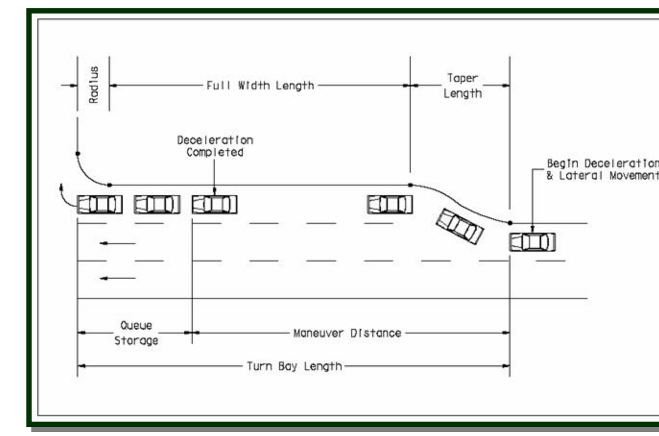


Figure 3-5: Right Turn Lane

Lengths of auxiliary lanes are a function of posted speed, but queue lengths are normally established on a case-by-case basis. The *Highway Capacity Manual* and TxDOT's *Operations and Procedures Manual* provide guidance on this matter. **Figure 3-5** illustrates the general layout and design for a right-turn lane. These improvements are not one size fits all. Consideration must be given for posted speed, traffic volume, and development type.

Left-Turn Lane

Much like right-turn lanes, left-turn lanes also allow the turning vehicles to exit the through lanes without affecting the through traffic. However, these lanes generally provide for more queue storage for left-turning vehicles for both signalized and unsignalized intersections. **Figure 3-6** illustrates the general design elements for a left-turn lane. The length of deceleration should consider the posted speed and the amount of speed differential acceptable for the thoroughfare.

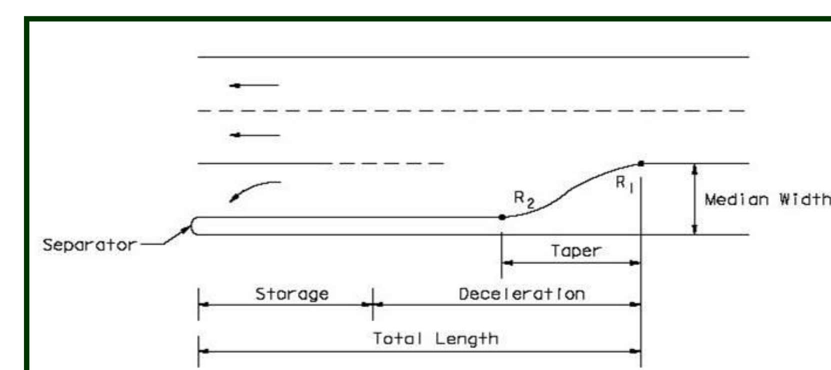


Figure 3-6: Left Turn Lane

Signal Timing

Signal timing is a critical technique to improve the overall traffic flow throughout the corridor. The timing of signals often involves coordinating an entire signal system. For the SH 6 corridor, most of the signals are part of a coordinated signal system and any recommendation related to signal timing should consider the ramifications of the system as a whole rather than an isolated signal.

3.3. POLICY IMPROVEMENTS

Authority and Purpose

This document will ultimately serve as an overlay for land use and design-related issues throughout the corridor. The access policy direction must be established in terms of:

- Coordination with TxDOT
- Shared- and Cross-Access Provisions
- Thoroughfare Planning
- Design Guidelines

Coordination with TxDOT

On September 25, 2003, the TxDOT Transportation Commission adopted the State's proposed rules on access management. The newly adopted rules direct TxDOT to apply access management statewide. In addition, the rules activate TxDOT's new *Access Management Manual*. The manual includes general policy implications and minimum driveway spacing criteria along state highways. There is a provision in the manual for local agencies to develop corridor access plan in coordination with TxDOT which could become a corridor overlay.

This corridor overlay would then supersede any criteria established by the local agency and/or TxDOT. The benefit of this approach is to allow for a more coordinated effort among all agencies involved. Moreover, it provides an interactive mechanism for developers and landowner to understand the vision for the corridor and gain general confidence of future access decisions in the corridor. If agreed to, all the agencies involved can enter into an inter-local agreement to activate this corridor access plan and provide for a clear delineation of access authority in the corridor.

Shared- and Cross-Access Provisions

Access management is much more than just spacing of driveways and providing raised medians. In order to fully realize the benefits of access management, certain land use provisions should be provided in the development regulations of the respective local municipalities.

Development regulations can require property owners to dedicate land on their common property lines or develop joint access easements. A parking lot cross-access provision assures that a single driveway can serve two or more properties. The result is greater internal circulation between neighboring properties, allowing vehicles to circulate between businesses without having to re-enter the major roadway. This effort may take on two separate forms. In the first, the consultant identifies specific locations that would benefit from sharing access through the use of aerial photos and project lists. The second involves changing local agencies' guidelines to initiate a shared-access provision.

Thoroughfare Planning

The local government code provides the authority for local agencies to adopt and implement thoroughfare plans. These plans generally describe the alignment and ROW requirements for major thoroughfares through a community. This policy goes a step further and investigates the potential for the use of collector roads and backage roads to serve local developments without adding more turning traffic onto the major thoroughfares. These roads will generally be localized and dependent on site development and property boundaries.

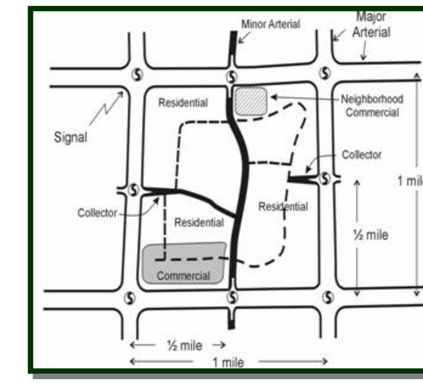


Figure 3-7: Thoroughfare Planning

Design Guidelines

These guidelines will form the basis for technical guidance with regard to access decisions along SH 6. Specific guidelines have been developed for access connection (driveway) spacing and median opening spacing.

<u>Access Connections</u>
The access connection distances in the following sections are intended for passenger cars on a level grade. These distances may be increased for downgrades, truck traffic, or where otherwise indicated for the specific circumstances of the site and the roadway. In other cases, shorter distances may be appropriate to provide reasonable access, and such decisions should be based on safety and operational factors supported by an engineering study.

The distance between access connections is measured along the edge of the traveled way from the closest edge of pavement of the first access connection to the closest edge of pavement of the second access connection.

Minimum Connection Spacing	
Posted Speed (MPH)	Distance (FT)
< 30	200
35	250
40	305
45	360
> 50	425

Table 3-1: Minimum Spacing for Access Points

A lesser connection spacing than set forth in this document may be allowed in the following situations:

- To keep from land-locking a property.
- Replacement or re-establishment of access to the highway under a reconstruction / rehabilitation projects.

Median Installation
Openings should only be provided for street intersections or at intervals for major developed areas. Spacing between median openings must be adequate to allow for introduction of left-turns with proper deceleration and storage lengths. Please refer to the TxDOT *Design Guidelines Manual* for proper deceleration and storage lengths.

Deceleration Lane Tolerances
When a raised median is present, a left-turn deceleration lane will be provided for every opening. Right-turn deceleration lanes will be required when the peak hour turning movement is greater than 60 vehicles.

3.4. Bicycle and Pedestrian Amenities

The bicycle and pedestrian improvements can be characterized by three different types of improvements. First, hike and bike trial additions, second, sidewalk and pedestrian connections, and finally, intersection pedestrian elements such as curb ramps, decorative cross walks and lighting and signal poles. Many of these improvements can be jointly funded between local agencies and TxDOT while others would be completely funded by local agency resources. Phasing of bicycle and pedestrian improvements is dependent on available funding. First, short-term improvements include Sidewalk improvements that can built within the existing right of way

3.5. Transit Service

Developing a set of viable transportation alternative will be centered on building ridership for future high capacity transit service. This not only includes making better use of the existing roadway capacity, but also managing the demand for travel in the corridor. Transportation Demand Management (TDM) is a set of strategies designed to make the best use of existing transportation facilities and enhance transportation improvements. Using strategies that promote alternative modes, increase vehicle occupancy, reduce travel distances, and ease peak hour congestion, TDM increases the efficiency and effectiveness of the transportation system.

Approaches include:

- Strategies to promote alternative modes of travel, such as carpooling, vanpooling, transit, biking, and walking
- Projects designed to maximize the efficient use of parking resources
- Efforts to shift travel demand to "non-peak" periods by promoting flexible work schedules and variable work hours
- Attempts to eliminate the demand for some trips through teleworking, teleconferencing, etc.
- Augmentation and coordination of existing demand response transit provisions

3.6. Other Improvements

Livable Centers

H-GAC currently has funding programmed in the Draft 2008-2011 Transportation Improvement Program (TIP) to support planning and infrastructure improvements for Livable Centers projects in several areas throughout the region including but not limited to: the East End, Midtown, and Uptown/Galleria areas of Houston; along the Galveston Seawall; in The Woodlands Town Center; and in downtown Waller. These projects illustrate that Livable Centers can be established in urban, suburban, and small town settings. Livable centers are an excellent way to reduce the overall dependency on auto-only trips and promote a more walkable pedestrian and transit friendly environment.

Ultimately, land use and development decisions are made by private investors and local governments -- the role of H-GAC and the 2035 RTP is to provide decision-makers with analyses for a spectrum of transportation investments. These analytical results will assist decision makers in determining cost-effective projects to improve future mobility within the confines of today's transportation budgets. Chapter 8 of this report provides more insight into how livable centers can be implemented in the SH 6 corridor.

3.7. References

1, 2, &3. Gluck, J., H.S. Levinson, and V. Stover. *NCHRP Report 420: Impacts of Access Management Techniques*. TRB, National Research Council, Washington, D.C., 1999.

4. Williams, K.M. *Ten ways to Promote Access Management*. Center for Urban Transportation Research, University of South Florida. 1999.

5 & 6. Stover, V.G., and F.J. Koepke. *Transportation and Land Development*. Institute of Transportation Engineers, Washington D.C., 1988

Chapter 4. Improvements (Houston, Harris County, and TxDOT)

The focus of this chapter is to provide the City of Houston, Harris County, and TxDOT with a concise list of improvements for SH 6 within the City of Houston and Harris County. From existing conditions to short-, medium-, and long-term solutions, this chapter will describe in detail each planned improvement.

4.1. Existing Conditions

The existing conditions in the Houston / Harris county area of SH 6 will be described in terms if intersection levels of service, crash experience, transit service, bicycle and pedestrian conditions and finally the road characteristics.

Intersection Level of Service

Peak hour turning movement counts for both A.M. and P.M. were collected and used to evaluate the intersection levels of service. Acceptable intersection levels of service vary by area, but, in general, levels of service below the letter "D" are considered failing. As indicated below, the worst SH 6 intersections are at IH-10, Westheimer, Richmond, and Bellaire. For specific intersection levels of service refer to **Table 4-1**: Intersection Levels of Service (Houston)and **Table 4-2**: Intersection Levels of Service (Harris County).

Intersection	AM Peak	PM Peak
IH-10 WB	F	E
IH-10 EB	F	F
Memorial Dr	A	D
Briar Hill Pkwy	B	A
Eagle Vista	A	A
Briar Forest Dr	C	D
Chili's Plaza	A	A
Piping Rock Ln.	B	A
Westheimer Rd (FM 1093)	F	F
Park Hollow Dr.	A	C
Richmond Ave	D	D
Westhollow Dr.	B	A
Westpark Dr	B	A

Table 4-1: Intersection Levels of Service (Houston)

Intersection	AM Peak	PM Peak
Bellaire Blvd	F	E
Empanada Dr	B	B
Beechnut St	D	E
Charlmont Dr/Parksgate Dr	A	A
Bissonnet St	D	D
Old Richmond Rd	C	C
Bellfort	B	B
Woodbridge Villages Dr/Woodbridge Estates Dr	A	A
W Airport Blvd	D	C
Voss Rd	C	C

Table 4-2: Intersection Levels of Service (Harris County)

Signal Phasing

Table 4-3: Existing Signal Phasing depicts the current phasing of each of the signals. Many of the signals are operating a split phase. This is something that is at times necessary, but can be changed as part of our medium- or long-term solutions.

	Left-turn Phase Types																Pedestrian Signals			
	NB				SB				EB				WB							
	Protected-Only	Protected- Permitted	Permitted Only	Split-phased	Protected-Only	Protected- Permitted	Permitted Only	Split-phased	Protected-Only	Protected- Permitted	Permitted Only	Split-phased	Protected-Only	Protected- Permitted	Permitted Only	Split-phased	N Side	S Side	W Side	E Side
IH-10 WBFR	1															1				
IH-10 EBFR					1							1								
Memorial Dr	1				1							1				1				
Briarhills Pkwy	1				1						1				1					
Eagle Vista Dr					1											1				
Briar Forest Dr					1											1				
Chili's Plaza	1				1		1				1							1		
Piping Rock Ln.	1				1						1				1					
Westheimer Rd (FM 1093)	1				1							1				1	1	1	1	1
Park Hollow Dr	1				1						1				1					
Richmond Ave	1				1				1				1							
Westhollow					1											1				
Westpark Dr	1											1								
Bellaire Blvd	1				1							1				1	1	1	1	1
Empanada Dr	1				1						1				1		1		1	1
Beechnut St	1				1							1				1				
Charlmont Dr / Parksgate Dr	1				1						1				1					
Bissonnet St	1				1				1				1				1	1	1	1
Old Richmond Rd	1				1						1				1					
Bellfort	1				1							1				1	1		1	1
Woodbridge Villages Dr / Woodbridge Estates Dr	1				1						1				1					
W Airport Blvd	1				1							1				1	1	1	1	1
Voss Rd	1				1							1				1		1	1	1

Table 4-3: Existing Signal Phasing

Transit Service

Currently the City of Houston and the City of Missouri City participate in the METRO transit system. As shown in **Figure 4-1**: Existing Transit Service, there are six routes that terminate or serve the SH 6 area. Many of these routes are local bus service, but also include a select number of express bus services. These express buses as meant for longer trips such as commuters traveling to downtown Houston.

Route Name	Frequency
Metro 131	6 per hour in peaks
Metro 53	4 per hour in peaks
Metro 82	4 per hour in peaks
Metro 2	2-3 per hour in peaks
Metro 132	4 per hour in peaks
TREK Express SugarLand to Greenway Plaza	4 per hour in peaks

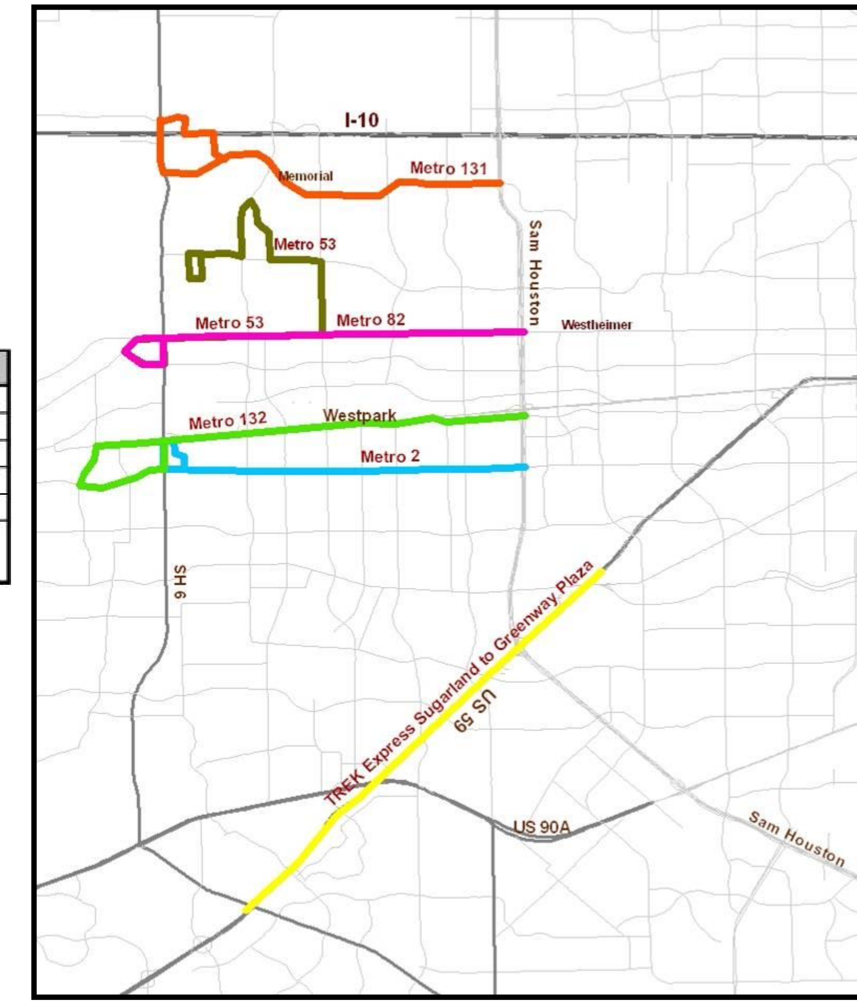


Figure 4-1: Existing Transit Service

Pedestrian and Bicycle Infrastructure

Pedestrian facilities along SH 6 are limited in access. Although sidewalks are present, there is limited connectivity to the adjacent existing neighborhoods and between jurisdictions. There are no on-street bike lanes along the SH 6 corridor. There are numerous trails adjacent to the corridor along electrical easements and near the reservoirs. Please refer to **Table 4-4:** Houston Summary of Characteristics and **Table 4-5:** Harris County Summary of Characteristics for locations of parallel sidewalks and bicycle facilities.

Summary of Characteristics

Selected Signalized Crossroads		IH-10 WB	to	IH-10 EB	to	Memorial Dr	to	Briar Hill Pkwy	To	Eagle Vista	to	Briar Forest Dr	to	Chili's Plaza	to	Piping Rock Ln.	to	Westheimer Rd (FM 1093)	to	Park Hollow Dr.	to	Richmond Ave	to	Westhollow Dr.	to	Westpark Dr
		HOUSTON																								
Access	Distance (miles)		0.06		0.63		0.5		0.4		0.4		0.8		0.3		0.3		0.2		0.2		0.2		0.4	
	Total Driveways		0		40		14		12		10		49		11		22		6		11		4		5	
	Total Driveway Density Per Mile		0		63		28		30		25		61		37		73		30		55		20		13	
	Driveway Density Ratio				1.59		2.00		2.50		2.50		1.25		3.33		3.33		5.00		5.00		5.00		2.50	
Crashes	Total		66		106		48		2		0		74		0		68		110		27		49		8	
Roadway Characteristics	Median Type		Median		TWLTL		TWLTL		TWLTL		TWLTL		TWLTL		TWLTL		TWLTL		TWLTL		TWLTL		TWLTL		TWLTL	
	Edge Treatment		Shoulder		Shoulder		Shoulder		Shoulder		Shoulder		Shoulder		Shoulder		Shoulder		Shoulder		Shoulder		Shoulder		Shoulder	
	Sidewalks		No		No		No		No		No		No		No		No		No		No		No		No	
	Bike Lanes		No		No		No		No		No		No		No		No		No		No		No		No	
	Speed (MPH)		45		45		45		50		50		50		50		50		50		50		50		50	

Table 4-4: Houston Summary of Characteristics

Selected Signalized Crossroads		to	Bellaire Blvd	to	Empanada Dr.	to	Beechnut St.	to	Charlmont Dr./Parksgate Dr.	to	Bissonnet St	to	Old Richmond Rd	to	Bellfort	to	Woodbridge villages Ln.	to	W Airport Blvd.	to	Voss Rd	to
		HARRIS COUNTY																				
Access	Distance (miles)	1.1		0.6		0.4		0.5		0.3		0.6		0.4		0.5		0.4		0.4		3.3
	Total Driveways	23		27		29		25		10		21		5		2		6		9		27
	Total Driveway Density Per Mile	21		45		73		50		33		35		13		4		15		23		8
	Driveway Density Ratio	0.91		1.67		2.50		2.00		3.33		1.67		2.50		2.00		2.50		2.50		0.30
Crashes	Total	109		198		102		95		44		9		36		6		5		5		29
Roadway Characteristics	Median Type	TWLTL		TWLTL		TWLTL		TWLTL		TWLTL		TWLTL		TWLTL		TWLTL		TWLTL		TWLTL		TWLTL
	Edge Treatment	Shoulder		Shoulder		Shoulder		Shoulder		Shoulder		Shoulder		Shoulder		Shoulder		Shoulder		Shoulder		Shoulder
	Sidewalks	No		No		No		No		No		No		No		No		No		No		No
	Bike Lanes	No		No		No		No		No		No		No		No		No		No		No
	Speed (MPH)	50		50		50		50		50		50		50		50		55		55		55

Table 4-5: Harris County Summary of Characteristics

4.2. MEDIAN, DRIVEWAY AND RIGHT TURN LANE IMPROVEMENTS

Short-Term Median Improvements

The primary short term improvement for the SH 6 Corridor Access Plan will be for the construction of raised medians. Within both the City of Houston and Harris County it is anticipated that the medians can be built for **$5,415,800** ($2,311,700 in Houston and $3,104,100.in Harris County) **(refer to Table 4-6)** Detailed concept plans are provided in **Figures 4-20** through **4-36**. For the detailed cost estimate for the City of Houston and Harris County refer to **Exhibit C**

City of Houston	$2,311,700
Harris County	$3,104,100

Table 4-6: Houston/Harris County Medians

Figure 4-2: Sample Median Improvement

Short-Term Right Turn Lane Improvements

Another short-term improvement will be re-striping the shoulders to clearly delineate right turn lanes. It is anticipated that no right of way or utility work will be need to re-stripe these lanes. **Table 4-7** shows the locations of the planned improvements in the City of Houston, while **Table 4-8** shows Harris County. Also, the drawings in **Figures 4-10** through **4-27** show the improvements graphically.

Cross Street	Improvement	Cost
Memorial	SB Right Turn Lane	$4,100
Eagle Vista	NB Right Turn Lane	$4,100
Chili's Plaza	SB Right Turn Lane	$4,100
Barker Oaks	SB Right Turn Lane	$4,100
Piping Rock	NB & SB Right Turn Lanes	$8,300
Westheimer	NB & SB Right Turn Lanes	$8,300
Park Hollow	SB Right Turn Lane	$4,100
Richmond	NB Right Turn Lane	$4,100
West Hollow	NB Right Turn Lane	$4,100
TOTAL		$45,300

Table 4-7: Houston Short-Term RT Turn Lanes

Cross Street	Improvement	Cost
Rancho Mission	SB Right Turn Lane	$4,100
Empanada	SB & NB Right Turn Lane	$8,300
Alderwick	SB Right Turn Lane	$4,100
Paradise Bridge	SB Right Turn Lane	$4,100
Park Pointe	SB Right Turn Lane	$4,100
TOTAL		$24,700

Table 4-8: Harris County RT Turn Lane

Medium-Term Cross-Access Improvements

These improvements are intended to provide five to ten year improvement plans for cross-access between developments. Improving cross-access allows vehicles to travel from one development to another without adding additional trips onto the adjacent roadways. Refer to **Table 4-9** for cross access costs.

Jurisdiction	Number of Cross Access Improvements	Cost
City of Houston	9 future cross access point constructed	$47,700
Harris County	15 future cross access point constructed	$112,602

Table 4-9: Houston/Harris County Cross Access Improvements

Medium-Term Driveway Consolidation Improvements

A majority of the medium-term improvements are driveway consolidations. Improvements for both the City of Houston and Harris County can be found in **Figures 4-10**. In addition, detailed cost estimates for the removal and reconstruction of driveways for the City of Houston and Harris County can be seen in **Figures 20-36**.

Jurisdiction	Driveways Closed	Cost
City of Houston	28 Driveway Closures	$148,400
Harris County	29 Driveway Closures	$217,700

Table 4-10: Houston/Harris County Driveway Consolidation

4.3. Signals and Intersection Improvements

The following details the needed short- and medium-term signal system improvements. Also, the longer-term intersection improvements are noted in **Table 4-11 and 4-12**. If the City of Houston desires to expedite the intersection improvements, it would be advisable to coordinate with TxDOT to have the intersection improvements done at the same time as the medians.

Short-Term Signal System Improvements:

1. The remaining isolated intersections should be incorporated into closed-loop systems. This could be done by expanding the geographical limits of the existing systems, installing new closed-loop systems per TxDOT's specification, or some combination thereof.
2. The timing of all of the systems should be optimized for current traffic.

Medium- and Long-Term Signal System Improvements:

1. It is recommended that communications infrastructure be upgraded over the next several years to support the eventual implementation of distributed signal systems. (Although twisted-pair cable can fully support signal system data communications, fiber optic cable provides the additional bandwidth needed for closed-circuit television [CCTV] and other intelligent transportation system [ITS] applications).
2. All new communication cable should be fiber optic rather than copper. This would include cable installed to connect currently isolated intersections as well as any cable that may be installed to replace the existing copper cable.
3. The freeway management system communications network should evolve to provide the means for linking the signals on specific arterial corridors (e.g., SH 6) with TxDOT's traffic signal management facility. The Cities of Sugar Land and Missouri City are currently operating under a similar type of system.

Long Term Intersection Improvements

Tables 4-11 and **4-12** illustrate the planned intersection improvements within the City of Houston and Harris County. These improvements are considered long range due the right of way that might be required. The timeline for implementation will be determined by the corporation that exists between the local agency and TxDOT.

Location	Improvement	Cost
IH-10 WBFR		N/A
IH-10 EBFR		
Grisby Dr. to Memorial Dr.	Backage Road Construction	$1,551,200
Memorial Dr	Addition of WB left turn lane for dual left and EB left turn lane	$401,200
Memorial Dr. South	Backage Road Construction	$413,600
Briarhills Pkwy		$0
Eagle Vista Dr		$0
Westway Rd. to Briar Forest Dr.	Backage Road Construction	$620,500
Briar Forest Dr		$0
Woble Rd. to Chili's Plaza	Backage Road Construction	$827,300
Chili's Plaza	Restripe EB to include dedicated left turn	$8,300
Piping Rock Ln.	Expand EB and WB to include dedicated left turn lanes	$264,700
Westheimer Rd (FM 1093)	Expand E/W segments to include dual lefts and three through lanes	$558,400
Park Hollow Dr	Restripe EB and WB to include dedicated left turn lanes	$16,500
Richmond Ave		$0
West Hollow		$0
TOTAL		$4,661,700

Table 4-11: Houston Intersection Improvements

Location	Improvement	Cost
Westpark Dr	Expand EB to include dual left turn	$264,700
Bellaire Blvd	Expand NB/SB to add dual lefts three through, Expand EB/WB to add dual lefts two through	$806,600
Empanada Dr	Restripe EB and WB to include dedicated left turn lanes	$16,500
Beechnut St	Restripe WB to include dedicated left and right turn lanes	$12,400
Charlmont Dr/Parksgate Dr	Restripe WB to include dedicated left and right turn lanes	$12,400
Bissonnet St		$0
Old Richmond Rd	Expand EB and WB to include dedicated left turn lanes	$264,700
Bellfort		$0
Woodbridge Villages Dr/Woodbridge Estates Dr	Restripe EB to provide dedicated left turn and expand wb to include dedicated left turn	$144,800
W Airport Blvd	Expand WB and EB to allow for dedicated left and right turn lanes	$277,100
Voss Rd		$0
TOTAL		$1,799,200

Table 4-12: Harris County Intersection Improvements

4.4. Bicycle and Pedestrian Improvements

Table 4-13 and 4-14 illustrates the planned bicycle and pedestrian improvements with the City of Houston, while Table 4-15 describes the planned improvements within Harris County. The bicycle and pedestrian improvements can be characterized by three different types of improvements. First, hike and bike trial additions; second, sidewalk and pedestrian connections; and finally, intersection pedestrian elements such as curb rams, decorative cross walks, and lighting and signal pole additions. Many of these improvements can be jointly funded between local agencies and TxDOT, while others would be completely funded by local agency resources. Furthermore, it is assumed that as improvements are made to intersections or pedestrian facilities they will be constructed to comply with ADA requirements.

Phasing of bicycle and pedestrian improvements is completely dependent on available funding. Short-range improvements might include sidewalk improvements that can built within the existing ROW. Refer to Figure 4-3 and 4-4 for graphical locations of the bicycle and pedestrian facilities.

Short-Term Sidewalk Improvements

There are no short-term sidewalk improvements identified in the City of Houston or Harris County along SH 6. However, if funding can be established for any of the below improvements, and the timing of improvements can be accelerated, it is possible to complete the improvement in the next few years.

Medium-Term Intersection Pedestrian Improvement

As noted above, these types of improvements are almost entirely dependent on the available finances of the local agencies. While Table 4-13 points to a few specific intersections for improvements, all should be considered. The intersections noted in the table for Grisby and Briar Forest were selected due to the amount of public comments received.

Street / Trail	Improvement Description	Project Cost
Grisby St. at SH 6	Intersection improvement — additional crosswalk beautification and lighting to provide enhanced pedestrian environment	$250,000
Briar Forest Dr. at SH 6	Intersection improvement — additional crosswalk beautification and lighting to provide enhanced pedestrian environment	$250,000

Table 4-13: Houston Medium-Term Pedestrian Intersection Improvement

Long-Term Bicycle and Pedestrian Improvements

A majority of the improvements in Tables 4-14 and 4-15 are considered long range due to the time needed to implement the improvements.

	Street / Trail	Improvement Description	Project Cost
Houston	Grisby St.	Trail connection from Barker Reservoir Trail to neighborhoods and businesses to the east of Highway 6	$15,000
	Briar Forest Dr.	Extension of Briar Forest bike lane across SH 6 to connect with future Buffalo Bayou Trail	$750
	Westheimer Rd.	Connection from the SE Retail center to neighboring residential area	$750
	Park Hallow Dr.	Connection from the SE Retail center to neighboring residential area	$750
	Bray's Bayou Trail	Trail running parallel to existing canal system with connections to San Pablo Trail	$11,250
	All Houston Intersections	Intersection improvement - Additional crosswalk beautification and lighting to provide enhanced pedestrian environment	To Be Determined
	Jurisdiction Total		$528,500

Table 4-14: Houston Hike and Bike Improvements

	Street / Trail	Improvement Description	Project Cost
Harris County	San Pablo Trail	Extension of San Pablo Trail to connect with future Bray's Bayou Trail	$9,000
	Bellaire Blvd.	Two pedestrian connections from SE retail center to existing and future residential developments	$1,500
	Bissonnet St. / Parksgate Dr.	Pedestrian connection from Eastern retail center to surrounding developments	$3,000
	Old Richmond	Shared Use Trail along Old Richmond and Clodine. Connecting to Barker Clodine Trail.	$22,500
	Voss Rd.	Pedestrian connections from all for intersection retail quadrants to surrounding neighborhoods.	$3,000
	Al Harris County Intersections	Intersection improvement - Additional crosswalk beautification and lighting to provide enhanced pedestrian environment	To Be Determined
	Jurisdiction Total		$39,000

Table 4-15: Harris County Long-Term Bike Improvements

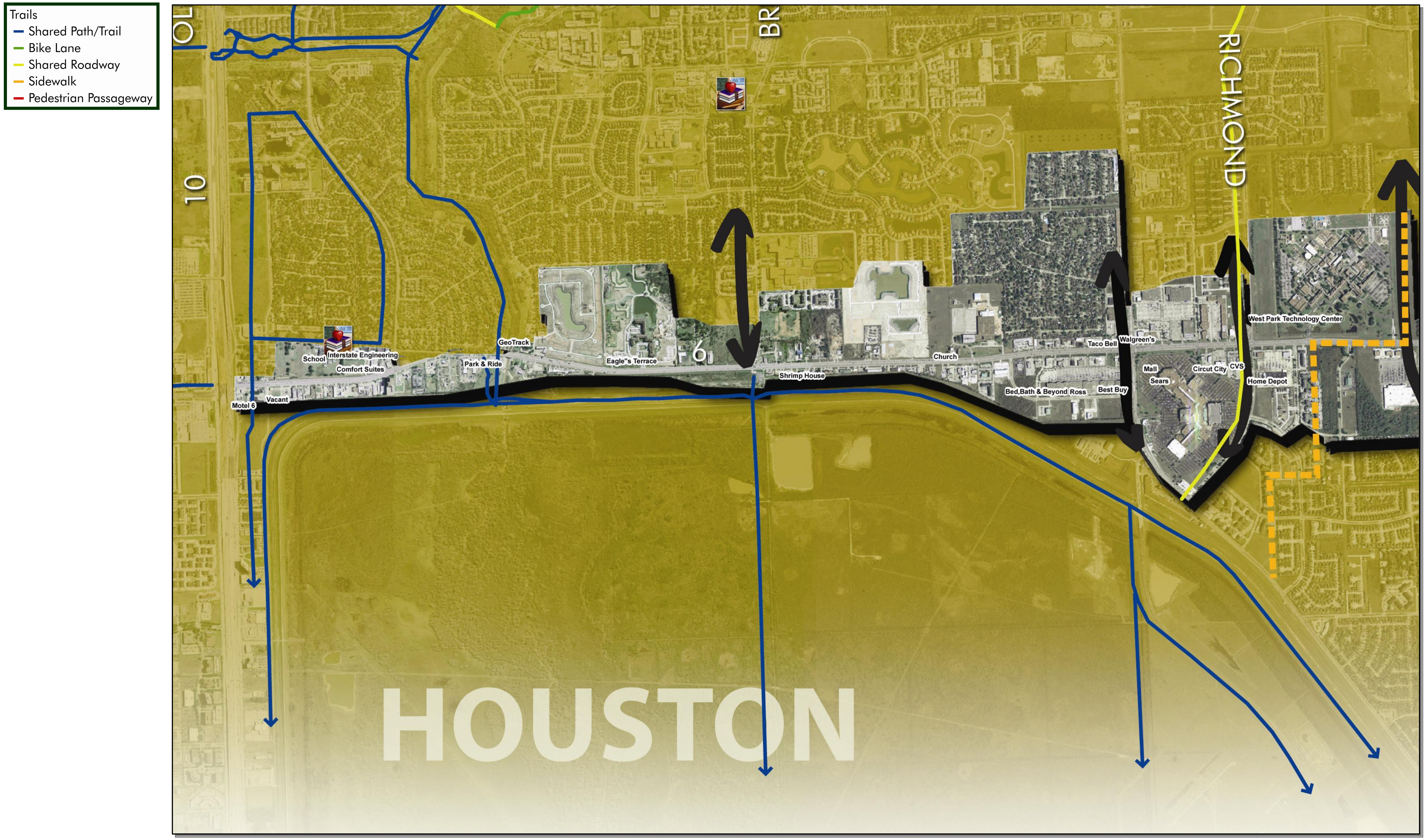


Figure 4-3: Houston Bicycle Pedestrian Map

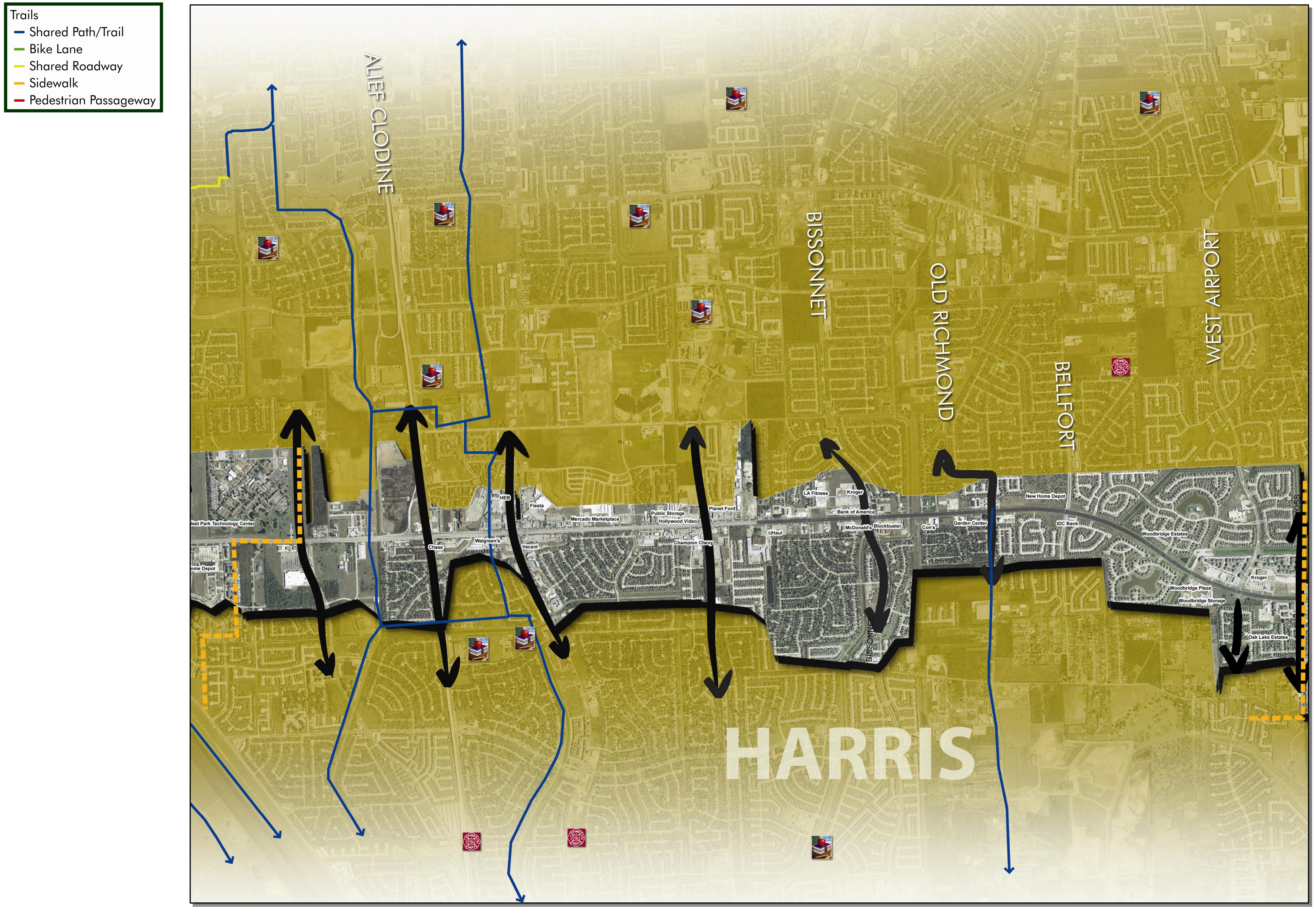


Figure 4-4: Harris County Bike / Pedestrian Map

4.5. Transit Improvements

This section indicates several locations within the City of Houston and Harris County that are candidates for Bus Rapid Transit (BRT) and local bus stops. Please refer to Figure 4-20 through 4-37 for graphical depictions of locations.

Long-Range Transit

The locations listed below are based on anticipated future key interchange points. Some locations may be found to have lower priority, allowing service to be provided only by local bus service. Local service in this corridor might have as many as 40 to 50 stops. Also, candidate locations of BRT stops were selected based on there areas having a higher demand for transit service. The Livable Centers Strategy in Section 4.8 and also in Chapter 8 discusses the optimum land use connection near transit stops. A list of candidate BRT stop locations can be found below.

Candidate BRT Locations for Houston and Harris County:

- Addicks Park and Ride
- Briar Forest
- Westheimer-Richmond
- Westpark Tollway
- Bellaire

Local buses in the corridor would stop at the following locations, including the BRT stops listed above:

- Addicks Park and Ride
- Grisby
- Memorial
- Briarhills
- No name
- Briar Forest
- New site
- Piping Rock
- Westheimer
- Richmond
- Branch Forest
- Westpark
- Parkwest Central
- Westpark Tollway
- Bellaire

4.6. Access Management Policy Updates

The SH 6 Corridor Access Management Plan seeks to improve safety, traffic flow, and reduce motorist delay. Therefore, the plan contributes to the public health, safety, and welfare of the communities. The cities may validate this plan or demonstrate an overall public commitment to managing access by including the following policy statements in the transportation and land use element into the City of Houston and Harris County's local ordinances.

Transportation Element

- A non-traversable, landscaped median will be provided on all new multilane major arterials. Undivided roadways and roadways with a continuous Two Way Left Turn Lanes (TWLTL) will be considered for reconstruction when the volume exceeds 20,000 VPD.
- Consider median barrier techniques for all unsignalized median openings.
- The Thoroughfare Plan should designate public ROW to mitigate impacts to the functional integrity of SH 6 and other major arterials.
- New driveway connections should not be located within the functional distance of an intersection.

Land Use Element

- Access to land development along SH 6 shall be preserved through the use of parallel roads, side streets, and cross-access easements connecting adjacent developments.
- Properties under the same ownership, consolidated for development, or part of phased development plans shall be considered one property for the purposes of access management. Access points to such developments shall be the minimum necessary to provide reasonable access, and not the maximum available, for that property frontage.
- New residential subdivisions should include an internal street layout that connects to the streets of surrounding developments to accommodate travel demand between adjacent neighborhoods, without the need to use the major thoroughfare system.
- Residential subdivisions abutting arterial roadways should be designed so that street connections conform to the access connection spacing standards for those roadways.
- Commercial development should be encouraged to share common access connections as well as to provide a convenient system of interparcel circulation so that customers as well as delivery and service vehicles can move between the sites.
- Commercial office and retail should be encouraged to develop livable centers (schematically illustrated as the preferred pattern in Chapter 8). This land use arrangement facilitates pedestrian circulation between businesses and eliminates the need for vehicles to use the public street when moving from one establishment to another. Also, as the corner clearance increases between driveways and the intersection, this improves safety and intersection operations by reducing the occurrence of conflicts within close proximity of the intersection.

Auxiliary Lanes

On urban arterial streets, speed change lanes generally provide space for the deceleration and storage of turning vehicles. At major developments, right-turn deceleration lanes should be considered when the peak hour volume (VPH) exceeds 60. The length of speed change lanes should be designed to comply with the TxDOT *Roadway Design Manual*.

Driveway Design

Driveways provide the physical transition between the public highway and the abutting property. Driveways should be located and designed to minimize negative impacts on traffic while providing safe entry and exit from the development served. The TxDOT *Roadway Design Manual* provides standards for driveway design that promote access management strategies.

Access Connection Spacing

The access connection distances in **Table 4-16** are intended for passenger cars on a level grade. These distances may be increased for downgrades, truck traffic, or where otherwise indicated for the specific circumstances of the site and the roadway. In other cases, shorter distances may be appropriate to provide reasonable access, and such decisions should be based on safety and operational factors supported by an engineering study.

Minimum Connection Spacing	
Posted Speed (MPH)	Distance (FT)
< 30	200
35	250
40	305
45	360
> 50	425

Table 4-16 TxDOT Driveway Spacing

4.7. Landscaping Treatments

TxDOT offers an optional program that will assist municipalities in improving intersections and landscape treatments.

The program, titled *Landscape Partnership Program and Landscape Cost Sharing Program*, target projects like those proposed herein. Cities or residents are responsible for the maintenance of the areas; however, funding is available for construction.

The City of Houston and Harris County are encouraged through this document to coordinate with TxDOT to develop their own landscape plan for the SH 6 corridor. **Figure 4-5** illustrates some of the design details that TxDOT requires for safety reasons.

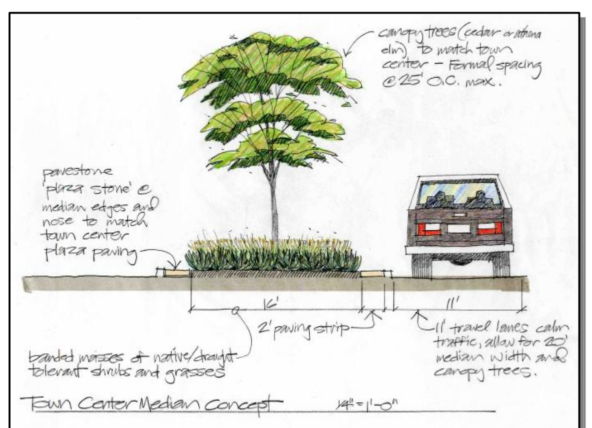


Figure 4-5 TxDOT Landscape Image

4.8. Livable Centers

Chapter 8 in this document details the needed steps to implement a livable centers strategy in a given area. For the City of Houston, Harris County, and H-GAC, promoting a livable centers strategy begins with identifying candidate areas and ends with watching the redevelopment emerge. Two specific areas should be investigated.

The first is the Westheimer area at SH 6. This area has unlimited potential, with a strong retail market, high traffic demand, and bus transit service.

The second candidate is within the Energy Corridor Management District. This area has already begun to redevelop and is anticipating new development and changes to streets and bike facilities. The Management District is extremely proactive, and tapping into their resources is one key to getting this livable center moving. The process outlined in **Chapter 8** provides a great deal of detail on how to evaluate and initiate a livable center. **Figure 4-6** is an illustration of a mixed use pedestrian environment that livable centers strive to achieve.

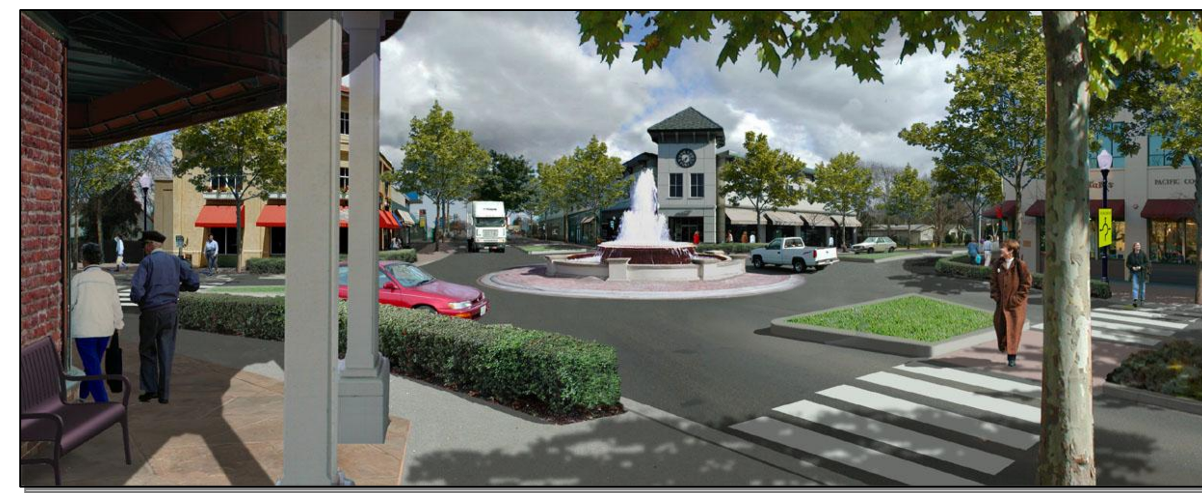
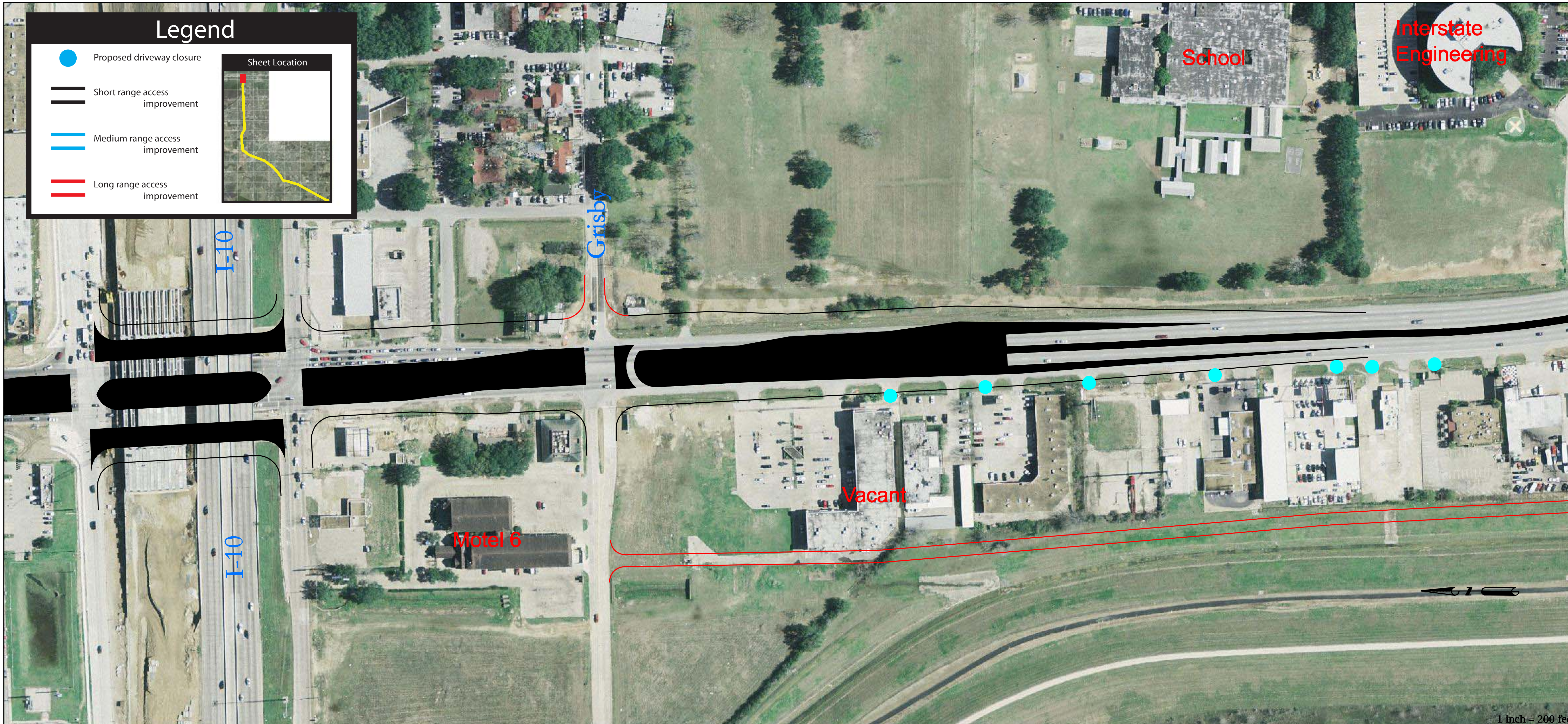


Figure 4-6: Mixed Use Image



DISTANCE BETWEEN INTERSECTIONS AND STORAGE LENGTHS

HOUSTON

ACCESS RECOMMENDATIONS

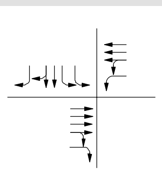
Add EB and WB right-turn overlaps

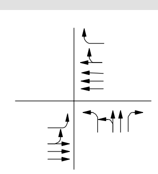
Add EB and WB right-turn overlaps

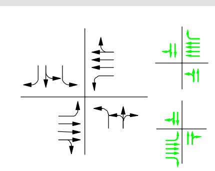
Grisby will have underpass with stop control devices

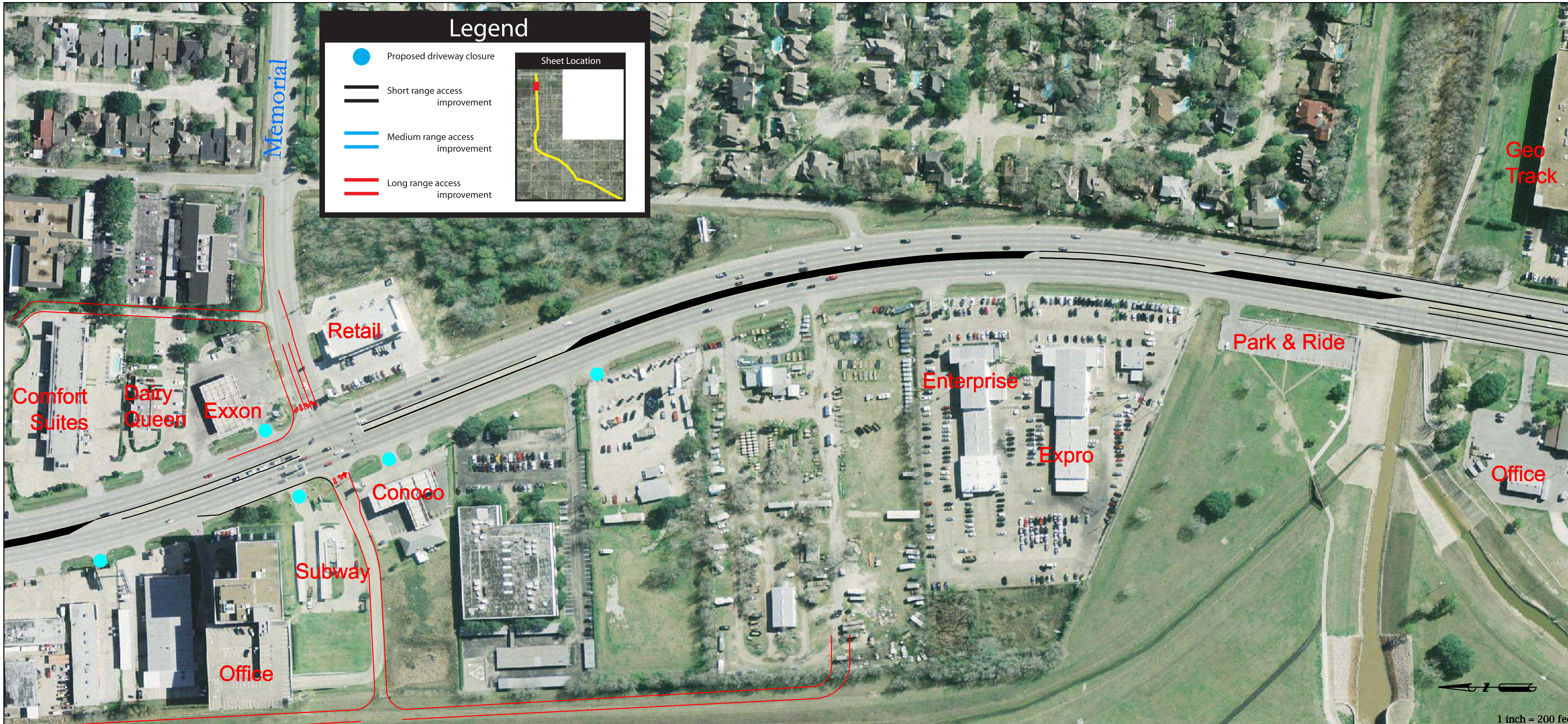
EXISTING AND PROPOSED INTERSECTION GEOMETRY

FIGURE 4-20









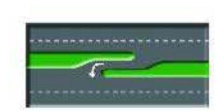
DISTANCE BETWEEN INTERSECTIONS AND STORAGE LENGTHS

HOUSTON

275' 200' 200' 275' 100' 275' 275' 200'

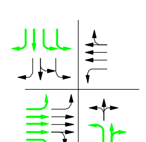
ACCESS RECOMMENDATIONS

Remove EB - WB Split Phase



EXISTING AND PROPOSED INTERSECTION GEOMETRY

FIGURE 4-21

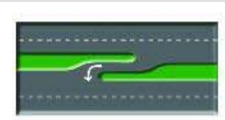


DISTANCE BETWEEN INTERSECTIONS AND STORAGE LENGTHS

HOUSTON

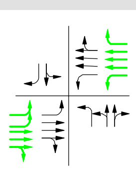
200' 275' 100' 275' 275' 200' 100' 275' 275'

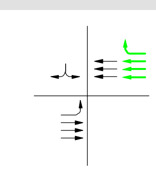
ACCESS RECOMMENDATIONS



EXISTING AND PROPOSED INTERSECTION GEOMETRY

FIGURE 4-22



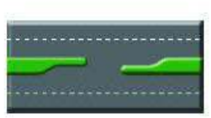


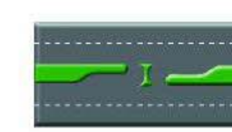
DISTANCE BETWEEN INTERSECTIONS AND STORAGE LENGTHS

HOUSTON

275' 100' 100' 275' 275' 200' 200' 275' 275' 100' 100'

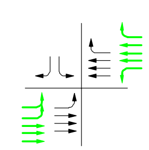
ACCESS RECOMMENDATIONS

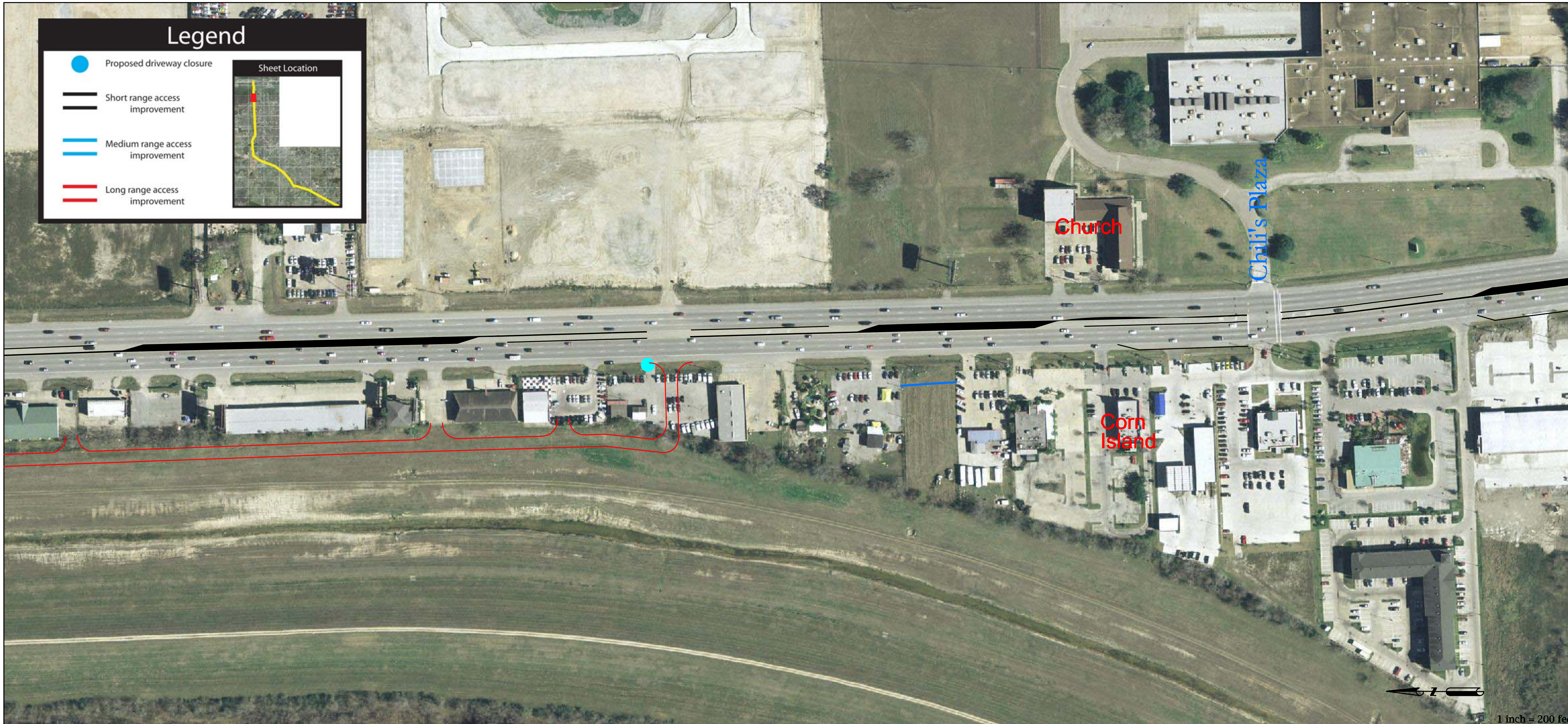




EXISTING AND PROPOSED INTERSECTION GEOMETRY

FIGURE 4-23





DISTANCE BETWEEN INTERSECTIONS AND STORAGE LENGTHS

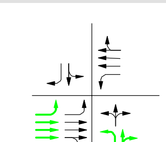
HOUSTON

275' | 275' | 100' | 100' | 275' | 275' | 150' | 150' | 275'

ACCESS RECOMMENDATIONS

EXISTING AND PROPOSED INTERSECTION GEOMETRY

FIGURE 4-24

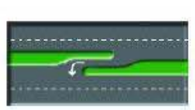


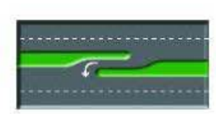
DISTANCE BETWEEN INTERSECTIONS AND STORAGE LENGTHS

HOUSTON

100' | 185' | 175' | 150' | 150' | 275' | 100' | 225' | 275' | 200' | 200' | 275'

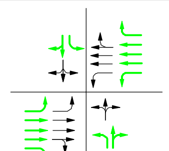
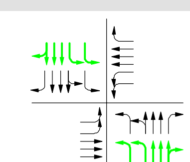
ACCESS RECOMMENDATIONS

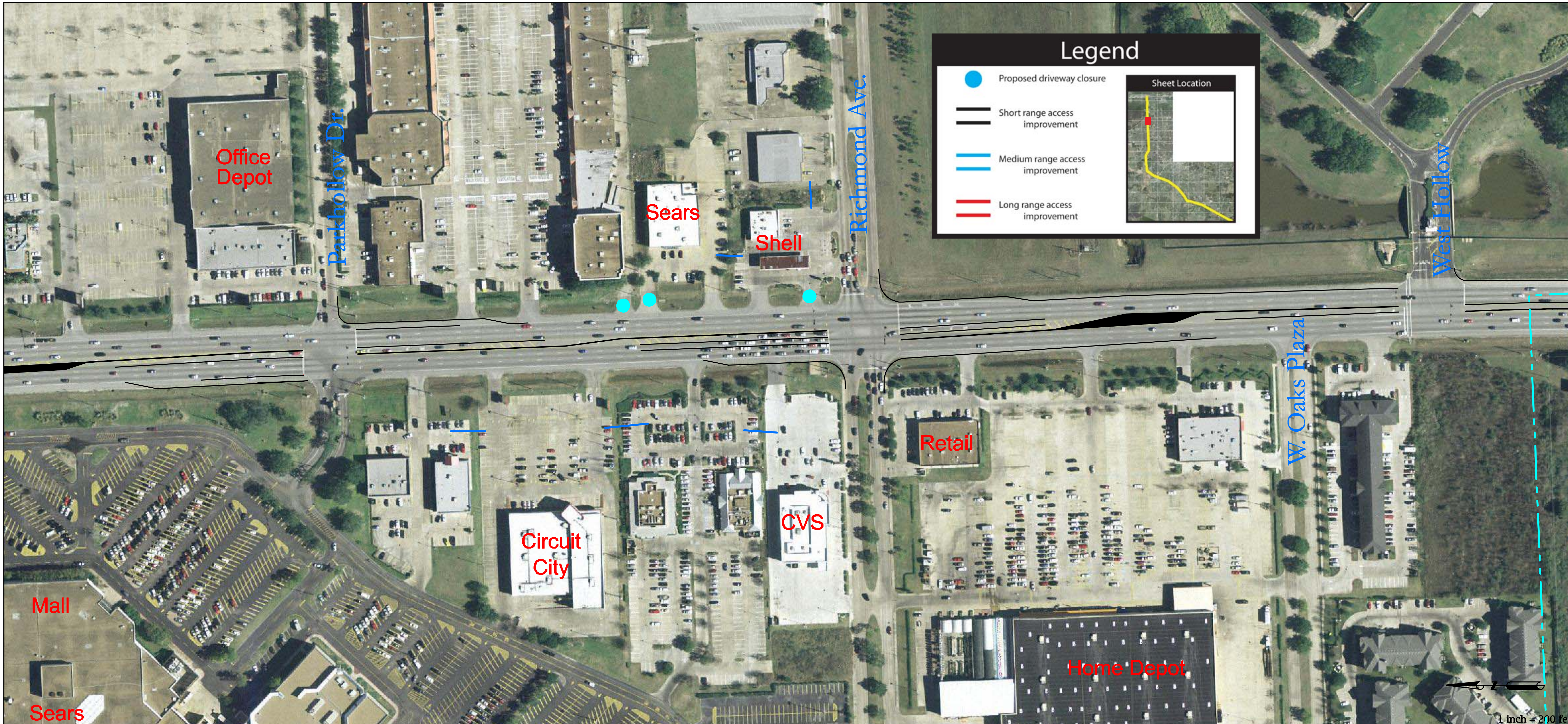





EXISTING AND PROPOSED INTERSECTION GEOMETRY

FIGURE 4-25



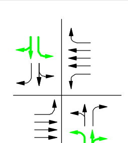
DISTANCE BETWEEN INTERSECTIONS AND STORAGE LENGTHS

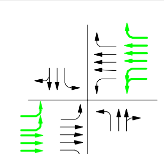
HOUSTON

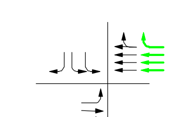
ACCESS RECOMMENDATIONS

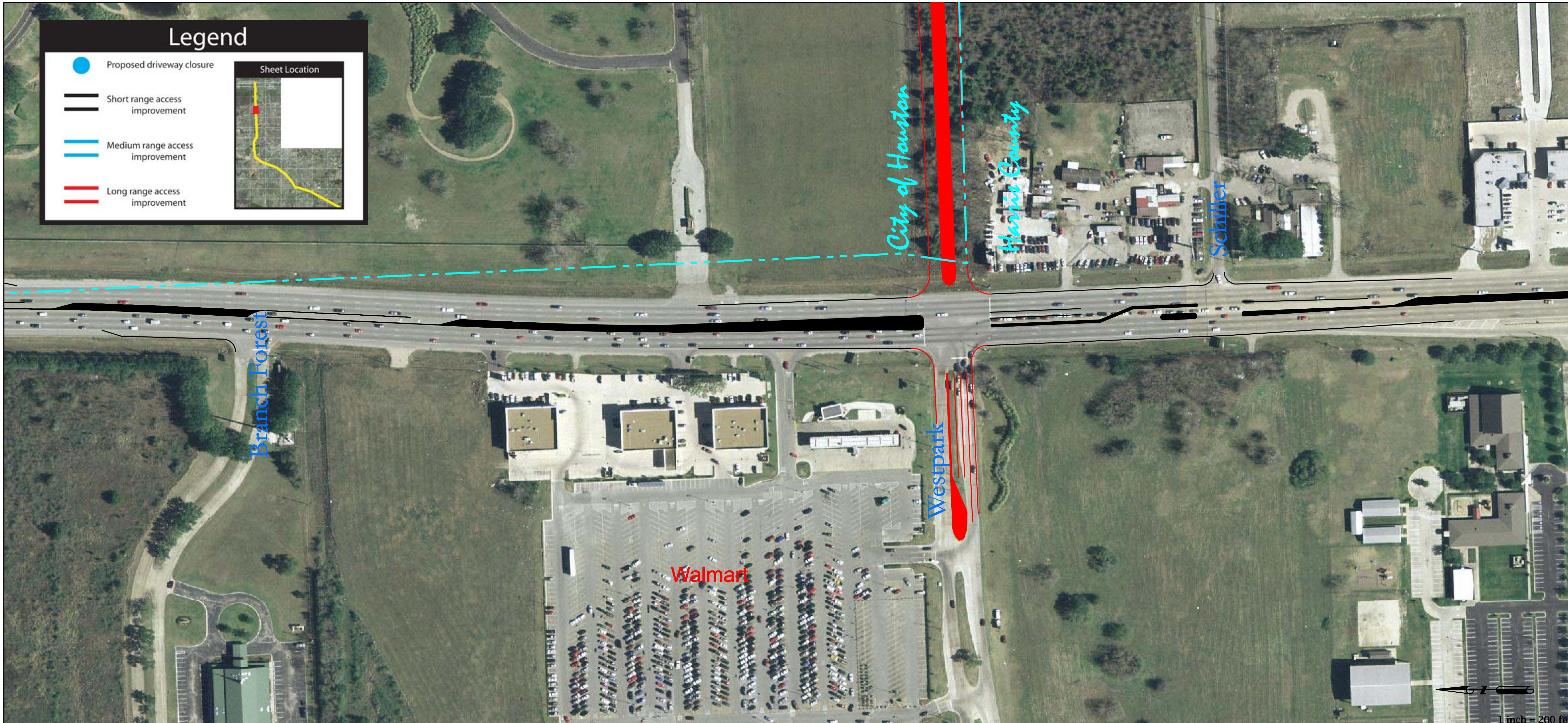
EXISTING AND PROPOSED INTERSECTION GEOMETRY

FIGURE 4-26





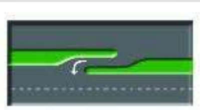




DISTANCE BETWEEN INTERSECTIONS AND STORAGE LENGTHS — HOUSTON — HARRIS COUNTY

100' | 285' | 100' | 175' | 150' | 50' | 100' | 250'

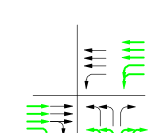
ACCESS RECOMMENDATIONS

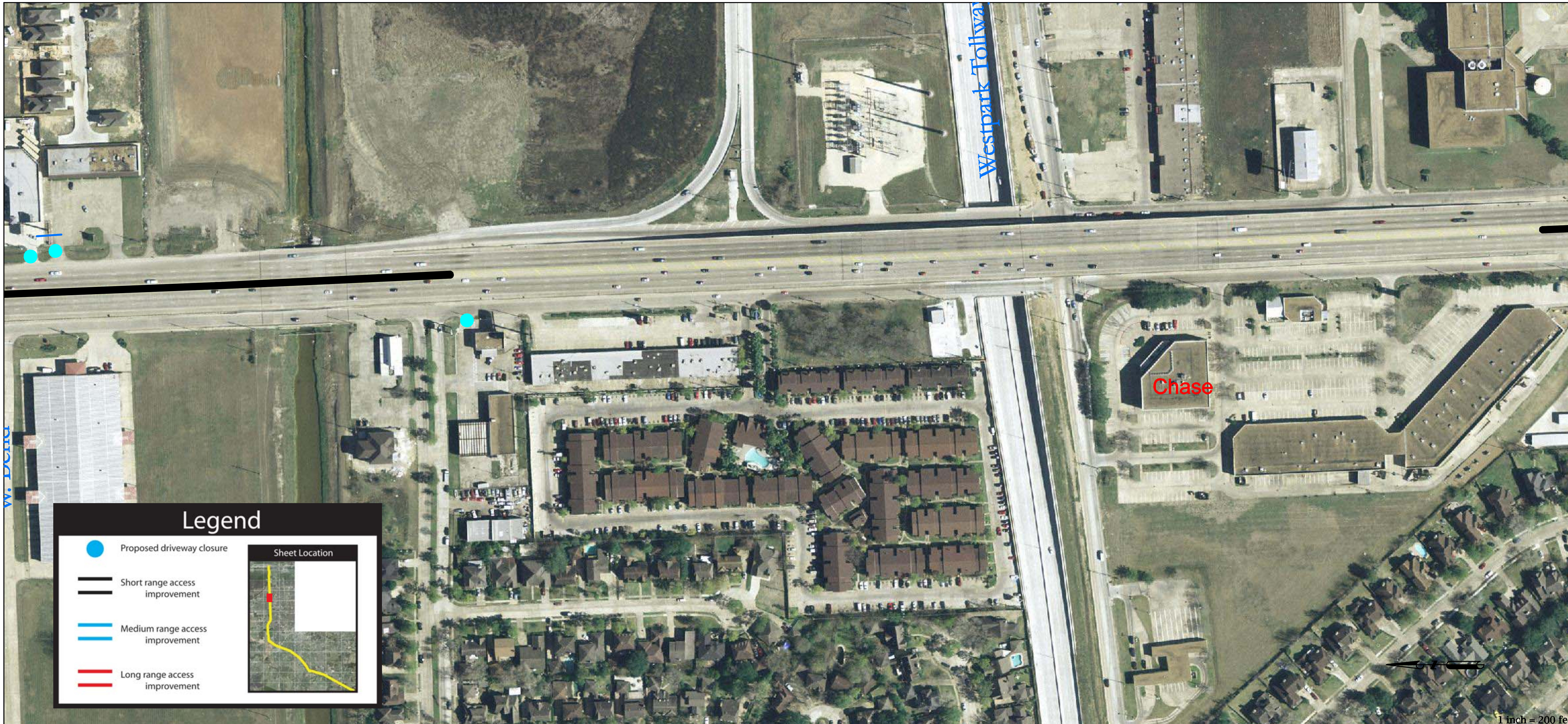


Provide EB right-turn overlap

EXISTING AND PROPOSED INTERSECTION GEOMETRY

FIGURE 4-27





DISTANCE BETWEEN INTERSECTIONS AND STORAGE LENGTHS

HARRIS COUNTY

ACCESS RECOMMENDATIONS

EXISTING AND PROPOSED INTERSECTION GEOMETRY

FIGURE 4-28

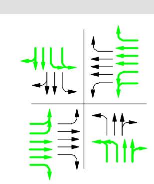
DISTANCE BETWEEN INTERSECTIONS AND STORAGE LENGTHS

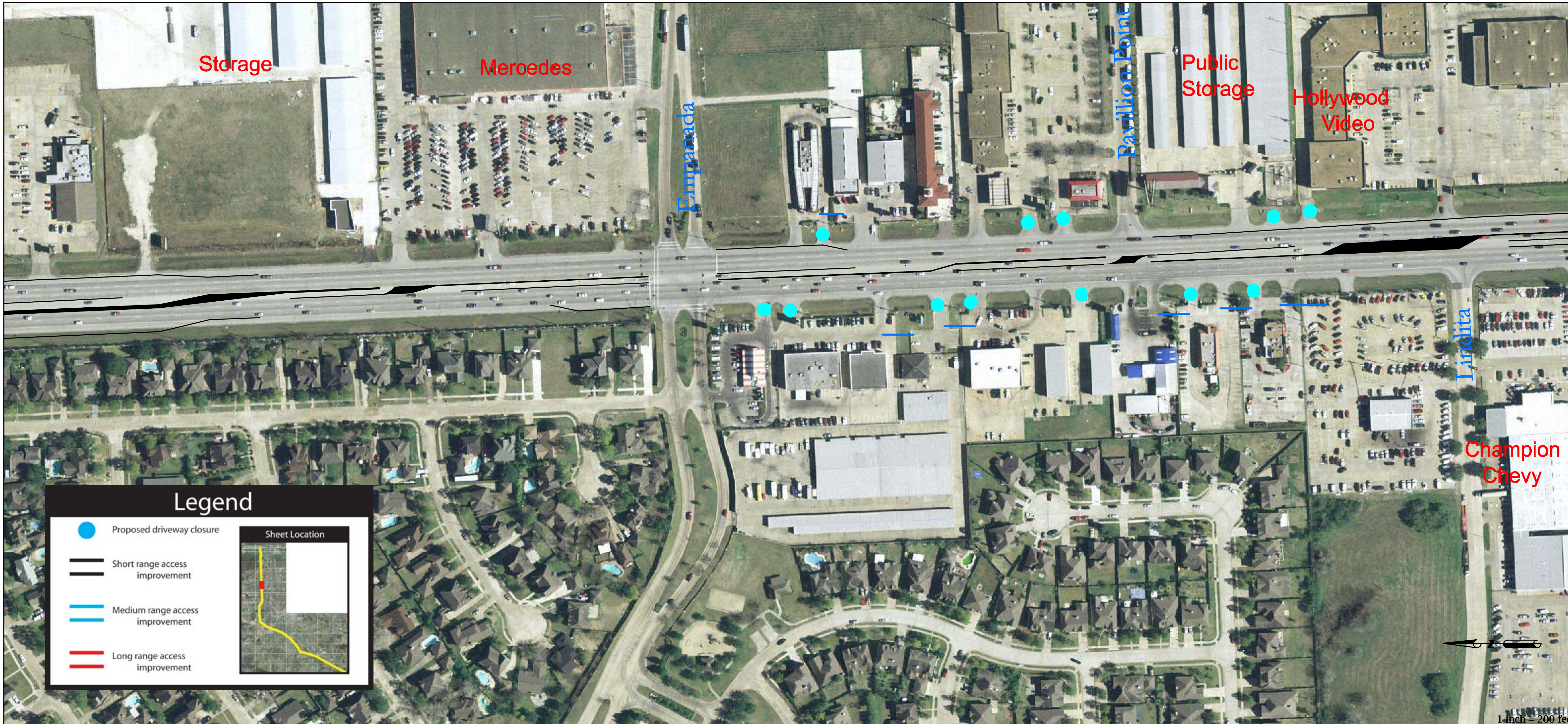
HARRIS COUNTY

ACCESS RECOMMENDATIONS

EXISTING AND PROPOSED INTERSECTION GEOMETRY

FIGURE 4-29

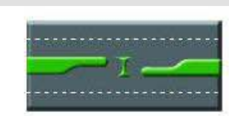




DISTANCE BETWEEN INTERSECTIONS AND STORAGE LENGTHS

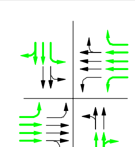
HARRIS COUNTY

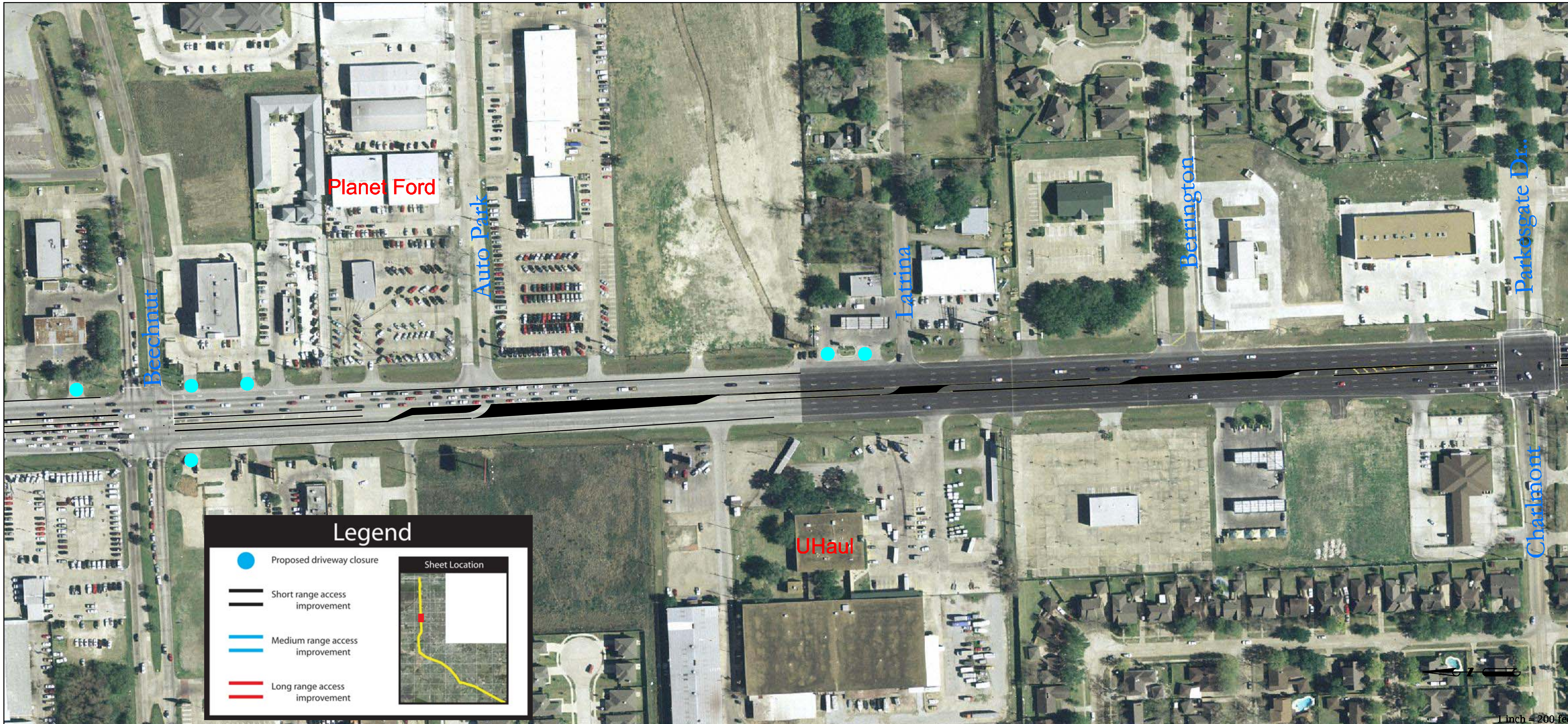
ACCESS RECOMMENDATIONS



EXISTING AND PROPOSED INTERSECTION GEOMETRY

FIGURE 4-30





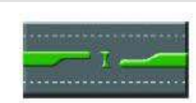
DISTANCE BETWEEN INTERSECTIONS AND STORAGE LENGTHS

HARRIS COUNTY

200' | 200' | 275' | 275' | 100' | 100' | 275' | 250' | 200' | 200'

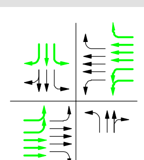
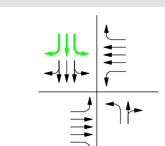
ACCESS RECOMMENDATIONS






EXISTING AND PROPOSED INTERSECTION GEOMETRY

FIGURE 4-31

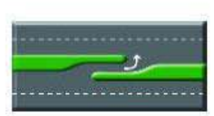



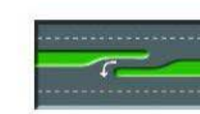
DISTANCE BETWEEN INTERSECTIONS AND STORAGE LENGTHS

HARRIS COUNTY

200' | 250' | 225' | 150' | 150' | 225' | 100' | 275' | 400'

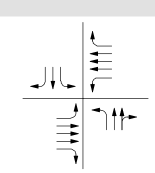
ACCESS RECOMMENDATIONS

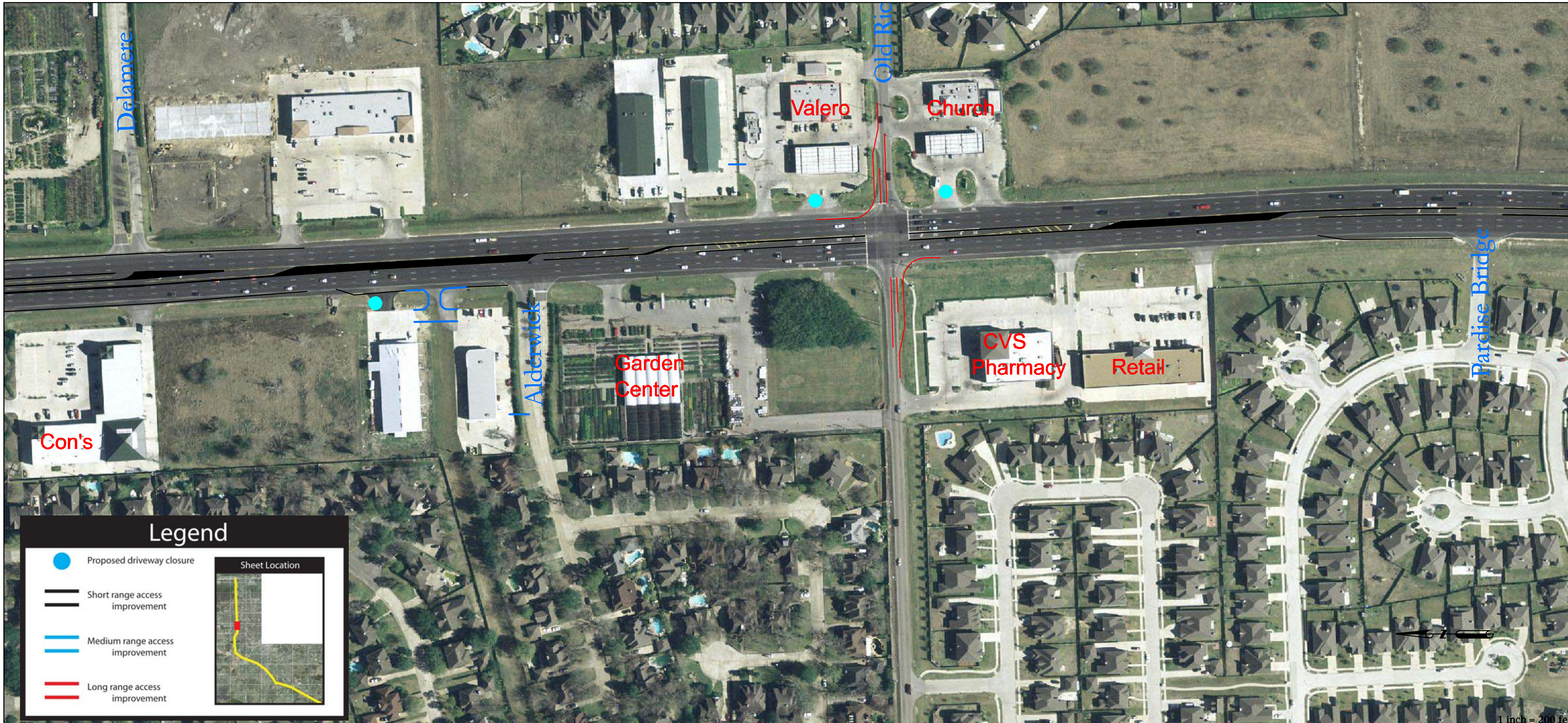




EXISTING AND PROPOSED INTERSECTION GEOMETRY

FIGURE 4-32



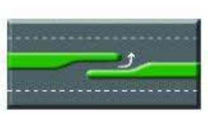


DISTANCE BETWEEN INTERSECTIONS AND STORAGE LENGTHS

HARRIS COUNTY

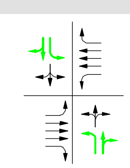
225'	200'	200'	225'	275'	100'	100'	200'

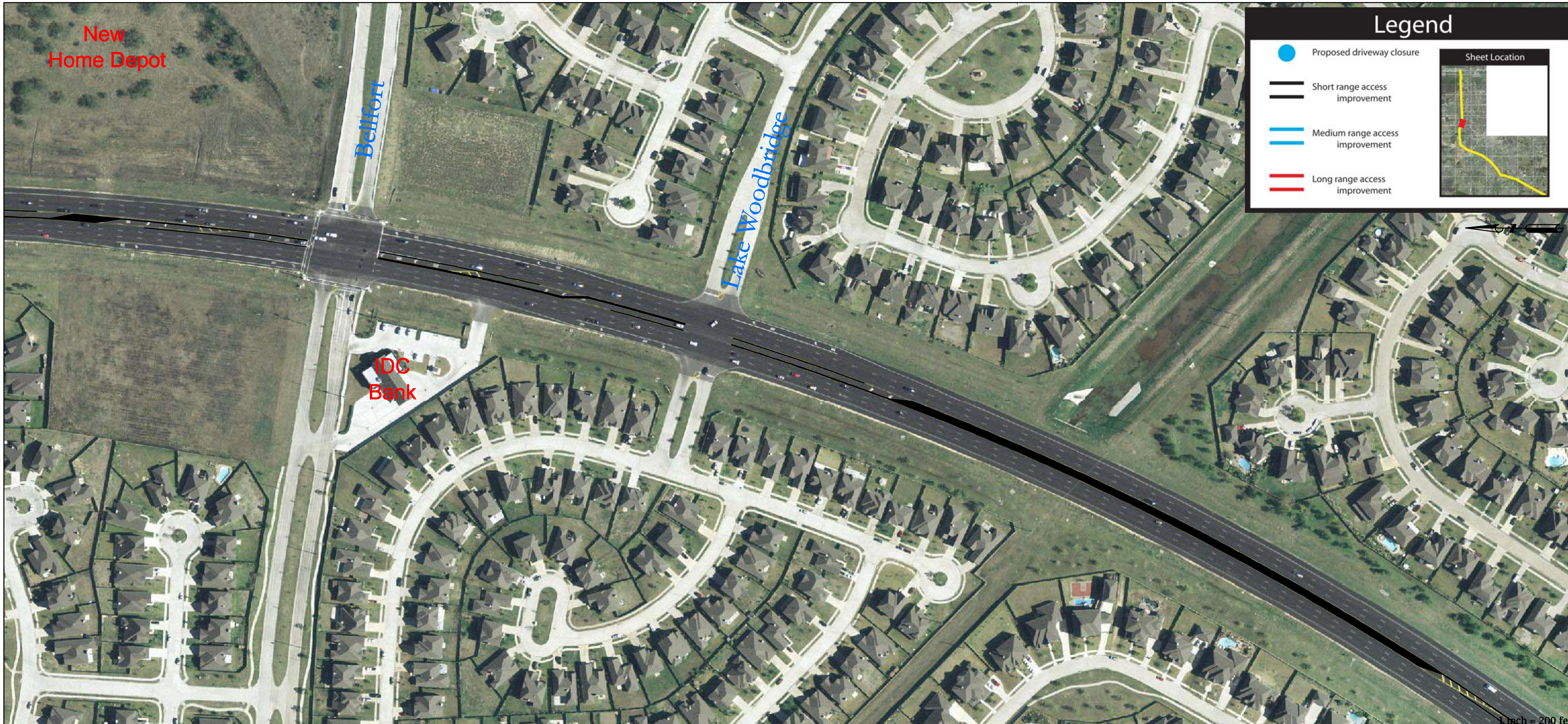
ACCESS RECOMMENDATIONS



EXISTING AND PROPOSED INTERSECTION GEOMETRY

FIGURE 4-33





DISTANCE BETWEEN INTERSECTIONS AND STORAGE LENGTHS

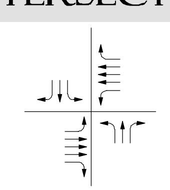
HARRIS COUNTY

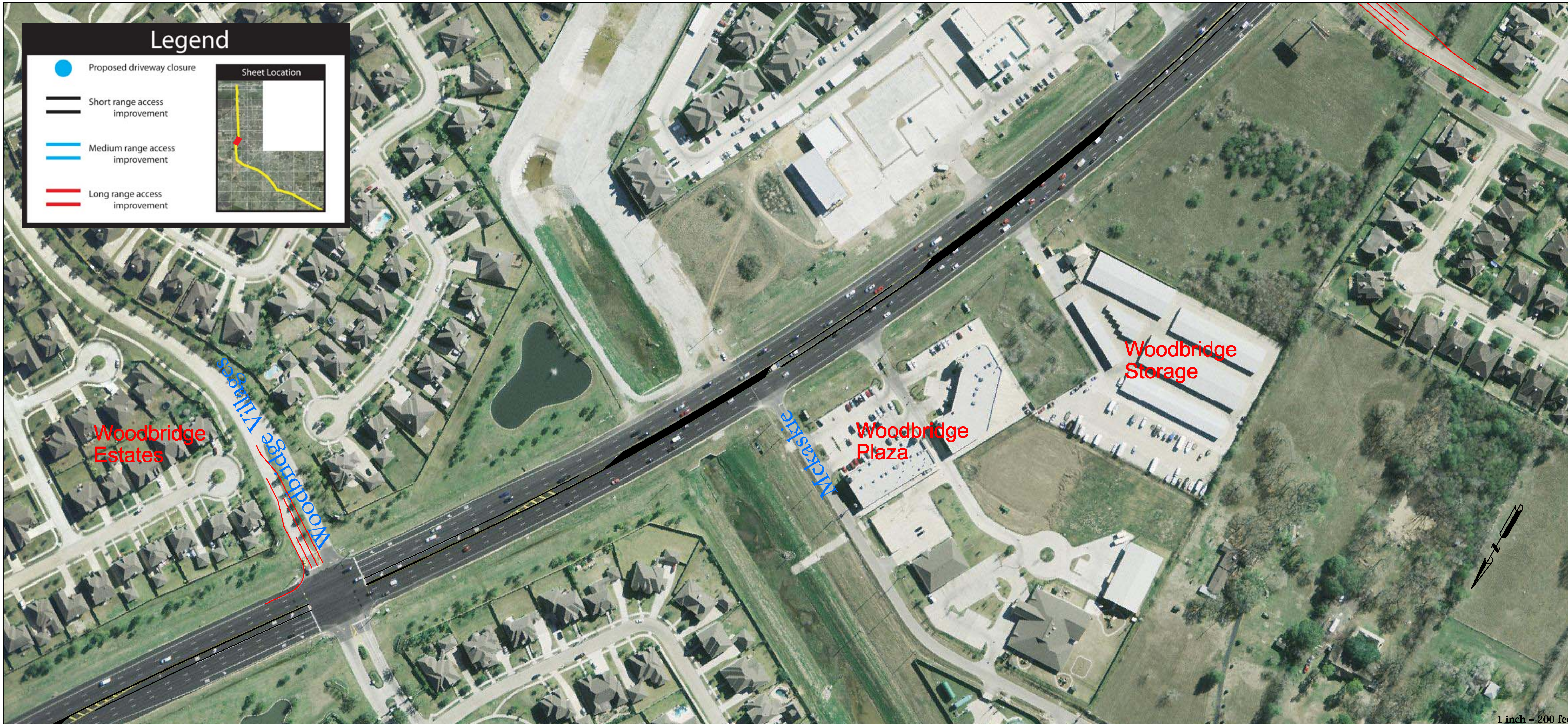
275' | 150' | 100' | 275' | 175' | 100' | 100' | 275' | 275'

ACCESS RECOMMENDATIONS

EXISTING AND PROPOSED INTERSECTION GEOMETRY

FIGURE 4-34



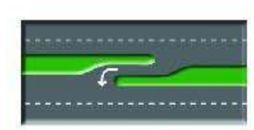


DISTANCE BETWEEN INTERSECTIONS AND STORAGE LENGTHS

HARRIS COUNTY

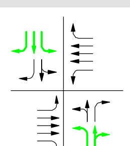
275' | 300' | 300' | 275' | 100' | 275'

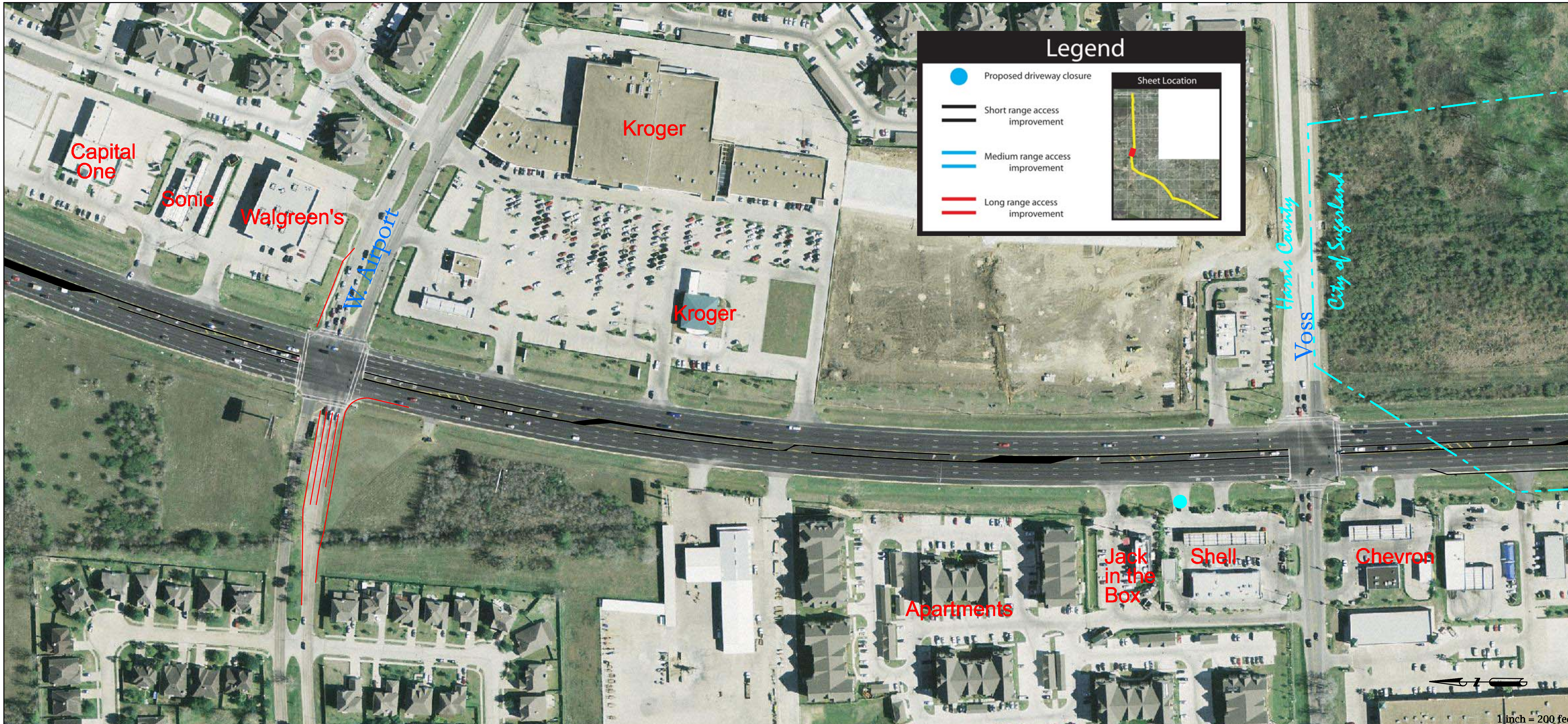
ACCESS RECOMMENDATIONS



EXISTING AND PROPOSED INTERSECTION GEOMETRY

FIGURE 4-35





DISTANCE BETWEEN INTERSECTIONS AND STORAGE LENGTHS

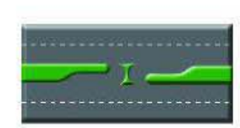
HARRIS COUNTY

CITY OF SUGARLAND

275' | 200' | 100' | 275' | 275' | 100' | 100' | 275' | 275' | 200' | 100' | 275'

ACCESS RECOMMENDATIONS

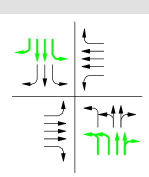
Remove EB - WB Split Phase

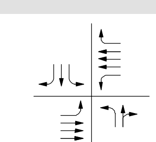


Remove EB - WB Split Phase

EXISTING AND PROPOSED INTERSECTION GEOMETRY

FIGURE 4-36





Chapter 5: Improvements (Sugar Land and TxDOT)

The focus of this chapter is to provide the City of Sugar Land and TxDOT information on the City of Sugar Land in the vicinity of SH 6. From existing conditions to short-, medium-, and long-term solutions, this chapter will describe in detail each planned improvement.

5.1. Existing Conditions

The existing conditions in the City of Sugar Land in the areas of SH 6 will be described in terms of intersection levels of service, crash experience, transit service, bicycle and pedestrian conditions, and finally the road characteristics.

Intersection Level of Service

Peak hour turning movement counts for both A.M. and P.M. were collected and used to evaluate the intersection levels of service. Acceptable intersection levels of service vary by area, but, in general, levels of service below the letter "D" are considered failing. As indicated in Table 5-1, the worst intersections are at US 59 and Williams Trace in the P.M. period. Generally, the City of Sugar Land has done a terrific job of timing and maintaining very good levels of mobility especially with very high traffic volumes.

Intersection	AM Peak	PM Peak
1st Colony Blvd	B	D
Lake Point	A	A
Fluor Daniel Dr.	B	C
Medical Dr.	A	A
Kensington Dr.	A	A
US 59 SB	E	E
US 59 NB	F	D
Town Center Dr.	E	C
Lexington Blvd	D	D
Grants Lake Blvd.	A	B
Williams Trace Blvd	D	F
Settlers Way Blvd	C	C
Frost Pass	A	A

Table 5-1: Sugar Land Existing Level of Service

Signal Phasing

Table 5-2 below depicts the current phasing of each of the signals. Many of the signals are operating a split phase. This is something that is necessary at times, but can be changed as part of our medium- or long-term solutions.

	Left-Turn Phase Types																Ped Signals			
	NB				SB				EB				WB							
	Protected-Only	Protected-Permitted	Permitted Only	Split-phased	Protected-Only	Protected-Permitted	Permitted Only	Split-phased	Protected-Only	Protected-Permitted	Permitted Only	Split-phased	Protected-Only	Protected-Permitted	Permitted Only	Split-phased	N Side	S Side	W Side	E Side
Brooks St / First Colony Blvd	1				1							1				1				
Lake Point	1				1							1				1	1	1	1	1
Flour Daniel Dr	1				1							1				1				
Medical Dr.	1				1							1				1	1	1	1	1
Kensington Dr	1				1							1				1	1	1	1	1
US 59 SBFR	1															1	1		1	1
US 59 NBFR					1							1						1	1	1
Town Center Dr																	1	1	1	1
Lexington Blvd	1				1							1				1	1	1	1	1
Grants Lake Blvd	1											1					1	1	1	1
Williams Trace Blvd	1				1				1				1				1	1	1	1
Settlers Way Blvd	1				1				1				1				1	1	1	1
Frost Pass	1				1						1				1		1	1	1	1

Table 5-2: Sugar Land Existing Phasing

Transit Service

Currently, dial a ride and para-transit service exist in the City of Sugar Land. Also, the Trek Express park-and-ride offers commuters the option to car pool to their final destination. Sugar Land is out the METRO service area and has no regular bus routes.

Pedestrian and Bicycle Infrastructure

Throughout the City sidewalks are generally present along SH 6 south of US 59 (refer to Figure 5-1 for a photo of the existing corridor south of US 59). North of US 59 sidewalks are limited or are not present. A majority of the side streets connecting to SH 6 have sidewalks throughout their neighborhoods. Please refer to Table 5-3 for locations of parallel sidewalks and bicycle facilities. In the areas south of US 59 where no sidewalks exist, it is recommended (if feasible) to connect the missing sidewalk segments.

Figure 5-1: Existing Sugar Land Photo

Selected Signalized Crossroads		CITY OF SUGAR LAND																										
		1st Colony Blvd	to	Lake Point	to	Fluor Daniel Dr.	to	Medical Dr.	to	Kensington Dr.	to	US 59 SB	to	US 59 NB	to	Town Center Dr.	to	Lexington Blvd	to	Grants Lake Blvd.	to	Williams Trace Blvd	to	Settlers Way Blvd	to	Frost Pass	to	Austin Pkwy Blvd./Dulles Ave.
Access	Distance (miles)		0.1		0.2		0.1		0.2		0.2		0.05		0.2		0.2		0.4		0.4		0.5		0.7		0.3	
	Total Driveways		1		6		2		4		1		0		3		7		1		4		23		10		12	
	Total Driveway Density Per Mile		10		30		20		20		5		0		15		35		3		10		46		14		40	
	Driveway Density Ratio		10.00		5.00		10.00		5.00		5.00				5.00		5.00		2.50		2.50		2.00		1.43		3.33	
Crashes	Total		3		27		9		5		21		14		31		40		27		34		27		43		22	
Roadway Characteristics	Median Type		RM		RM		RM		RM		RM		Median		RM		RM		RM		RM		RM		RM		TWLT L	
	Edge Treatment		Curb		Curb		Curb		Curb		Curb		Curb		Curb		Curb		Curb		Curb		Curb		Curb		Shoul der	
	Sidewalks		No		No		No		No		No		No		Yes		Yes		Yes		Yes		Yes		Yes		No	
	Bike Lanes		No		No		No		No		No		No		No		No		No		No		No		No		No	
	Speed (MPH)		45		45		45		45		45		45		45		45		45		45		45		45		50	

Table 5-3: Sugar Land Existing Corridor Characteristics

5.2. Median and Driveway Improvements

Short-Term Improvements

The primary short-term improvement for the SH 6 Corridor Access Plan in Sugar Land will be construction of raised medians. Within Sugar Land, it is anticipated that the medians can be built for $1,719,500. Detailed concept plans are provided in Figures 5-20 through 5-31. For the detailed cost estimate for the City of Sugar Land, please refer to Appendix C.

Figure 5-2: Sugar Land Existing Medians

Medium-Term Improvements

A majority of the medium-term improvements are driveway consolidations (Table 5-4 shows the cost). These improvements can be seen in Figures 5-20 through 5-31. In addition, detailed cost estimates for the removal and reconstruction of driveways for the City are located in Appendix C.

Jurisdiction	Driveways Closed	Cost
City of Sugar Land	3 Driveway Closures	$21,100

Table 5-4: Sugar Land Driveway Consolidations

Medium-Term Cross-Access Improvements

These improvements are intended to provide cross-access between developments. Improving cross-access allows vehicles to travel from one development to another without adding additional trips onto the adjacent roadways. Please refer to Table 5-5 for cross-access costs. Overall, the City of Sugar Land has been a model city in connecting developments with cross access.

Jurisdiction	Number of Cross Access Improvements	Cost
City of Sugar Land	3 future cross access point constructed	$35,200

Table 5-5: Sugar Land Cross Access Improvements

5.3. Signals and Intersection Improvements

The following section details the needed long-term intersection improvements, which are noted in Table 5-6. If the City desires to expedite the intersection improvements it would be advisable to coordinate with TxDOT to have the intersection improvements done at the same time as the medians.

Long-Term Intersection Improvements

The following improvements represent long-term intersection projects. These projects are considered long-range simply because of the ROW that would be needed to make the improvements. The City of Sugar Land obviously has the discretion to accelerate the projects by getting involved in the ROW negotiations.

Intersection	Improvement	Cost
Voss Rd. to Sugar Land Airport	Parcel connection to future thoroughfare	$517,100
Sugar Land Airport		$0
Brooks St/First Colony Blvd	Expand SB to include dual left turn lane	$140,600
Lake Point	Restripe SB to include dual left	$12,400
Flour Daniel Dr	Restripe SB to include dual left	$12,400
Medical Dr.	Restripe SB and NB for dedicated left turn lanes	$8,300
Kensington Dr	Restripe NB to include dedicated dual left turn lane	$8,300
US 59 SBFR	Coordinate with TxDOT to modify signage to direct mall traffic to new University interchange.	$0
US 59 NBFR		$0
Town Center Dr	Expand SB to include dedicated left turn lane	$136,500
Lexington Blvd		$0
Grants Lake Blvd		$0
Williams Trace Blvd	Expand SB to allow for dual left and dedicated right, expand NB to allow for dual left	$281,300
Settlers Way Blvd	Expand NB to include dedicated right turn lane	$140,600
Frost Pass	Restripe NB to include dedicated left turn	$8,300
TOTAL		$1,265,800

Table 5-6: Sugar Land Intersection Improvements

5.4. Bicycle and Pedestrian Improvements

The City of Sugar Land has done a wonderful job of blending the massive needs of the automobile into a framework along SH 6 that is safe and offers choices for pedestrians. To further expand the bicycle and pedestrian environment, additional bicycle and pedestrian facilities are recommended (refer to **Figures 5-7** and **5-8**). The bicycle and pedestrian improvements can be characterized by three different types of improvements. First, hike and bike trial additions; second, sidewalk and pedestrian connections; and, finally, intersection pedestrian elements such as curb ramps, decorative cross walks, and lighting and signal poles. Many of these improvements can be jointly funded between local agencies and TxDOT, while others would be completely funded by local agency resources. Phasing of bicycle and pedestrian improvements is dependent on available funding. Short-term improvements include sidewalk improvements that can built within the existing ROW. It is also assumed that as improvements are made to intersections or pedestrian facilities they will be constructed to comply with ADA requirements.

Short-Term Sidewalk improvements

South of US 59, the City (in conjunction with developers) has already built sidewalks on both sides of SH 6. However, sidewalks are limited north of US 59. Therefore, it is recommended that sidewalks be built (within existing ROW and to City standards) from US 59 north to the northern City limits. **Table 5-7**: Sugar Land Sidewalk Improvements shows the approximate cost of the sidewalk improvements.

It is critical to design the sidewalks to allow for an appropriate pedestrians realm. **Figure 5-3**: Pedestrian Realm shows how each element of the realm is unique and should be treated as such. It is recommended that an urban design vision plan be developed along SH 6 to identify key areas and unique features. The vision should highlight the pedestrian environment and build on an already beautiful corridor.

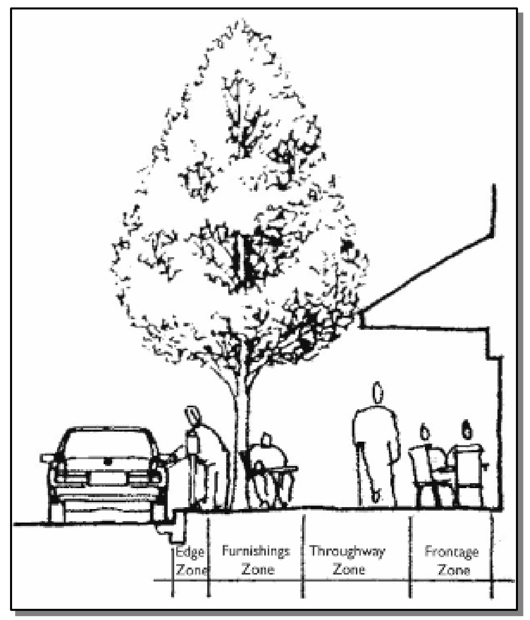


Figure 5-3: Pedestrian Realm

SH 6	Sidewalk construction and pedestrian improvements from Flour Danial Dr. to Town Center Drive. Including added intersection improvements at US 59.	$256,000

Table 5-7: Sugar Land Sidewalk Improvements

Medium-Term Intersection Pedestrian Improvement

H-GAC recently completed a bicycle and pedestrian planning project for the City of Sugar Land. The planning study recommended that pedestrian improvements be implemented at the intersections near the Sugar Land Town Square. This study agrees with those recommendations, and is expanding the scope of improvements to include all the City intersections. The improvements noted in **Table 5-8** include decorative crosswalks, lighting, and urban design features, where applicable. The "before" and "after" images in **Figures 5-3** and **5-4** show how decorative paving at an intersection will improve the look and feel of the intersection.

All Sugar Land Intersections	Intersection improvement — additional crosswalk beautification and lighting to provide enhanced pedestrian environment	To Be Determined

Table 5-8: Sugar Land Intersection Pedestrian Improvements

Figure 5-4 Sugar Land "Before" Intersection

Figure 5-5 Sugar Land "After" Intersection

Long-Term Bicycle and Pedestrian Improvements

The long-term improvement in Table 5-9: Sugar Land Hike and Bike Improvements are primarily for the construction of a hike and bike system. Figure 5-6 is an example of an existing hike and bike trail.

Additional long-range options include looking into the possibility of creating pedestrian connections between developments over or under SH 6. These connections would provide for additional green time for the signals while allowing pedestrians to cross the street in a safer more enjoyable environment. Pedestrian overpasses can be done in a way that adds beauty and character to an area. The overpass essentially can become an icon or entry feature to the area. The image below is an example of an overpass conceptualized for the City of Southlake, Texas.

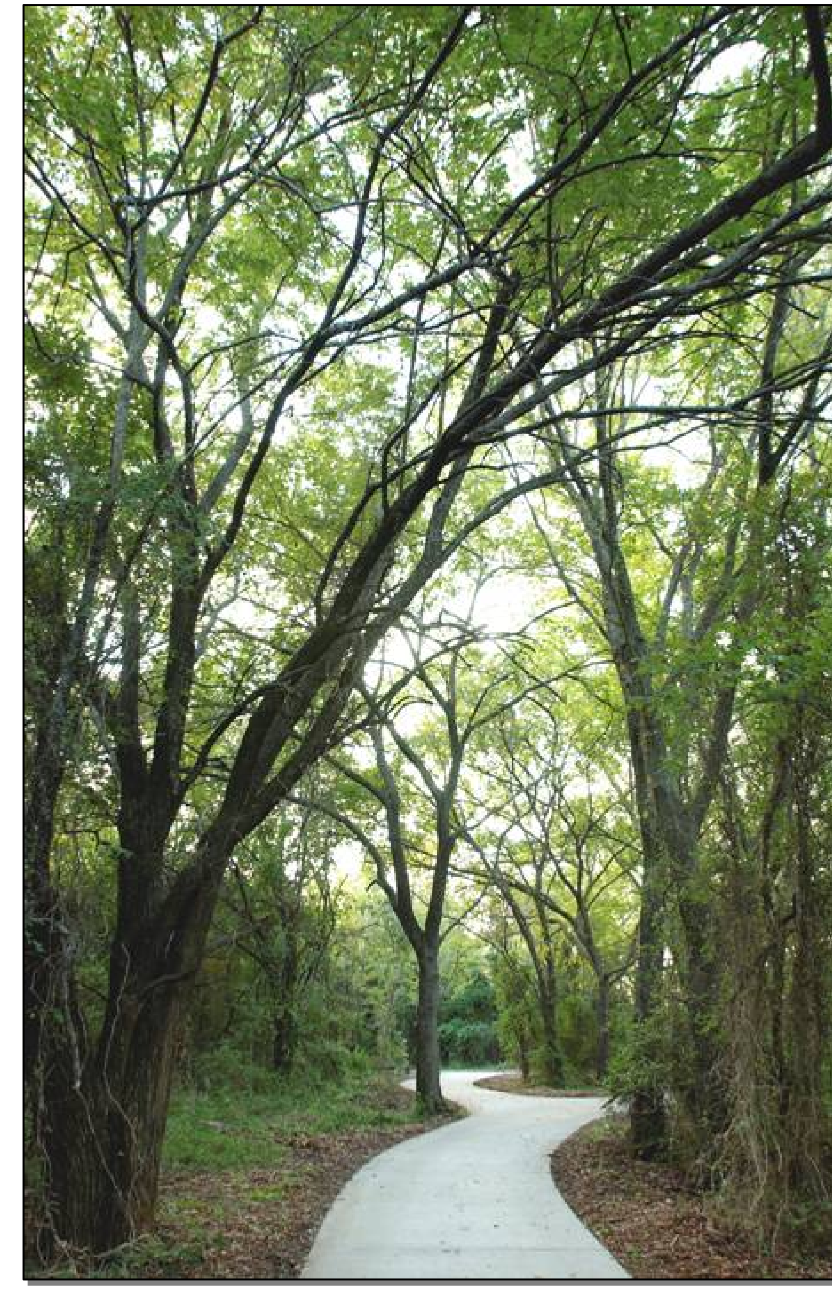


Figure 5-6: Hike and Bike Example

William Trace Blvd.	Connections from Southside Park to SH 6 retail and neighborhoods	$3,000

Table 5-9: Sugar Land Hike and Bike Improvements

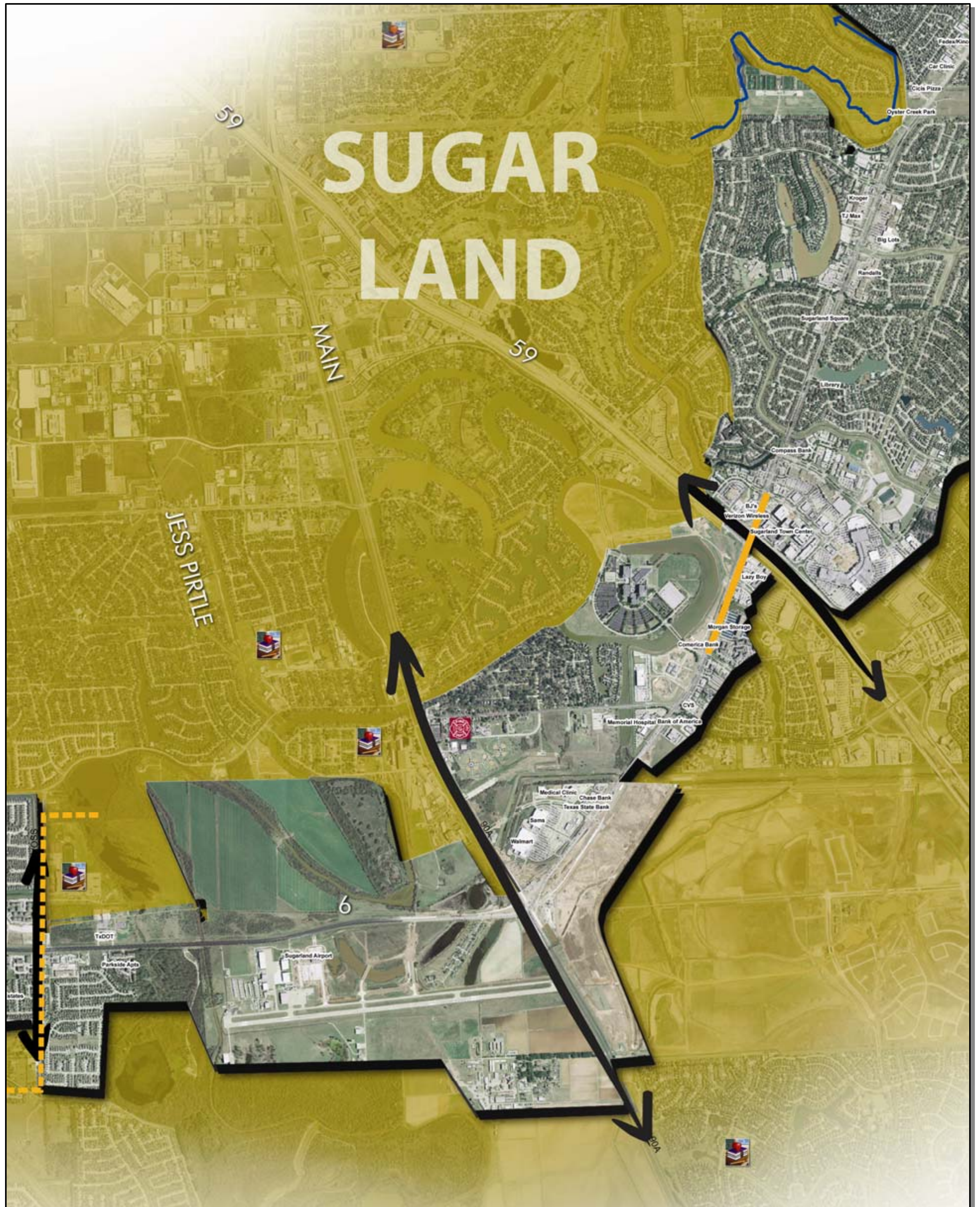


Figure 5-6: Sugar Land Bike/Ped Map North

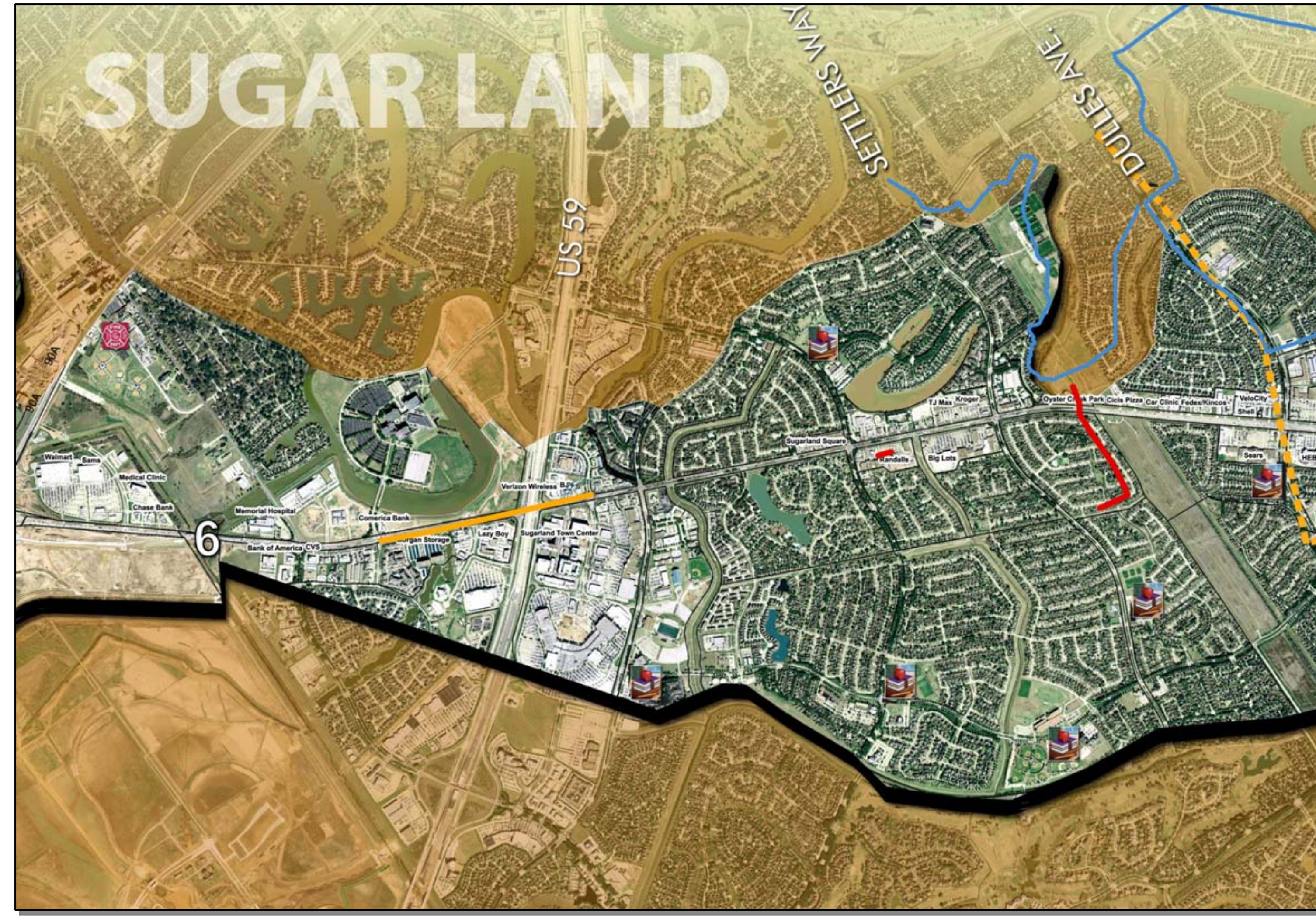


Figure 5-7: Sugar Land Bike/Ped Map South

Trails
- Shared Path/Trail
- Bike Lane
- Shared Roadway
- Sidewalk
- Pedestrian Passageway

5.5. Transit Improvements

For the City of Sugar Land the following are potential locations for Bus rapid Transit (BRT) and Local bus stops. Please refer to Figures 5-20 through 5-31 for graphical depiction of locations. Transit service into Sugar Land of course depends on the City becoming part of the Metro service area. The City can also contract for transit service if it desires.

- Local fixed-route service in Sugar Land and elsewhere, tying into the express and limited-stop services
- Special shuttle services radiating from major centers such as Sugar Land Town Square.
- Continuation and expansion of demand-responsive service within the area, to complement fixed-route services.

One special problem area is at the congested US 59 / SH 6 intersection. It may be possible to relocate the existing Trek Express park and ride operation and to revise the access route used, to increase convenience and reduce bus travel time. An ultimate solution may be to provide a flyover for direct connection to and from US 59, to avoid traffic congestion on SH 6.

Preliminary List of SH 6 BRT Stops

The locations listed below are based on anticipated future key interchange points with other transit services. Some locations may be found to have lower priority, allowing service to be provided only by BRT service. Candidate locations of bus stops are as follows:

- US 90A (potential commuter rail station)
- Sugar Land Town Center (US 59)
- Williams Trace
- Austin Parkway

5.6. Access Management Policy Updates

The SH 6 Corridor Access Management Plan seeks to improve safety, traffic flow, and reduce motorist delay through the City. Therefore, the plan contributes to the public health, safety, and welfare of the communities. The cities may validate this plan or demonstrate an overall public commitment to managing access by including policy statements in the transportation and land use element of the comprehensive plan.

Transportation Element

- A nontraversable, landscaped median will be provided on all new multi-lane major arterials. Undivided roadways and roadways with a continuous TWLTL will be considered for reconstruction when the volume exceeds 20,000 VPD.
- Consider median barrier techniques for all unsignalized median openings.

Land Use Element

- Access to land development along SH 6 shall be preserved through the use of parallel roads, side streets, and cross access easements connecting adjacent developments.
- Properties under the same ownership, consolidated for development, or part of phased development plans shall be considered one property for the purposes of access management. Access points to such developments shall be the minimum necessary to provide reasonable access, and not the maximum available, for that property frontage.
- New residential subdivisions should include an internal street layout that connects to the streets of surrounding developments to accommodate travel demand between adjacent neighborhoods, without the need to use the major thoroughfare system.
- Residential subdivisions abutting arterial roadways should be designed so that street connections conform to the access connection spacing standards for those roadways.
- Commercial development should be encouraged to share common access connections as well as to provide a convenient system of interparcel circulation so that customers as well as delivery and service vehicles can move between the sites.
- Commercial office and retail should be encouraged to develop livable centers, schematically illustrated as the preferred pattern in Chapter 8. This land use arrangement facilitates pedestrian circulation between businesses and eliminates the need for vehicles to use the public street when moving from one establishment to another. Also, the corner clearance increases between driveways and the intersection, this improves safety and intersection operations by reducing the occurrence of conflicts within close proximity of the intersection.

Auxiliary Lanes

On urban arterial streets, speed change lanes generally provide space for the deceleration and storage of turning vehicles. At major developments right turn deceleration lanes should be considered when the peak hour volume (VPH) exceeds 60. The length of speed change lanes should be designed to comply with the *TxDOT Roadway Design Manual*.

5.7. Landscaping Treatments

The City of Sugar Land is the model City for how to beautify median areas on State Highways. The new medians that are built as part of this project should be built to the same high quality that the Citizens of Sugar Land have come to expect. Figure 5-9 is an example of the quality landscaping that went into the City's medians.

For the new median areas of the City the Texas Department of Transportation offers an optional program that will assist municipalities in improving intersections and landscape treatments. The programs titled, *Landscape Partnership Program and Landscape Cost Sharing Program*, target projects like those proposed in this report. Cities or residents are responsible for the maintenance of the areas; however funding is available for construction.

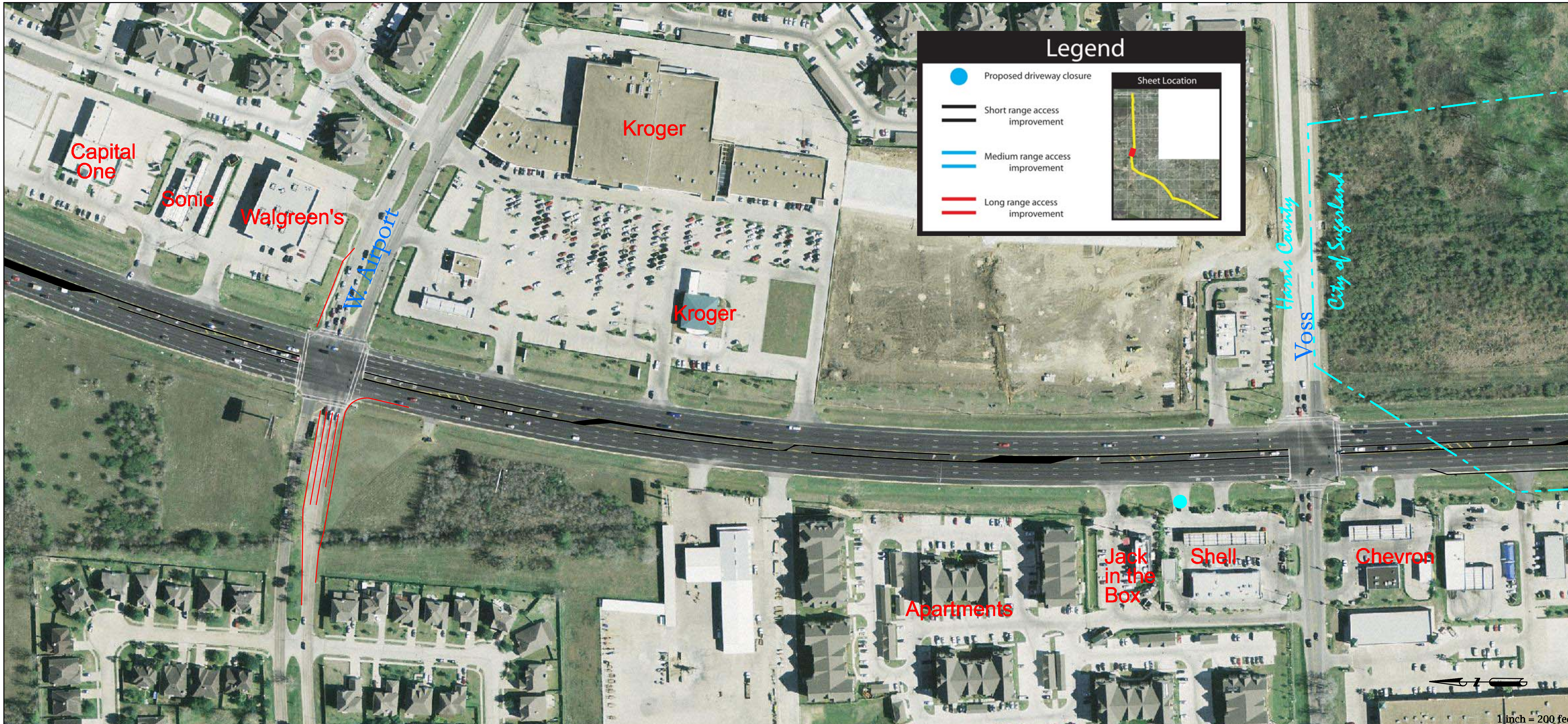
The local agencies are encouraged through this document to coordinate with TxDOT to develop their own landscape plan for the SH 6 corridor.

5.8. Livable Centers in Sugar Land

Chapter 8 details the necessary steps to implement a livable centers strategy in a given area. For the City of Sugar Land and H-GAC, promoting a livable centers strategy begins with identifying candidate areas and ends with watching the redevelopment emerge. One specific area that should be investigated is the area at Austin Parkway and SH 6. Figure 5-9 illustrates a rough concept of rethinking the land pattern at the old abandoned Randall's site. As you can see the circulation is internal to the development and the buildings are close to the streets to create a park once and walk development. The City's biggest livable center is of course the Sugar Land Town Square. The public private partnerships that created that great development is exactly what needs to occur at Austin Parkway.

Figure 5-9 Austin Parkway Area Redevelopment Concept

Figure 5-10: Sugar Land Landscaping



DISTANCE BETWEEN INTERSECTIONS AND STORAGE LENGTHS — HARRIS COUNTY — CITY OF SUGARLAND

275' | 200' | 100' | 275' | 275' | 100' | 100' | 275' | 275' | 200' | 100' | 275'

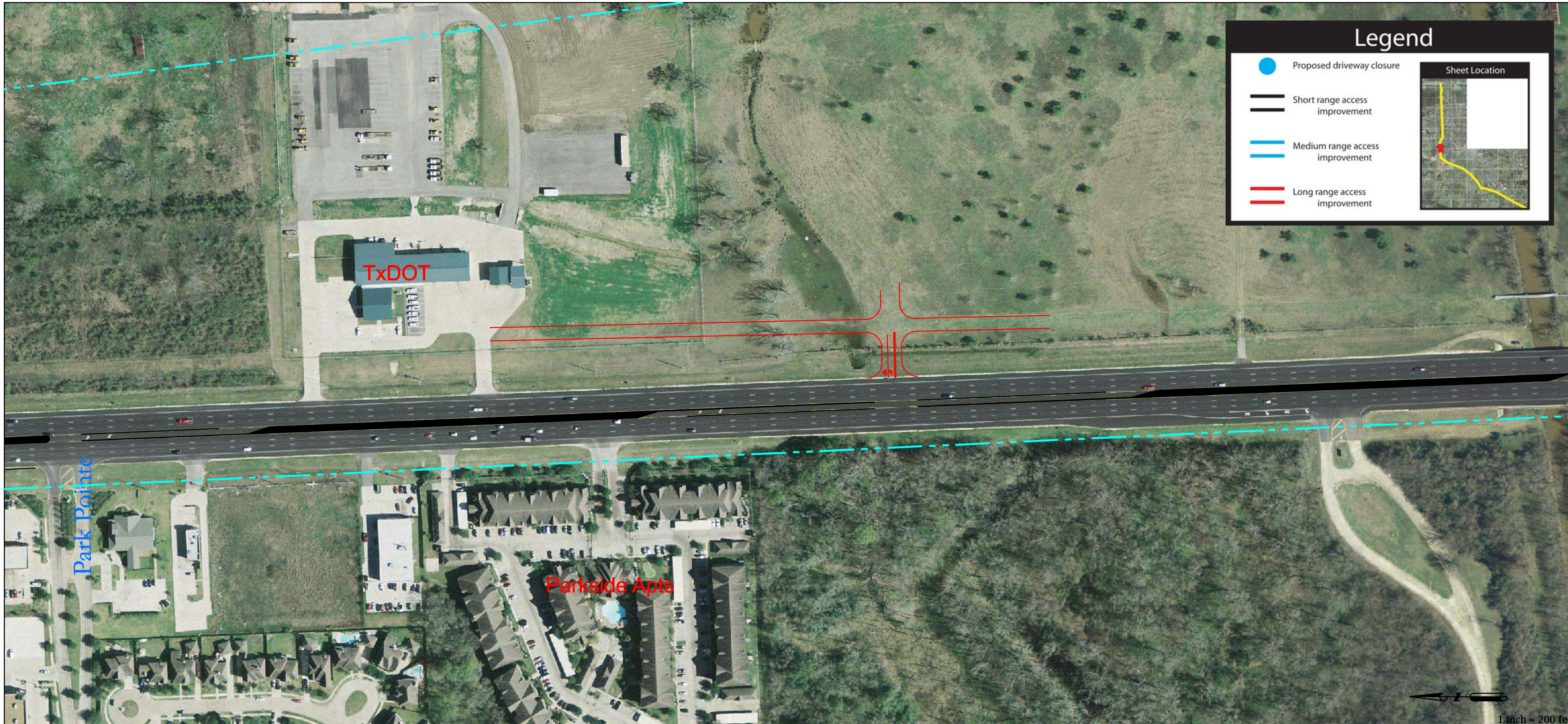
ACCESS RECOMMENDATIONS

Remove EB - WB Split Phase

Remove EB - WB Split Phase

EXISTING AND PROPOSED INTERSECTION GEOMETRY

FIGURE 5-20



DISTANCE BETWEEN INTERSECTIONS AND STORAGE LENGTHS

SUGARLAND

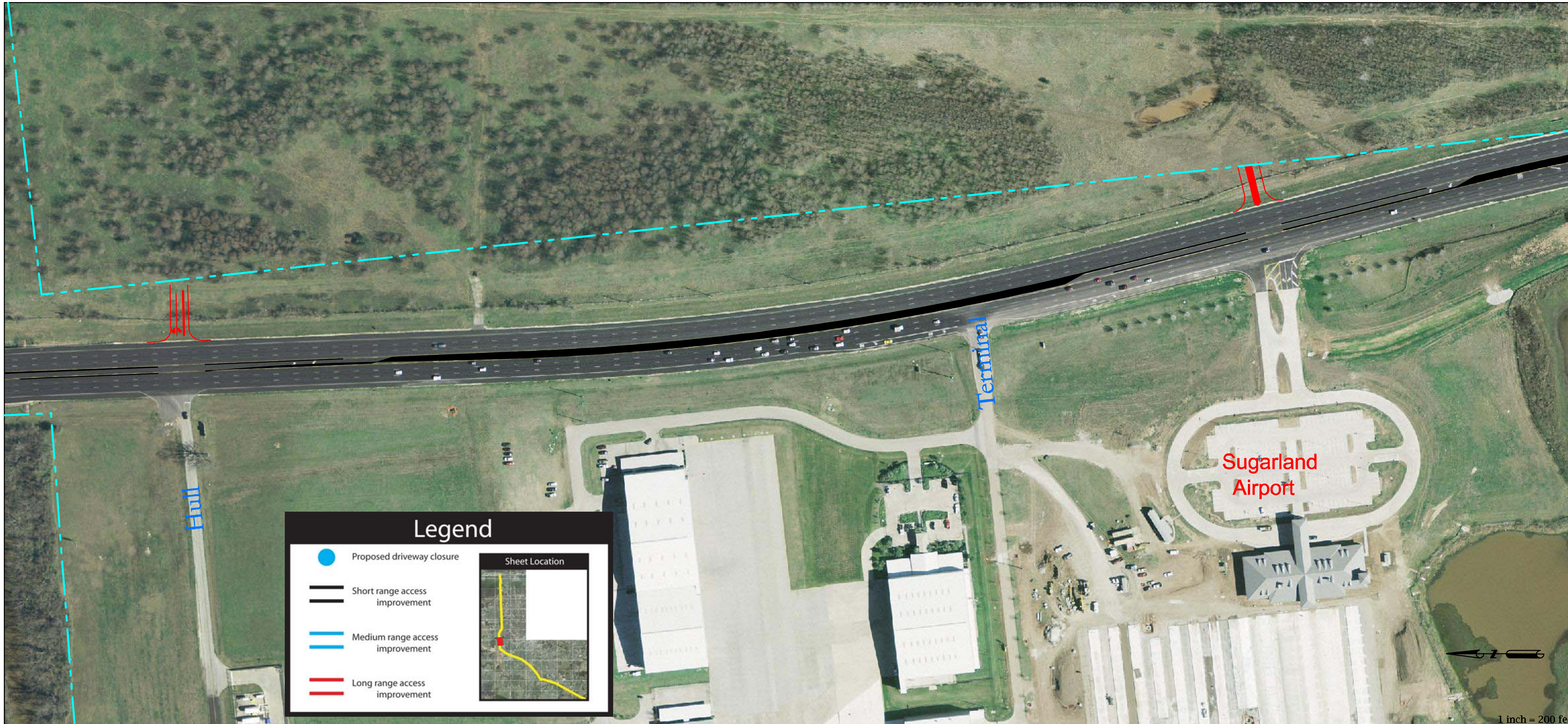
100' 275' 275' 200' 200' 275'

ACCESS RECOMMENDATIONS

Future Signal

EXISTING AND PROPOSED INTERSECTION GEOMETRY

FIGURE 5-21



DISTANCE BETWEEN INTERSECTIONS AND STORAGE LENGTHS

SUGARLAND

275' 100' 100' 275'   275' 100' 100' 275'

ACCESS RECOMMENDATIONS


Future Signal

EXISTING AND PROPOSED INTERSECTION GEOMETRY

FIGURE 5-22

DISTANCE BETWEEN INTERSECTIONS AND STORAGE LENGTHS

SUGARLAND

ACCESS RECOMMENDATIONS

UNDER CONSTRUCTION

EXISTING AND PROPOSED INTERSECTION GEOMETRY

FIGURE 5-23

DISTANCE BETWEEN INTERSECTIONS AND STORAGE LENGTHS

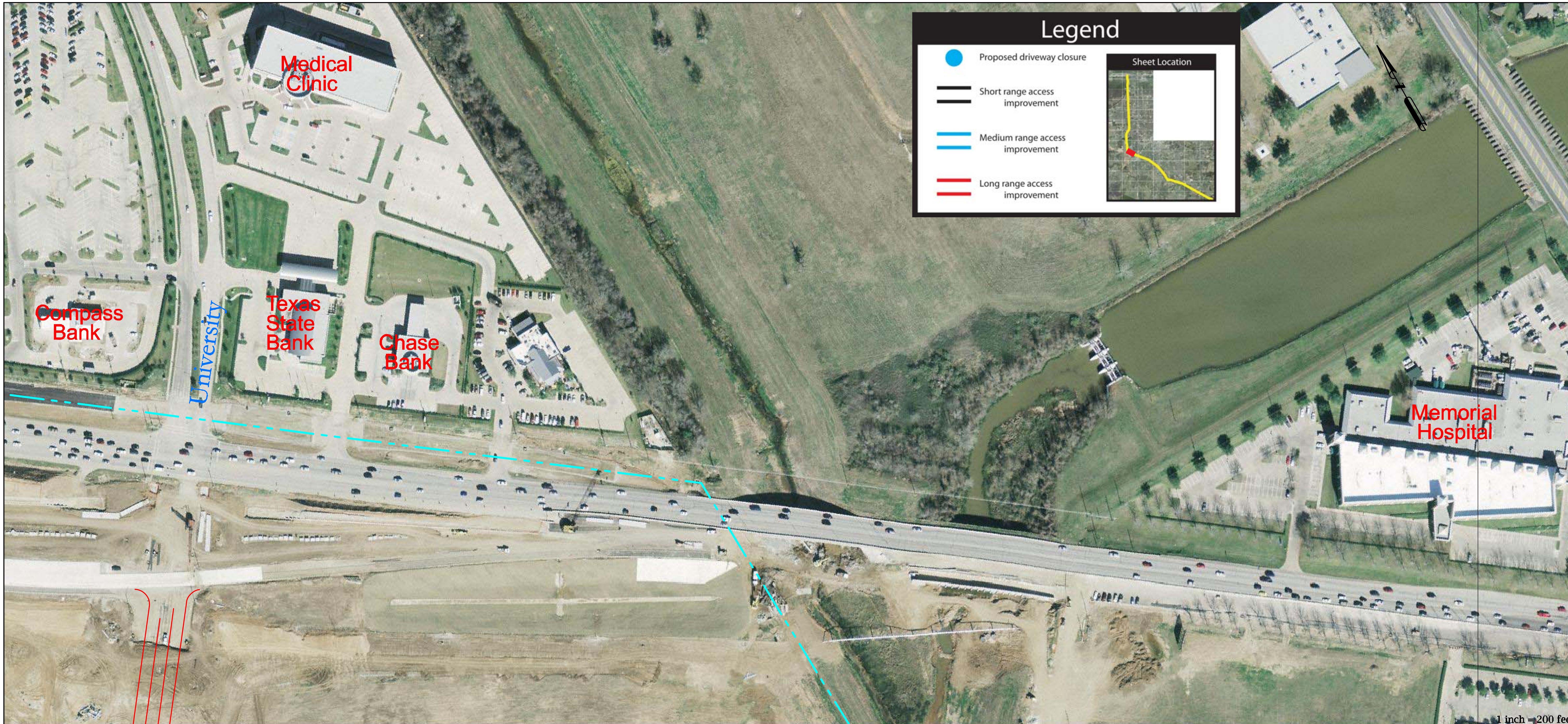
SUGARLAND

ACCESS RECOMMENDATIONS

UNDER CONSTRUCTION

EXISTING AND PROPOSED INTERSECTION GEOMETRY

FIGURE 5-24



DISTANCE BETWEEN INTERSECTIONS AND STORAGE LENGTHS

SUGARLAND

ACCESS RECOMMENDATIONS

UNDER CONSTRUCTION

EXISTING AND PROPOSED INTERSECTION GEOMETRY

FIGURE 5-25

DISTANCE BETWEEN INTERSECTIONS AND STORAGE LENGTHS

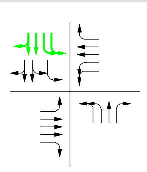
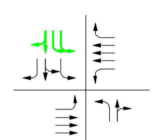
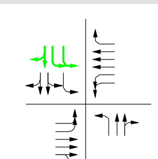
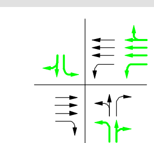
SUGARLAND

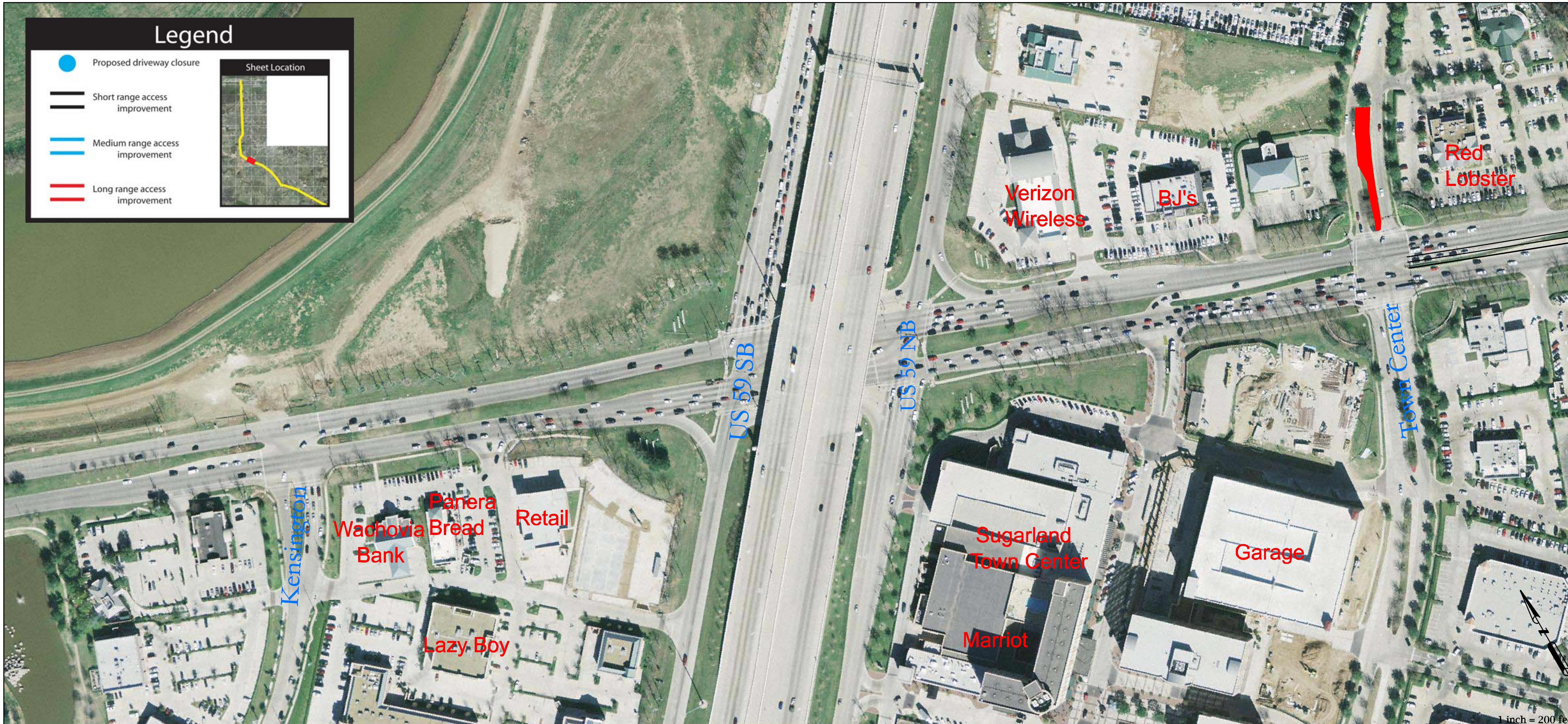
ACCESS RECOMMENDATIONS




EXISTING AND PROPOSED INTERSECTION GEOMETRY

FIGURE 5-26



DISTANCE BETWEEN INTERSECTIONS AND STORAGE LENGTHS

SUGARLAND

150' 250'

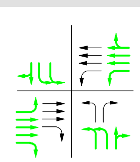
ACCESS RECOMMENDATIONS

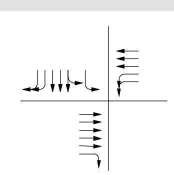
Add EB and WB right-turn overlaps (which should be used during AM peak only)

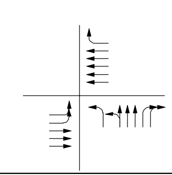
Add EB and WB right-turn overlaps (which should be used during AM peak only)

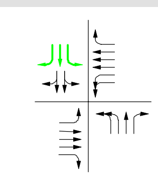
EXISTING AND PROPOSED INTERSECTION GEOMETRY

FIGURE 5-27









DISTANCE BETWEEN INTERSECTIONS AND STORAGE LENGTHS

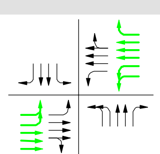
SUGARLAND

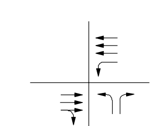
275' 150' 150' 275'

ACCESS RECOMMENDATIONS

EXISTING AND PROPOSED INTERSECTION GEOMETRY

FIGURE 5-28





DISTANCE BETWEEN INTERSECTIONS AND STORAGE LENGTHS

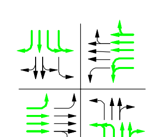
SUGARLAND

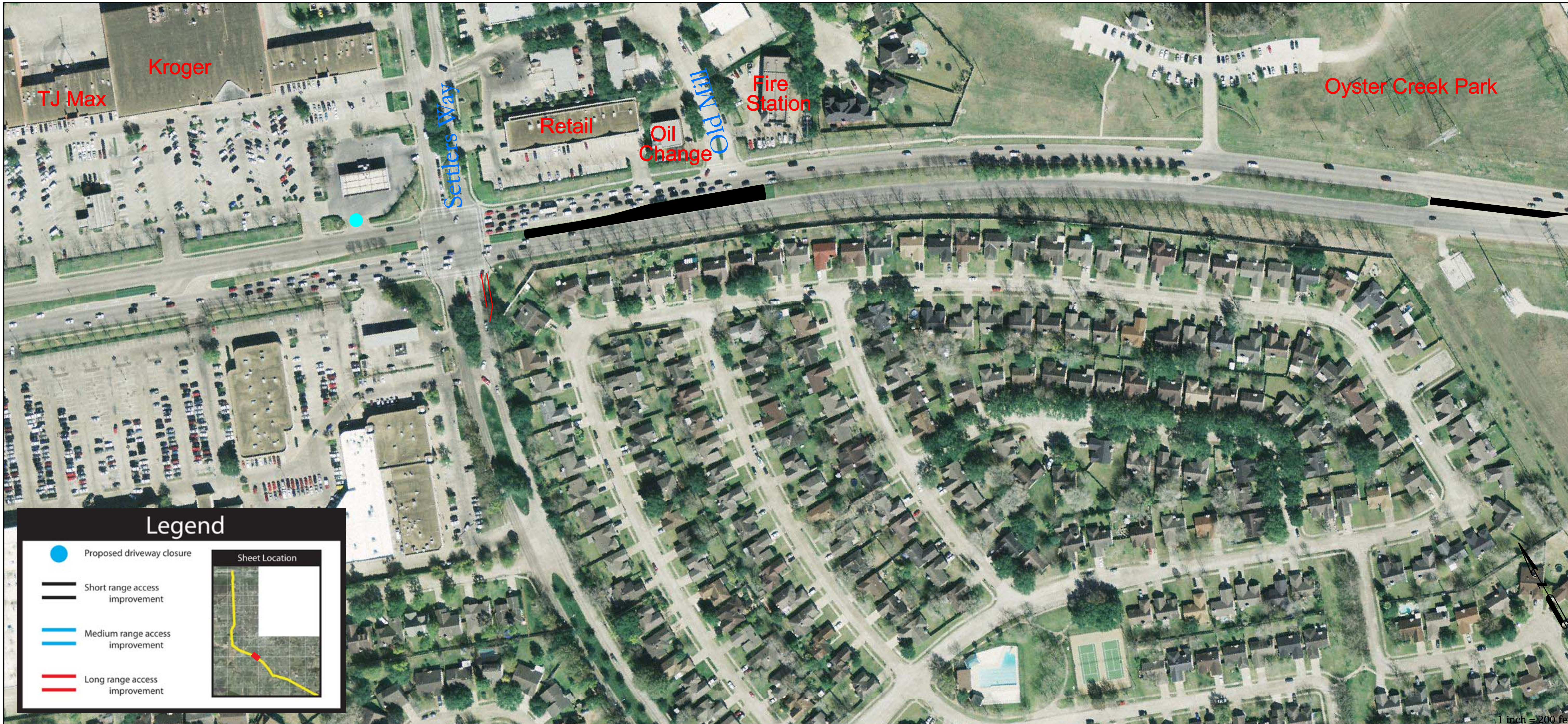
100' 275'

ACCESS RECOMMENDATIONS

EXISTING AND PROPOSED INTERSECTION GEOMETRY

FIGURE 5-29



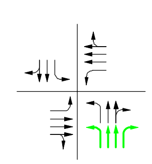


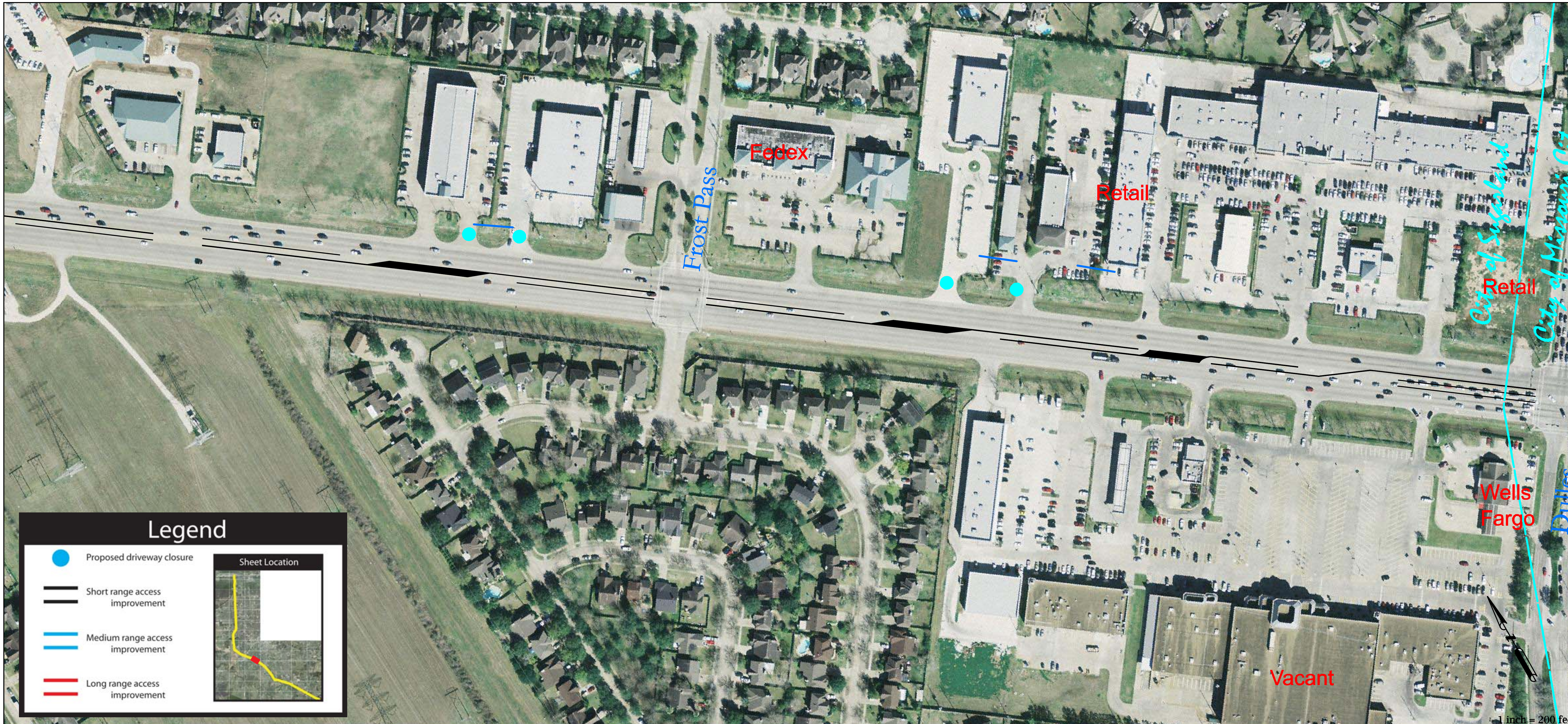
DISTANCE BETWEEN INTERSECTIONS AND STORAGE LENGTHS

ACCESS RECOMMENDATIONS

EXISTING AND PROPOSED INTERSECTION GEOMETRY

FIGURE 5-30





DISTANCE BETWEEN INTERSECTIONS AND STORAGE LENGTHS

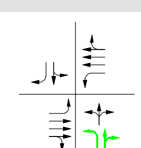
SUGARLAND

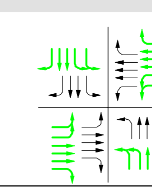
275' | 100' | 100' | 275' | 275' | 100' | 100' | 275' | 250' | 150'

ACCESS RECOMMENDATIONS

EXISTING AND PROPOSED INTERSECTION GEOMETRY

FIGURE 5-31





Chapter 6: Improvements (Missouri City, Fort Bend County)

Much like the other two chapters the focus of the this chapter is to provide the City of Missouri City, Fort Bend County, and TxDOT with a specific list of improvements for SH 6 within Missouri City and Fort Bend County. From existing conditions to short, medium and long term solutions this chapter will describe in detail each planned improvement in detail.

6.1. EXISTING CONDITIONS

The existing conditions in the Missouri City area of SH 6 will be described in terms if intersection levels of service, crash experience, transit service, bicycle and pedestrian conditions and finally the road characteristics.

Intersection Level of Service

The A.M. and P.M. peak hour turning movement counts were collected and used to evaluate the intersection levels of service. Acceptable intersection levels of service exist at most intersections within the SH 6 corridor in Missouri City (refer to **Table 6-1**). However, Austin Parkway/Dulles Avenue is currently at a LOS D and will soon be an E, especially with all the planned and permitted development along the corridor.

Intersection	AM Peak	PM Peak
Austin Pkwy Blvd./Dulles Ave.	D	D
Colonial Lakes Dr.	A	B
Riverstone Blvd.	A	A
Shops	A	B
Township Ln.	A	B
University Blvd./Stafford DeWalt Rd (FM 1092)	C	C
Glenn Lakes Ln.	B	A
Lake Olympia Parkway	B	B
Knight's Court / Flat Bank	B	A
Oyster Creek Place Dr.	A	A
Sienna Parkway	B	B
Vicksburg Blvd.	A	A

Table 6-1: Missouri City Existing Level of Service

The three signals within Fort Bend County are all operating within an acceptable level of service. Refer to **Table 6-2** for specific levels of service.

Intersection	AM Peak	PM Peak
Darby Ln. or Teal Bend Blvd.	B	A
Post Oak Blvd	A	A
FM 521 EB	B	A

Table 6-2: Fort Bend County Existing Level of Service

Signal Phasing

Table 6-3 depicts the current phasing of each of the signals. Many of the signals are operating a split phase. This is something that is at times necessary, but can be changed as part of our medium or long term solutions.

	Left-Turn Phase Types																Ped Signals			
	NB				SB				EB				WB							
	Protected-Only	Protected-Permitted	Permitted Only	Split-phased	Protected-Only	Protected-Permitted	Permitted Only	Split-phased	Protected-Only	Protected-Permitted	Permitted Only	Split-phased	Protected-Only	Protected-Permitted	Permitted Only	Split-phased	N Side	S Side	W Side	E Side
Austin Pkwy Blvd/Dulles Ave	1				1				1				1				1	1	1	1
Colonial Lakes Dr/Lake Colony Dr	1				1				1				1				1	1	1	1
Riverstone Blvd	1				1							1				1	1	1	1	1
Wal-Mart Entrance	1				1							1				1	1	1	1	1
Township Ln.	1				1						1				1					
University Blvd	1				1							1				1				
Glenn Lakes Ln.	1				1						1				1					
Lake Olympia Pkwy	1				1							1				1				
Kinght's Court	1				1			1				1								
Oyster Creek Place Dr																				
Sienna Pkwy																				
Vicksburg Blvd					1											1				
Fort Bend Pkwy Toll																				
Darby	1				1						1				1					
Post Oak Dr					1											1				
FM 521	1				1							1				1				

Table 6-3: Missouri City and Fort Bend County Existing Signal Phasing

Summary of Characteristics

Table 6-4 shows the existing corridor characteristics. This exhibit shows access inventory, crash data, ROW, pedestrian and bicycle facilities, and median and edge treatments.

		CITY OF MISSOURI CITY																						FORT BEND COUNTY						
Selected Signalized Crossroads		to	Colonial Lakes Dr.	to	Riverstone Blvd.	to	Shops	to	Township Ln.	to	University Blvd./Stafford DeWalt Rd (FM 1092)	to	Glenn Lakes Ln.	to	Lake Olympia Parkway	to	Knight's Court / Flat Bank	to	Oyster Creek Place Dr.	to	Sienna Parkway	to	Vicksburg Blvd.	to	Darby Ln. or Teal Bend Blvd.	to	Post Oak Blvd	to	FM 521 EB	to	FM 521 WB
Access	Distance (miles)	0.4		0.4		0.2		0.2		0.3		0.2		0.7		0.5		0.5		0.8		1.2		2.4		0.6		0.8		0.05	
	Total Driveways	8		6		2		4		8		4		14		6		0		0		7		17		5		9		0	
	Total Driveway Density Per Mile	20		15		10		20		27		20		20		12		0		0		6		7		8		11		0	
	Driveway Density Ratio	2.50		2.50		5.00		5.00		3.33		5.00		1.43		2.00						0.83		0.42		1.67		1.25			
Crashes	Total	36		14		1		12		18		34		66		10		10		31		62		44		20		6		25	
Roadway Characteristics	Median Type	TWLTL		TWLTL		TWLTL		TWLTL		TWLTL		TWLTL		TWLTL		TWLTL		TWLTL		TWLTL		TWLTL		TWLTL		TWLTL		TWLTL		TWLTL	
	Edge Treatment	Shoulder		Shoulder		Shoulder		Shoulder		Shoulder		Shoulder		Shoulder		Shoulder		Shoulder		Shoulder		Shoulder		Shoulder		Shoulder		Shoulder		Shoulder	
	Sidewalks	No		No		Yes		Yes		No		No		No		No		No		No		No		No		No		No		No	
	Bike Lanes	No		No		No		No		No		No		No		No		No		No		No		No		No		No		No	
	Speed (MPH)	50		50		50		50		50		50		50		50		50		50		55		55		60		60			

Table 6-4: Missouri City and Fort Bend County Summary of Characteristics

6.2. MEDIAN, DRIVEWAY AND RIGHT TURN LANE IMPROVEMENTS

Short-Term Median Improvements

The primary short term improvement for the SH 6 Corridor Access Plan will be for the construction of raised medians throughout Missouri City and Fort bend County. Within the Cities it is anticipated that the medians can be built for $5,464,500. Detailed concept plans are provided in Figures 6-20 through 6-37. For the detailed cost estimate refer to Appendix C.

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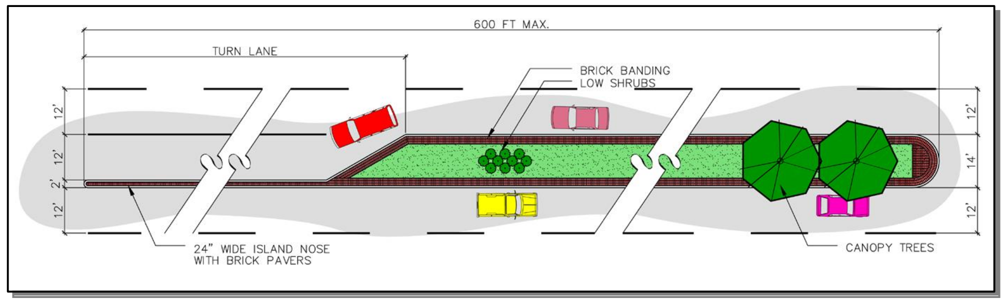


Short-Term Right Turn Lanes Improvements

Another short-term improvement will be re-striping the shoulders to clearly delineate a right turn lane. It is anticipated that no right of way or utility work will be need to build these lanes. Table 6-5 shows the locations of the planned improvements. Also, the drawings in Figures 6-20 through 6-37 show the improvements graphically.

Cross Street	Improvement	Cost
Riverstone	NB Right Turn Lane	$4,100
Wal-Mart	NB Right Turn Lane	$4,100
Township	NB Right Turn Lane	$4,100
Oyster Creek	NB Right Turn Lane	$4,100
Sienna	SB Right Turn Lane	$4,100
TOTAL		$20,500

Table 6-5: Short-Term Right Turn Lanes

Medium Term Improvements

Because of the excellent job the Missouri City staff has done in controlling driveway connections and spacing there are no planned driveway consolidations. Fort Bend County also has no driveway consolidations.

Jurisdiction	Driveways Closed	Cost
Missouri City	No Driveway Closures	$0
Fort Bend County	No Driveway Closures	$0

Table 6-6: Missouri City and Fort Bend County Driveway Consolidations

Medium-Term Cross Access Improvements

The areas of proposed cross access are identified in Figures 6-20 through 6-37. Also, Table 6-7: Missouri City and Fort Bend County Cross Access Improvements shows the potential cost of the improvements.

Jurisdiction	Number of Cross Access Improvements	Cost
Missouri City	No future cross access point constructed	$0
Fort Bend County	1 future cross access point constructed	$15,578

Table 6-7: Missouri City and Fort Bend County Cross Access Improvements

6.3. SIGNAL AND INTERSECTION IMPROVEMENTS

The long-term intersection improvements are noted in Table 6-8: Missouri City Intersection Improvements and Table 6-9: Fort Bend County Intersection Improvements. If the City and County desires to expedite the intersection improvements it would be advisable to coordinate with TxDOT to have the intersection improvements done at the same time as the medians.

Long-Term Intersection Improvements

Cross Street	Improvement Description	Cost
Austin Pkwy Blvd/Dulles Ave	Expand NB and SB to include dedicated dual left turn lanes	$409,500
Riverstone Blvd	Restripe SB to include dedicated left turn and expand NB to include dual left lanes	$148,900
Wal-Mart Entrance	Restripe NB to include dedicated left turn lane	$8,300
Township Ln.	Restripe NB and SB to include dedicated left turn lanes	$16,500
University Blvd	Expand NB to include dedicated right turn lane and expand SB to allow for dual left turns	$264,700
Glenn Lakes Ln.	Expand SB to include dedicated right and left turn lanes	$132,400
Lake Olympia Pkwy/Oilfield Dr	Expand NB and SB to include dedicated left turn lanes	$273,000
Knight's Court	Restripe SB to include dedicated left turn lane and expand NB to include dual left turn lanes	$144,800
Sienna Pkwy	Expand NB to include dedicated dual left turn lanes	$132,400
Fort Bend Pkwy Toll Road	Expand WB frontage to include a dual right turn lane	$132,400
TOTAL		$4,194,500

Table 6-8: Missouri City Intersection Improvements

	Cross Street	Improvement Description	Cost
Fort Bend County	Darby Ln./Teal Bend Blvd	Restripe NB and SB to include dedicated left turn lanes	$20,682
	Post Oak Dr		$0
	FM 521		$0
		TOTAL	$20,682.16

Table 6-9: Fort Bend County Intersection Improvements

6.4. Bicycle and Pedestrian Improvements

Within Missouri City and Fort Bend County there are several opportunities to improve the bicycle and pedestrian system. First, hike and bike trial additions, second, sidewalk and pedestrian connections, and finally, intersection pedestrian elements such as curb rams, decorative cross walks and lighting and signal pole additions. Many of these improvements can be jointly funded between local agencies and TxDOT while others would be completely funded by local agency resources. Furthermore, it is assumed that as improvements are made to intersections or pedestrian facilities they will be constructed to comply with ADA requirements.

Phasing of bicycle and pedestrian improvements is completely dependent on available funding. Short range improvements might include Sidewalk improvements that can built within the existing right of way.

Short Term Sidewalk improvements

There are no short term sidewalk improvements identified in the City of Missouri City or Fort Ben County along SH 6. However, if funding can be established for any of the improvements below and the timing of improvement can be accelerated than it is possible to get the improvement done in the next few years.

Long Term Bicycle and Pedestrian Improvements

Table 6-10: Missouri City Hike and Bike Improvements are indicated below. These improvements are again long-term and should be coordinated with the City's master plans for these areas. A graphical depiction of the planned improvements can be found in **Figure 6-2.**

	Cross Street	Improvement Description	Cost
Missouri City	Oyster Creek Trail	Expansion of Oyster Creek Trail to neighborhoods south of SH 6 would include an enhanced crossing possibly elevated or tunneled.	$252,250
	Riverside Blvd. to University Blvd	Creation of a trail system from neighborhoods near Riverside Dr. to University Blvd. Mirroring the trail system on the North side of SH 6	$16,500
	Riverside Blvd.	Connections from retail centers on the south side of SH 6 to the proposed trail	$6,000
	Riverside Blvd.	Addition of retail and residential connections to Oyster Creek Trail (three total).	$2,250
	Knight's Court	Connection of University Blvd Trail to future Flat Bank Trail	$250,750
	Knight's Court	Creation of Flat bank Trail that will connect the existing trail system along Lake Olympia PKWY to the proposed University Blvd. Trail	$7,500
	Jurisdiction Total		**$535,250**

Table 6-10: Missouri City Hike and Bike Improvements

Figure 6-1: Missouri City / Fort Bend County Bike / Pedestrian Map

6.5. Transit Improvements

For the City of Missouri City and Fort Bend County the following locations for Bus rapid Transit (BRT) and Local bus stops. Refer to **Figures 6-20** through **6-37** for graphical Depiction of locations.

- Extension of appropriate fixed-route services into Missouri City at least as far as SH 6, with park-and-ride at SH 6 or Sienna Plantation
- Provision of limited-stop service (bus or possibly commuter rail) in the SH 521 corridor between the METRO LRT park-and-ride south of I-610 and SH 6 or Sienna Plantation, with a park-and-ride station at either or both locations

Preliminary List of SH 6 BRT Stops

The locations listed below are based on anticipated future key interchange points with other transit services. Some locations may be found to have lower priority, allowing service to be provided only by local bus service. Local service in this corridor might have as many as 18 stops. Candidate locations of BRT stops are as follows:

- Dulles-Austin Parkway
- University-1092 (Murphy Road)
- Sienna Parkway
- Fort Bend Tollway Park and Ride
- FM 521 park and ride (possible commuter rail station)

Potential Local Bus Stops:

- Dulles-Austin Parkway
- Colonial Lake
- Riverstone
- No name (Shops)
- Township
- University-1092 (Murphy Road)
- Glenn Lakes
- Lake Olympia
- Flat Bank
- Oyster Creek Place
- Sienna Parkway
- Vicksburg Drive
- Vicksburg Blvd.
- Fort Bend Tollway Park and Ride
- Hurricane
- Teal Bend
- South Post Oak
- FM 521 park and ride (possible commuter rail station)

6.6. Access management policy Updates

The SH 6 Corridor Access Management Plan seeks to improve safety, traffic flow, and reduce motorist delay throughout all the local jurisdictions. Therefore, the plan contributes to the public health, safety, and welfare of the communities. The local jurisdictions may validate this plan or demonstrate an overall public commitment to managing access by: Including policy statements in the transportation and land use element of the comprehensive plan:

Transportation Element

- A nontraversable, landscaped median will be provided on all new multi-lane major arterials. Undivided roadways and roadways with a continuous TWLTL will be considered for reconstruction when the volume exceeds 20,000 VPD.
- Consider median barrier techniques for all unsignalized median openings.

Land Use Element

- Access to land development along SH 6 shall be preserved through the use of parallel roads, side streets, and cross access easements connecting adjacent developments.
- Properties under the same ownership, consolidated for development, or part of phased development plans shall be considered one property for the purposes of access management. Access points to such developments shall be the minimum necessary to provide reasonable access, and not the maximum available, for that property frontage.
- New residential subdivisions should include an internal street layout that connects to the streets of surrounding developments to accommodate travel demand between adjacent neighborhoods, without the need to use the major thoroughfare system.
- Residential subdivisions abutting arterial roadways should be designed so that street connections conform to the access connection spacing standards for those roadways.
- Commercial development should be encouraged to share common access connections as well as to provide a convenient system of interparcel circulation so that customers as well as delivery and service vehicles can move between the sites.

Auxiliary Lanes

On urban arterial streets, speed change lanes generally provide space for the deceleration and storage of turning vehicles. At major developments right turn deceleration lanes should be considered when the peak hour volume (VPH) exceeds 60. The length of speed change lanes should be designed to comply with the *TxDOT Roadway Design Manual*.

Driveway Design

Driveways provide the physical transition between the public highway and the abutting property. Driveways should be located and designed to minimize negative impacts on traffic while providing safe entry and exit from the development served. The *TxDOT Roadway Design Manual* provides standards for driveway design that promote access management strategies.

6.7. Landscaping Treatments

The City of Missouri City and Fort Bend County have the opportunity to partner with TxDOT to design and implement an extensive landscaping program for all the proposed medians. Much like the medians in Sugar Land, Missouri City and Fort Bend County residents spoke to the team during public workshops communicating their desire to have beautifully landscaped medians.

The Texas Department of Transportation offers an optional program that will assist municipalities in improving intersections and landscape treatments.

The programs titled, *Landscape Partnership Program and Landscape Cost Sharing Program*, target projects like those proposed here today. Cities or residents are responsible for the maintenance of the areas; however funding is available for construction.

The local agencies are encouraged through this document to coordinate with TxDOT to develop their own landscape plan for the SH 6 corridor. Figure 6-2 is an example median concept plan.

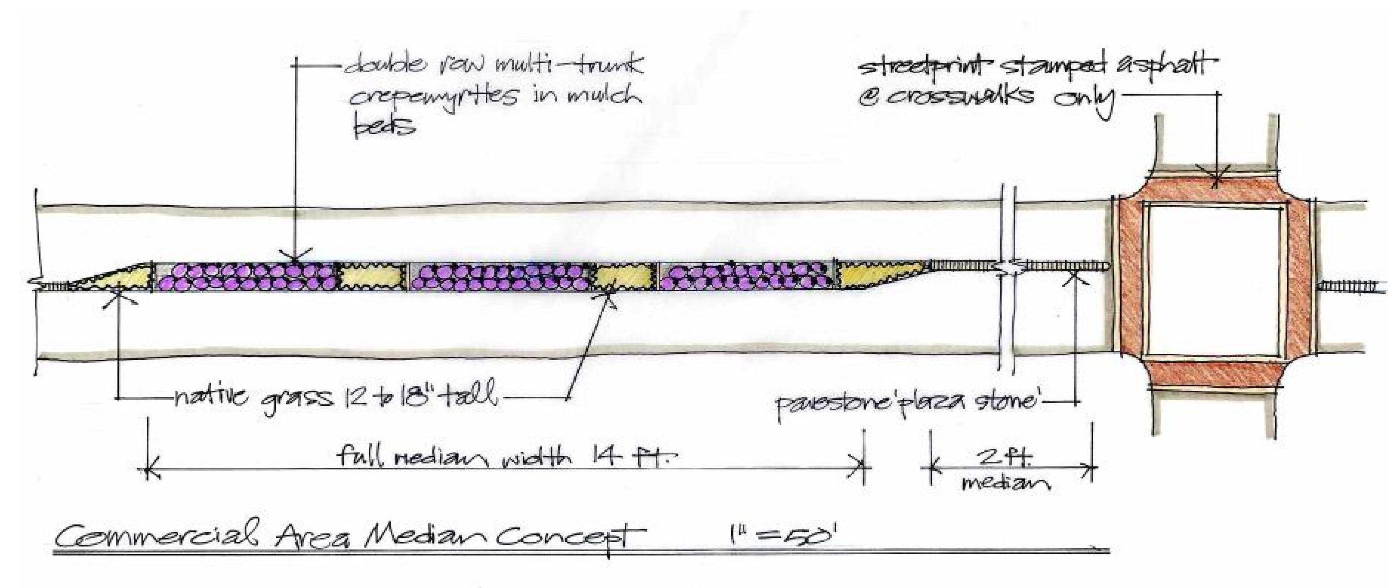
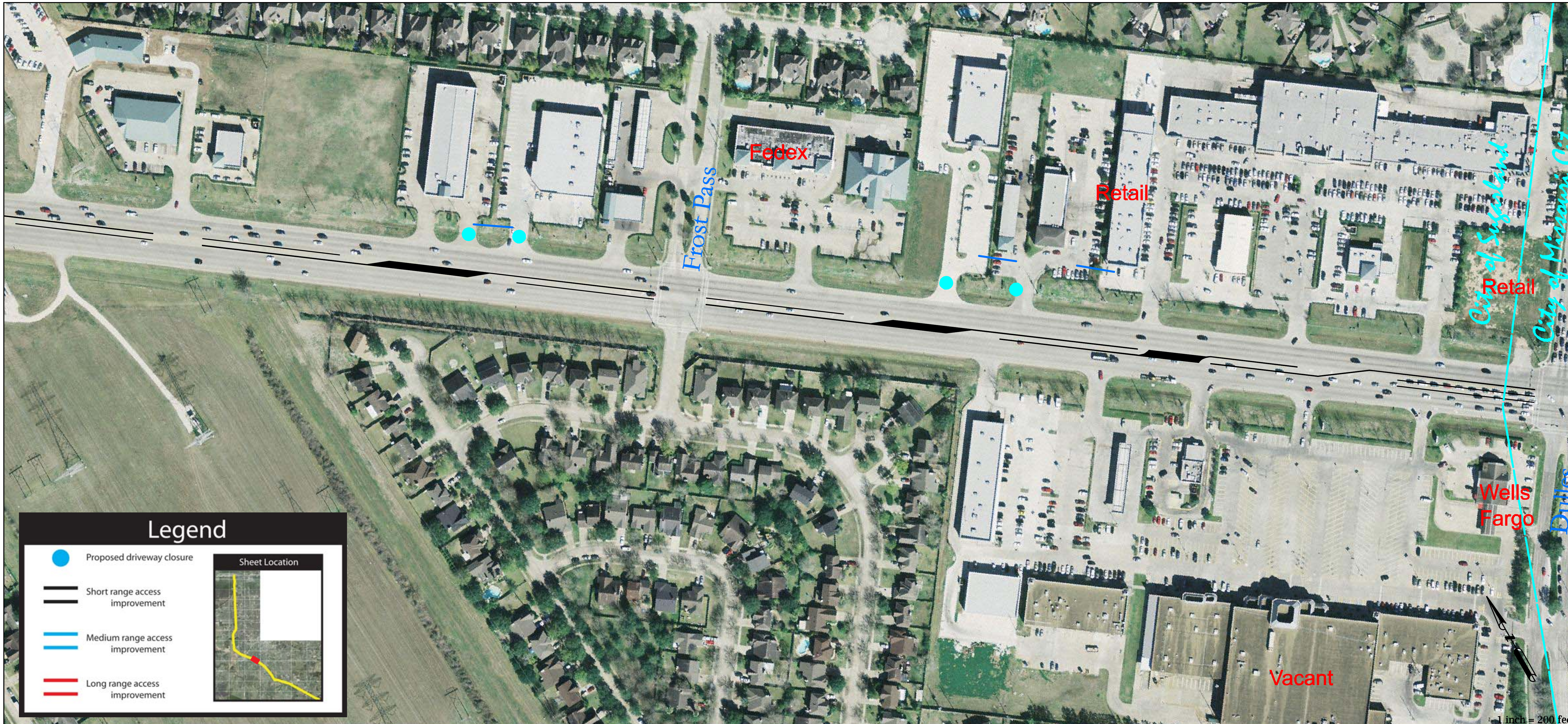


Figure 6-2: Sample Median Concept Plan



DISTANCE BETWEEN INTERSECTIONS AND STORAGE LENGTHS

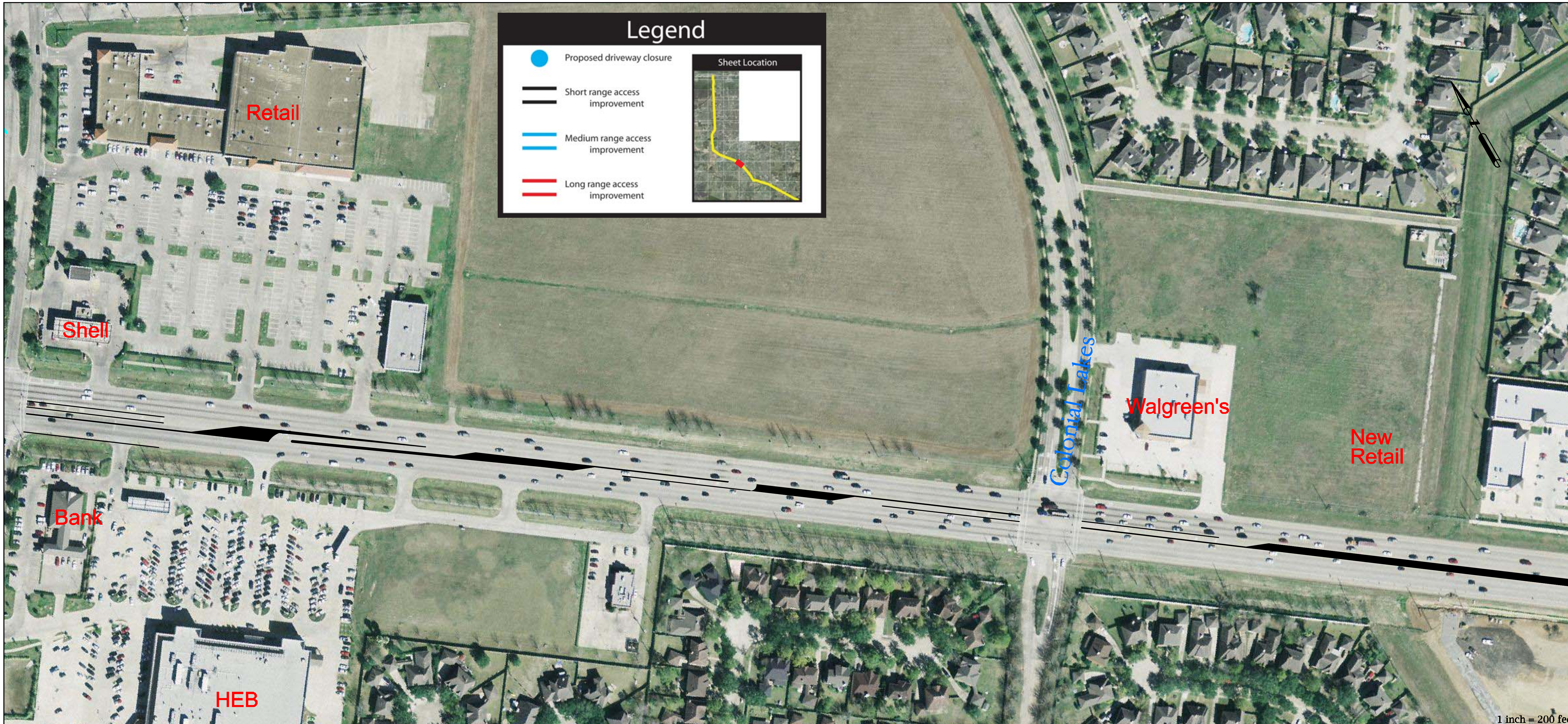
SUGARLAND

275' 100' 100' 275' 275' 100' 100' 275' 250' 150'

ACCESS RECOMMENDATIONS

EXISTING AND PROPOSED INTERSECTION GEOMETRY

FIGURE 6-20

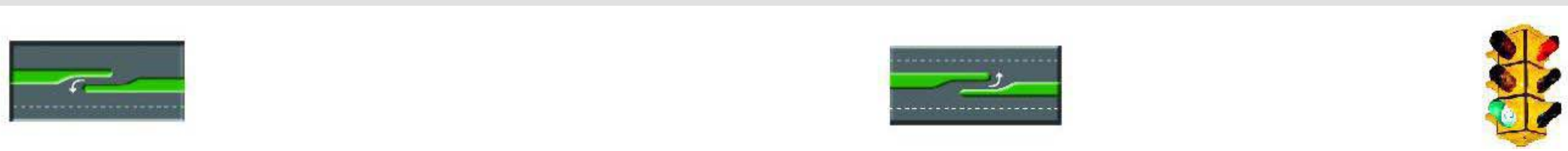


DISTANCE BETWEEN INTERSECTIONS AND STORAGE LENGTHS

MISSOURI CITY

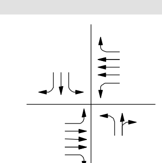
200' 225' 100' 275' 225' 100' 275' 100' 100' 275'

ACCESS RECOMMENDATIONS



EXISTING AND PROPOSED INTERSECTION GEOMETRY

FIGURE 6-21



DISTANCE BETWEEN INTERSECTIONS AND STORAGE LENGTHS

MISSOURI CITY

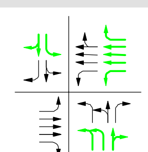
275' | 100' | 275' | 100' | 100' | 275' | 275' | 200' | 100' | 275' | 275' | 300'

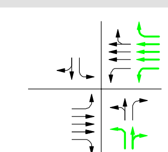
ACCESS RECOMMENDATIONS

Remove EB - WB Split Phase

EXISTING AND PROPOSED INTERSECTION GEOMETRY

FIGURE 6-22





MISSOURI CITY

DISTANCE BETWEEN INTERSECTIONS AND STORAGE LENGTHS

300' | 100' | 275' | 225' | 200' | 200' | 250' | 275' | 100' | 100' | 275'

ACCESS RECOMMENDATIONS

Remove EB - WB Split Phase

EXISTING AND PROPOSED INTERSECTION GEOMETRY

FIGURE 6-23

DISTANCE BETWEEN INTERSECTIONS AND STORAGE LENGTHS

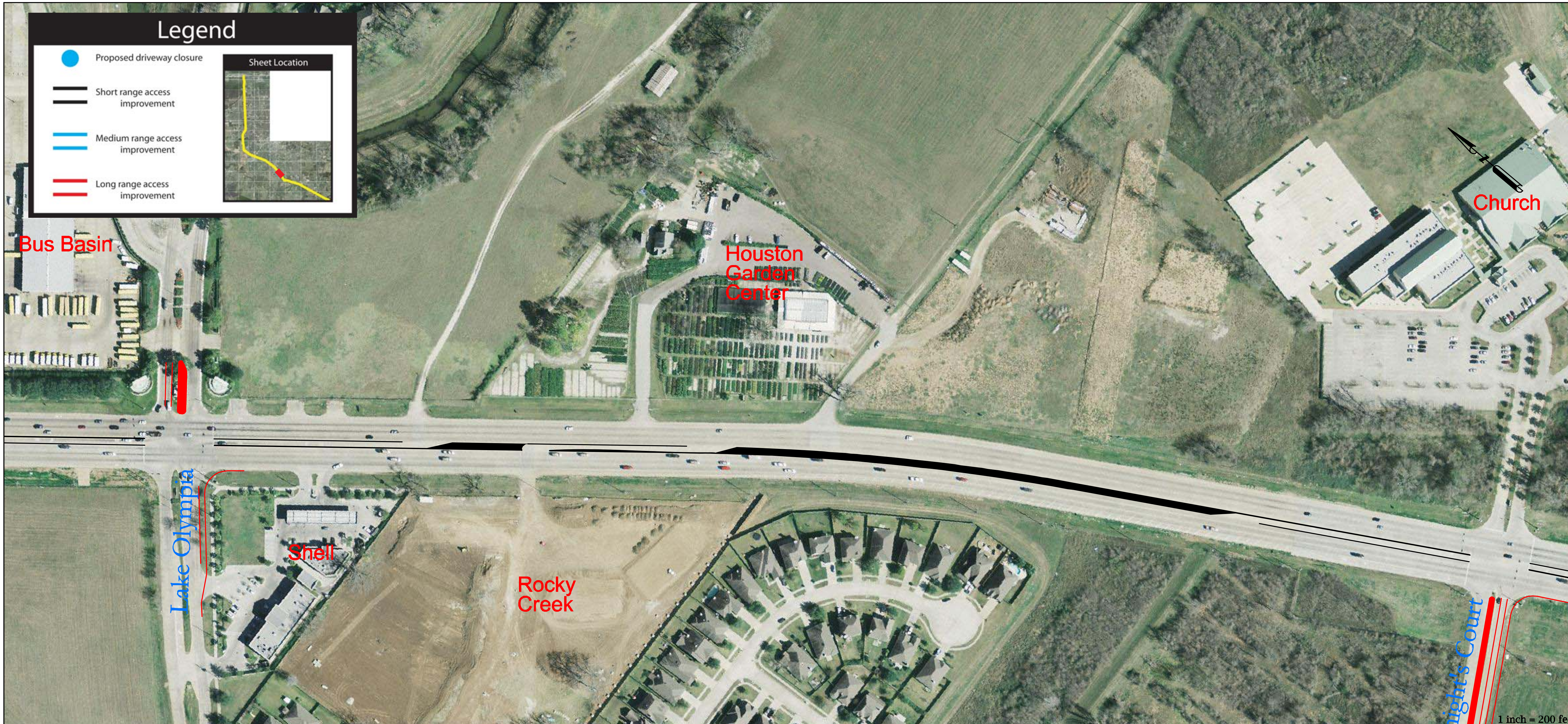
MISSOURI CITY

275' 100' 100' 275' 275' 100' 100' 275' 275'

ACCESS RECOMMENDATIONS

EXISTING AND PROPOSED INTERSECTION GEOMETRY

FIGURE 6-24



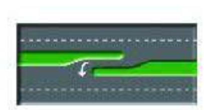
Distance Between Intersections and Storage Lengths

MISSOURI CITY

200' | 200' | 275' | 100' | 275' | 275' | 250' | 250'

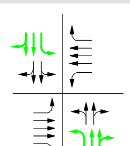
Access Recommendations

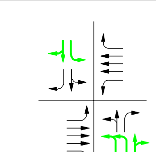
Remove EB - WB Split Phase



Existing and Proposed Intersection Geometry

FIGURE 6-25





DISTANCE BETWEEN INTERSECTIONS AND STORAGE LENGTHS

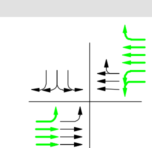
MISSOURI CITY

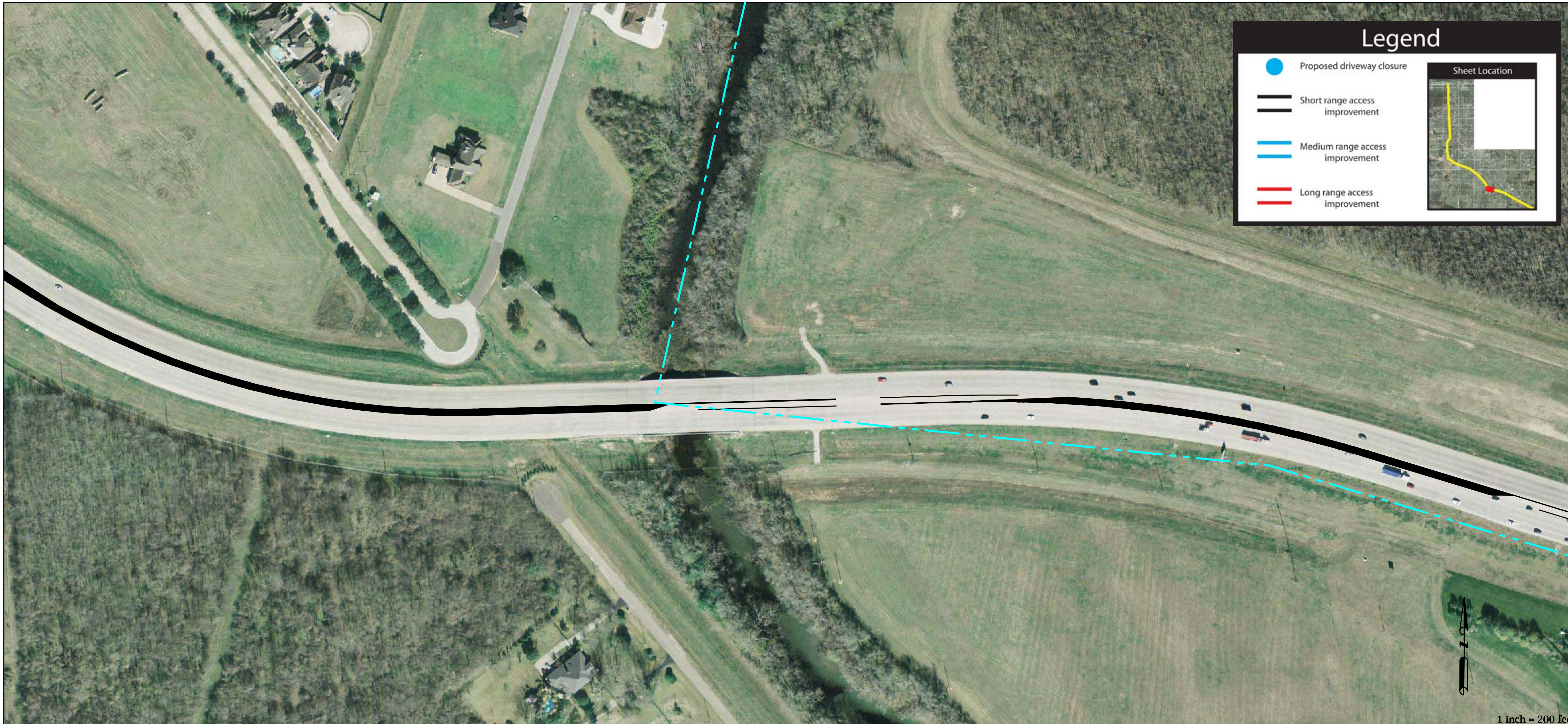
275' 275' 100' 100' 275'

ACCESS RECOMMENDATIONS

EXISTING AND PROPOSED INTERSECTION GEOMETRY

FIGURE 6-26





DISTANCE BETWEEN INTERSECTIONS AND STORAGE LENGTHS

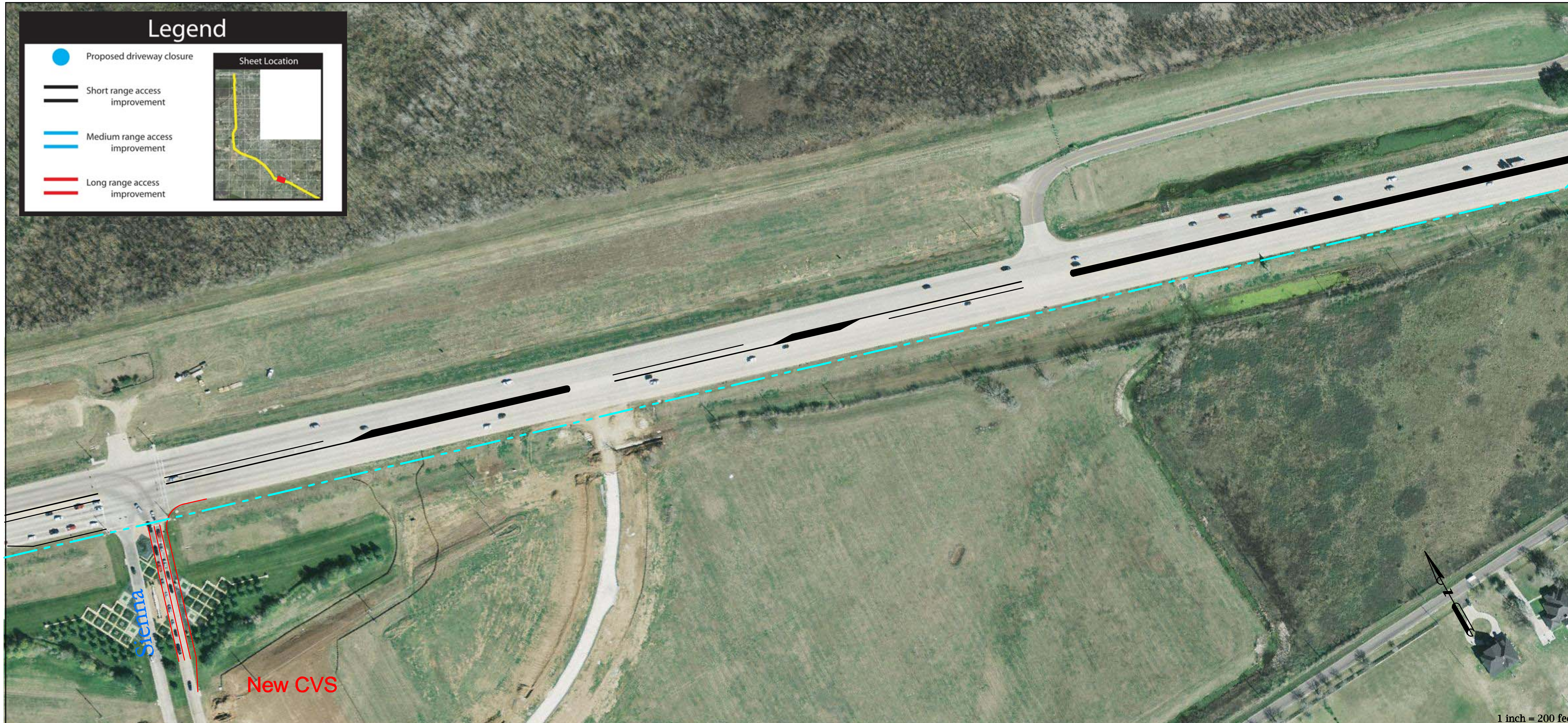
MISSOURI CITY

275' 100' 100' 275'

ACCESS RECOMMENDATIONS

EXISTING AND PROPOSED INTERSECTION GEOMETRY

FIGURE 6-27

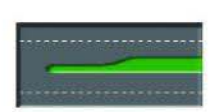


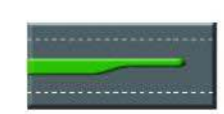
DISTANCE BETWEEN INTERSECTIONS AND STORAGE LENGTHS

MISSOURI CITY

275' | 100' | 150' | 275' | 100' | 275' | 275' | 100'

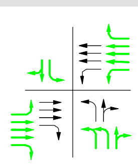
ACCESS RECOMMENDATIONS





EXISTING AND PROPOSED INTERSECTION GEOMETRY

FIGURE 6-28



DISTANCE BETWEEN INTERSECTIONS AND STORAGE LENGTHS

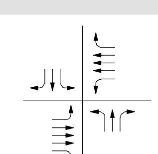
MISSOURI CITY

275' | 100' | 100' | 275' | 275'

ACCESS RECOMMENDATIONS

EXISTING AND PROPOSED INTERSECTION GEOMETRY

FIGURE 6-29



DISTANCE BETWEEN INTERSECTIONS AND STORAGE LENGTHS

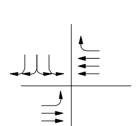
MISSOURI CITY

275' | 150' | 100' | 275' | 275' | 100' | 100' | 275'

ACCESS RECOMMENDATIONS

EXISTING AND PROPOSED INTERSECTION GEOMETRY

FIGURE 6-30



DISTANCE BETWEEN INTERSECTIONS AND STORAGE LENGTHS

MISSOURI CITY

ACCESS RECOMMENDATIONS

EXISTING AND PROPOSED INTERSECTION GEOMETRY

FIGURE 6-31

DISTANCE BETWEEN INTERSECTIONS AND STORAGE LENGTHS

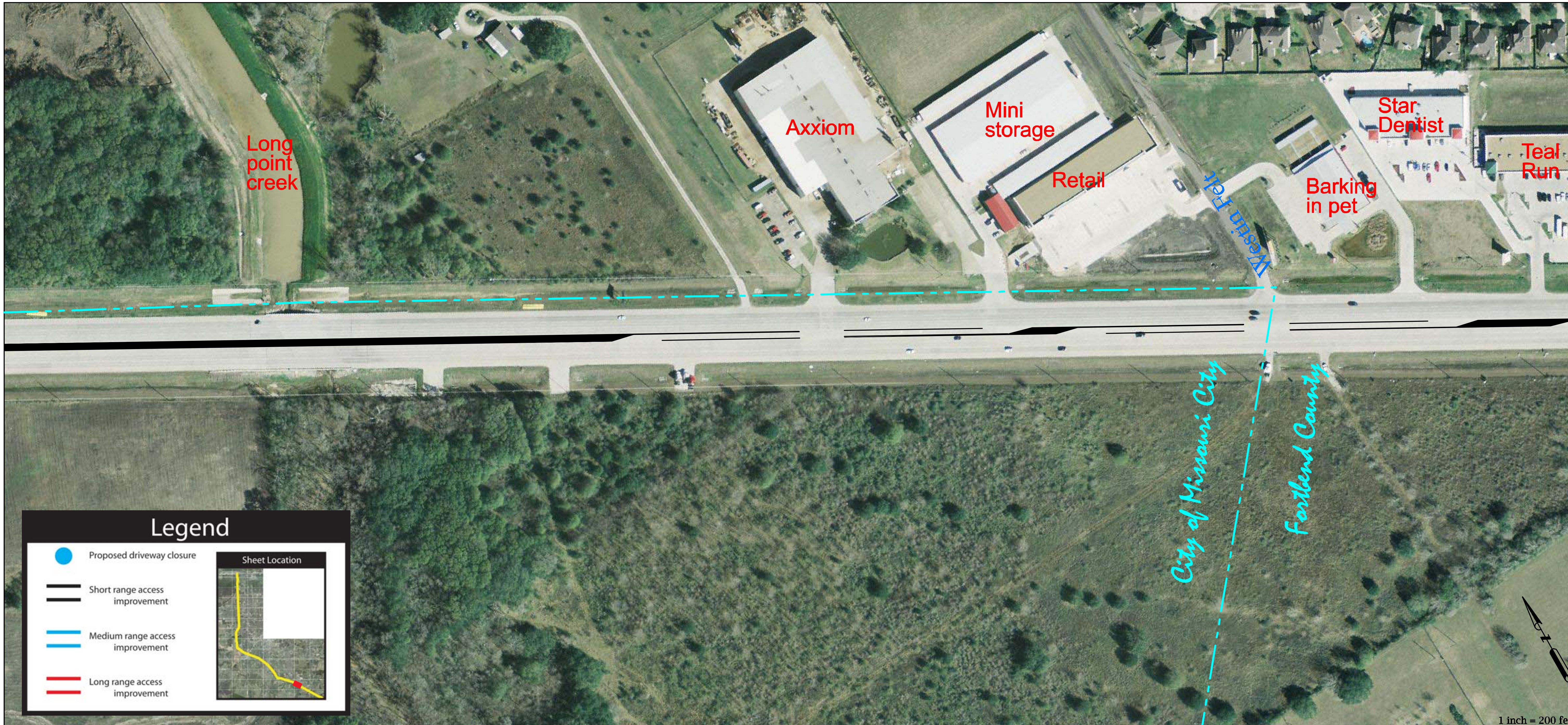
MISSOURI CITY

275' 100' 100' 275' 275' 100' 100' 275'

ACCESS RECOMMENDATIONS

EXISTING AND PROPOSED INTERSECTION GEOMETRY

FIGURE 6-32



DISTANCE BETWEEN INTERSECTIONS AND STORAGE LENGTHS — MISSOURI CITY — FORTBEND COUNTY

275' 100' | 100' 275' | 275' 100' | 100' 275'

ACCESS RECOMMENDATIONS

EXISTING AND PROPOSED INTERSECTION GEOMETRY

FIGURE 6-33

DISTANCE BETWEEN INTERSECTIONS AND STORAGE LENGTHS

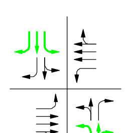
FORTBEND COUNTY

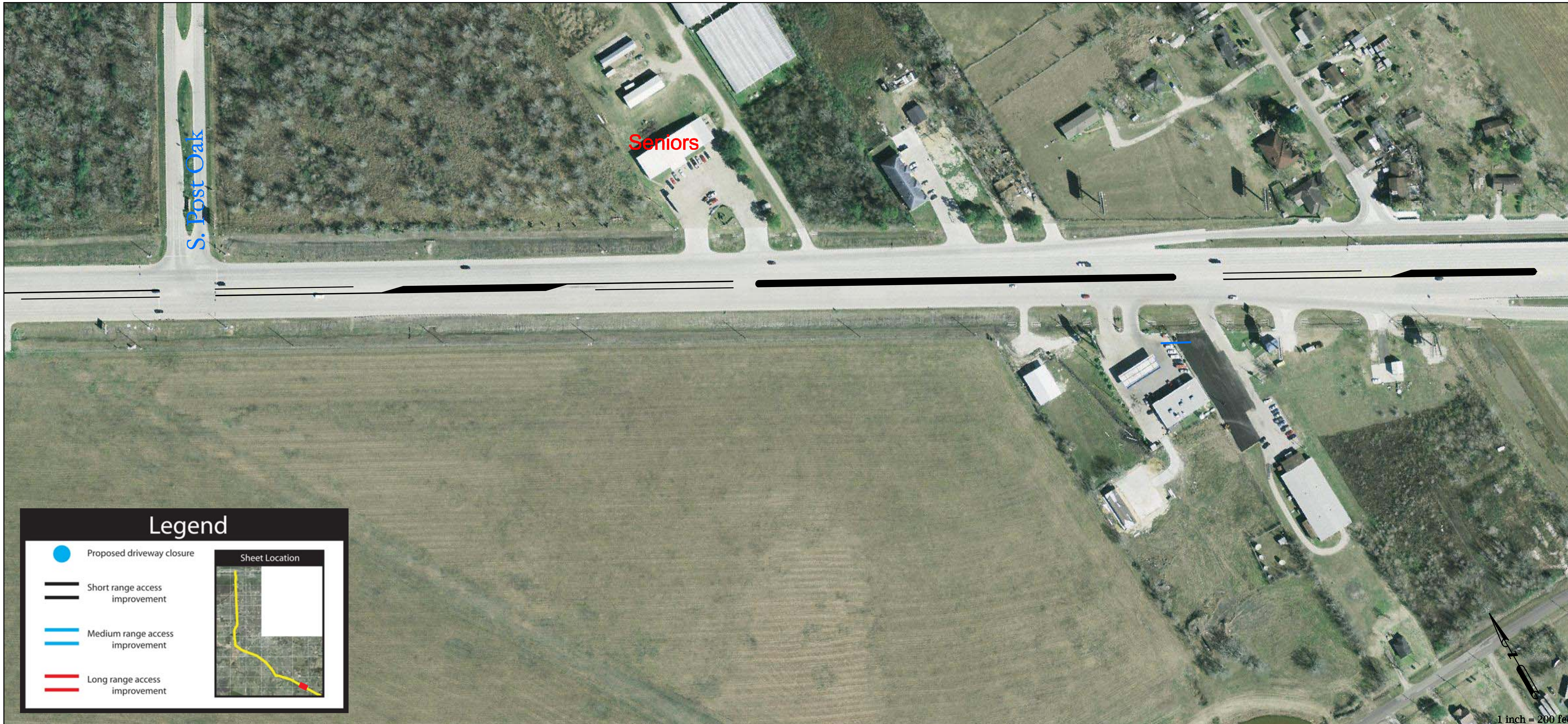
275' | 150' | 150' | 275' | 275' | 100' | 100' | 275'

ACCESS RECOMMENDATIONS

EXISTING AND PROPOSED INTERSECTION GEOMETRY

FIGURE 6-34



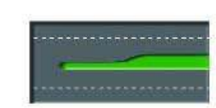


DISTANCE BETWEEN INTERSECTIONS AND STORAGE LENGTHS

FORTBEND COUNTY

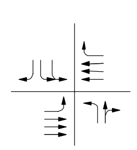
275' 100' 100' 275' 275' 100' 100' 275'

ACCESS RECOMMENDATIONS



EXISTING AND PROPOSED INTERSECTION GEOMETRY

FIGURE 6-35



DISTANCE BETWEEN INTERSECTIONS AND STORAGE LENGTHS

FORTBEND COUNTY

ACCESS RECOMMENDATIONS

EXISTING AND PROPOSED INTERSECTION GEOMETRY

FIGURE 6-36

Chapter 7: Summary of Improvements/Mobility Findings

The previous chapters detailed all the planned improvements within the City of Houston, Sugar Land, Missouri City, Harris County, and Fort Bend County, this section provides the overall corridor costs and the anticipated mobility improvements. With all the planned improvements in place, congestion levels in the future will remain high at a few key intersections. It is therefore essential to initiate a major corridor study to look at a long term solution for this area.

7.1. Corridor-Wide Costs By Improvement Type

Table 7-1 demonstrates the cost distribution and type of improvements that is recommended as part of this corridor access plan. Each improvement and associated phasing can and should be coordinated by each involved agency. A great deal of coordination needs to occur with TxDOT on all the planned improvements, as SH 6 is a State Highway.

Jurisdiction	Short		Medium		Long		TOTAL
	Medians	Right Turn Lanes	Driveway Consolidations	Cross Access	Street and Intersection Improvements	Bike and Pedestrian Improvements	
Houston	$2,311,700	$45,300	$148,400	$47,700	$4,661,700	$528,500	$7,743,300
Harris County	$3,104,100	$24,700	$217,700	$112,600	$1,799,200	$39,000	$5,297,300
Sugar Land	$1,719,500	$0	$21,100	$35,200	$1,265,800	$259,000	$3,300,600
Missouri City	$5,464,400	$20,500	$0	$0	$4,194,500	$535,250	$10,214,650
Fort Bend County	$880,400	$0	$0	$15,600	$20,700	$0	$916,700
TOTAL	$13,480,100	$90,500	$387,200	$211,100	$11,941,900	$1,361,750	$27,472,550

Table 7-1: Corridor Wide Cost Summary

7.2. Mobility Findings

At the end of the day improving mobility is one of the primary goals of the SH 6 Corridor Access Plan. As such, the study team used an A.M and P.M operations models to model the mobility benefits of all the planned improvements. The following benefits are directly tied to the planned improvements and demonstrate the importance of implementing the recommended improvements.

Intersection Levels of Service

Table 7-2 and **7-3** indicate the level of service expected after all the improvements are implemented. The highlighted levels of service in the table are intersections that are expected to be failing with an LOS of E or F. The needed improvements to fix these under performing intersections will involve developing a larger scale longer range set of solutions, beyond the short term scale of this project.

Cross Street	Existing Conditions		Study Recommendations	
	AM	PM	AM	PM
IH-10 WBFR	F	E	F	E
IH-10 EBFR	F	F	F	F
Memorial Dr	A	D	A	C
Briarhills Pkwy	B	A	C	A
Eagle Vista Dr	A	A	A	A
Briar Forest Dr	C	D	B	C
Chili's Plaza	A	A	A	A
Piping Rock Ln.	B	A	B	A
Westheimer Rd (FM 1093)	F	F	F	F
Park Hollow Dr	A	C	A	B
Richmond Ave	D	D	D	D
West Hollow	B	A	A	A
Westpark Dr	B	D	B	B
Bellaire Blvd	F	E	E	D
Empanada Dr	B	B	B	B
Beechnut St	D	E	D	E
Charlmont Dr/Parksgate Dr	A	A	A	A
Bissonnet St	D	D	D	D
Old Richmond Rd	C	C	B	C
Bellfort	B	B	B	B
Woodbridge Villages Dr / Woodbridge Estates Dr	A	A	A	A
W Airport Blvd	D	C	D	D
Voss Rd	C	C	C	C
Brooks St/First Colony Blvd	B	D	C	C
Lake Point	A	A	A	A
Flour Daniel Dr	B	C	B	C
Medical Dr.	A	A	A	A
Kensington Dr	A	A	B	B
US 59 SBFR	E	E	E	E
US 59 NBFR	F	D	F	D
Town Center Dr	B	C	B	C
Lexington Blvd	D	D	C	D
Grants Lake Blvd	A	B	B	B

Table 7-2: Existing & Improved LOS

Cross Street	Existing Conditions		Study Recommendations	
	AM	PM	AM	PM
Williams Trace Blvd	D	F	D	D
Settlers Way Blvd	C	C	C	C
Frost Pass	A	A	A	B
Austin Pkwy Blvd/Dulles Ave	D	D	D	D
Colonial Lakes Dr/Lake Colony Dr	A	B	A	B
Riverstone Blvd	A	A	A	A
Wal-Mart Entrance	A	B	A	B
Township Ln.	A	B	A	B
Stafford DeWalt Rd (FM 1092)/University Blvd	C	D	C	D
Glenn Lakes Ln.	B	A	B	B
Lake Olympia Pkwy (east leg)/Oilfield Dr (west leg)	B	B	B	B
Knight's Court	B	A	B	A
Oyster Creek Place Dr	A	A	A	A
Sienna Pkwy	B	B	B	B
Vicksburg Blvd	A	A	B	A
Darby Ln. (west leg)/Teal Bend Blvd (east leg)	B	A	B	A
Post Oak Dr	A	A	A	A

Table 7-3: Existing & Improved LOS

Corridor Delay

Table 7-4 and **Figures 7-1** and **7-2** represent the system delay by City and for the entire corridor. System delay is measured by the difference between the free flow condition on a roadway and the congested condition. The access management improvements detailed in this report translate into an overall corridor reduction in delay by **289-hours** in the PM peak travel time and **150-hours** in the AM peak travel time.

Total Delay (hr)				
Jurisdiction	Existing Conditions		Study Recommendations	
	AM	PM	AM	PM
Houston	1162	1084	1132	1007
Harris County	424	478	374	363
Sugar Land	637	1031	575	949
Missouri City	113	156	103	142
Fort Bend County	19	15	20	13

Table 7-4: Corridor Wide Delay

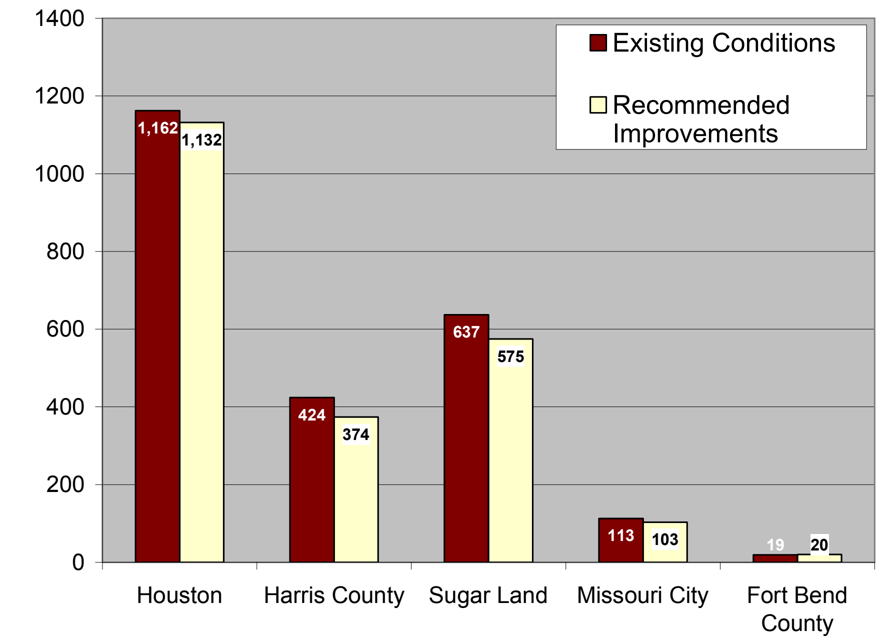


Figure 7-1: A.M. Delay by Agency

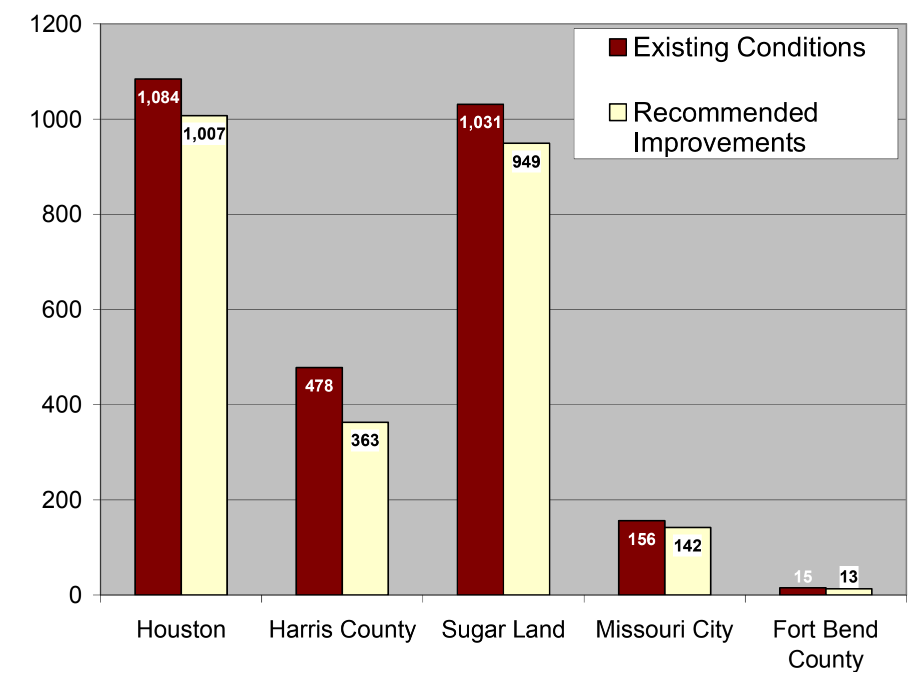


Figure 7-2: P.M. Delay by Agency

Corridor Stops

The number of stops a vehicle makes has a direct correlation to the overall mobility within the corridor. **Table 7-5** and **Figures 7-3** and **7-4** demonstrate by jurisdiction what benefits can be derived from implementing the recommended improvements.

Jurisdiction	Stops (#) Existing Conditions AM	Existing Conditions PM	Study Recommendations AM	Study Recommendations PM
Houston	32,083	37,990	28,408	35,058
Harris County	28,653	31,328	23,204	23,158
Sugar Land	33,344	46,097	28,761	42,460
Missouri City	17,205	17,260	13,371	16,,601
Fort Bend County	3,584	2,523	2,868	2,215

Table 7-5: Corridor Wide Number of Stops

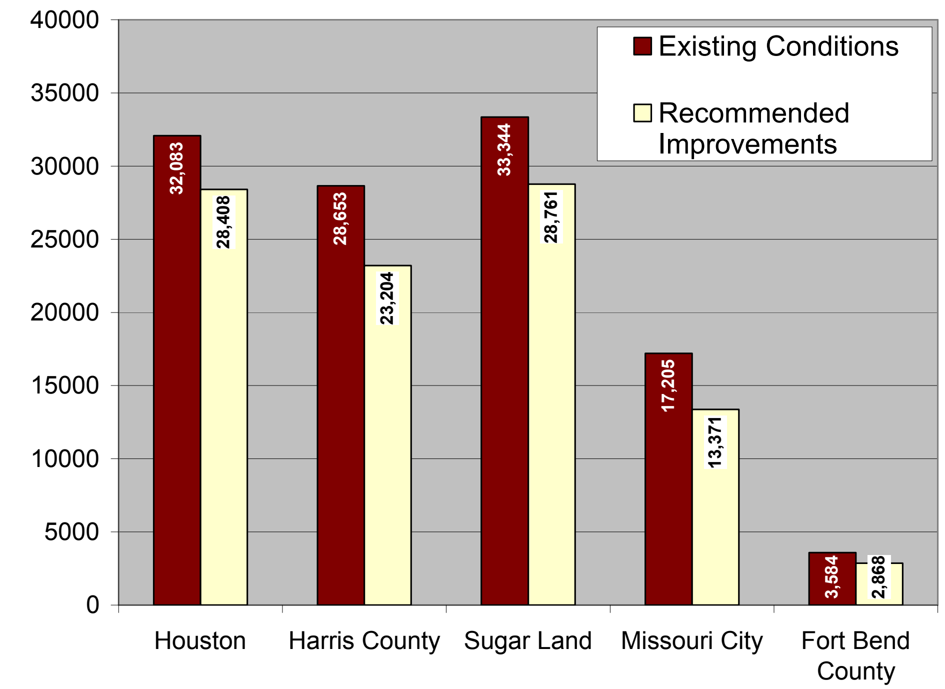


Figure 7-3: A.M. Peak Number of Stops

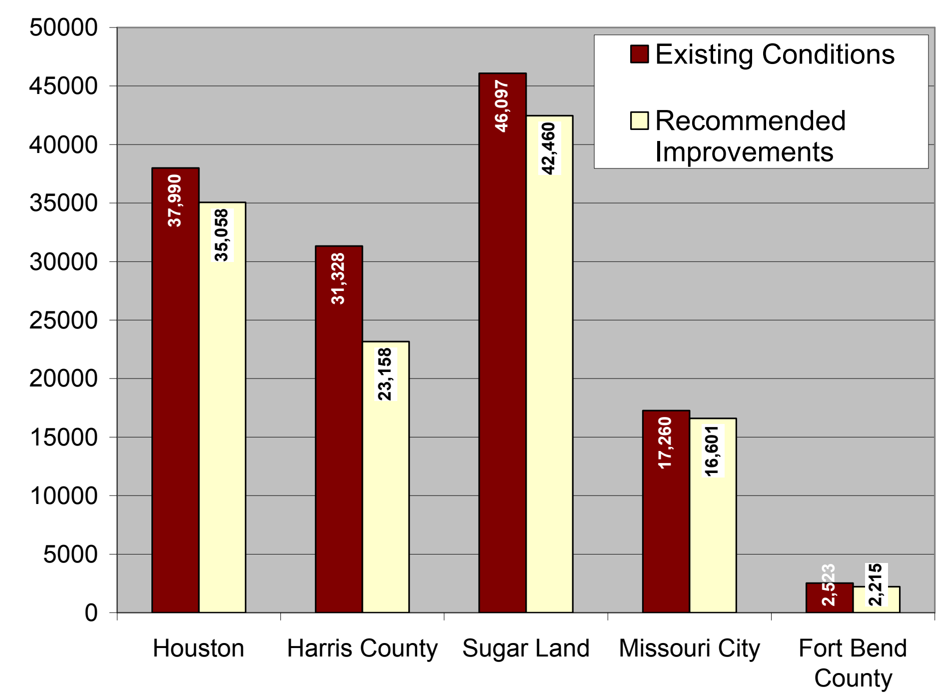


Figure 7-4: P.M. Peak Number of Stops

Cost of Congestion

The costs of congestion are extremely high. It is anticipated that based on the P.M period operations model the cost of delay is approximately $5,100 per day, $150,000 per month, or **$1,800,000** per year. The number of stops that can be mitigated with the planned improvements in the A.M. period is 18,300 and 15,700 in the P.M. peak periods.

Chapter 8: SH 6 Livable Centers

The goal of the Houston-Galveston Area Council's (H-GAC) new "livable centers" program is to assist local areas in creating quality places where people can travel between several destinations without having to use their cars.

In a Livable Center, destinations are concentrated within walking distance of each other by safe, convenient pedestrian facilities. Depending on the concentration of activities and the quality of the pedestrian environment, internal car trips within a Livable Center can be reduced by 5% to 55%[1]. Another mobility benefit provided by livable centers is that they are easier to serve than dispersed destinations with frequent transit and other commute alternatives.

H-GAC currently has funding programmed in the 2008-2011 Transportation Improvement Program (TIP) to support planning and infrastructure improvements for livable centers projects in several areas throughout the region, including the East End, Midtown, and Uptown / Galleria areas of Houston, along the Galveston Seawall, in The Woodlands Town Center, and in downtown Waller. These projects illustrate that livable centers can be established in urban, suburban, and small-town settings.

H-GAC plans to work with interested local governments to help establish livable centers throughout the eight-county region. H-GAC can help by coordinating planning for transit and other multimodal transportation connections between livable centers, and providing technical assistance and funding support to local governments on Livable Center planning and implementation projects.

In the SH 6 corridor, livable centers like the Sugar Land Town Center are already embracing this development philosophy. Others areas such as the intersections of Westheimer Road, Austin Parkway, FM 1092 / University, US 90A, and Bellaire Boulevard are prime locations for new livable centers. This report outlines a five-step process to develop livable centers along SH 6 and conceptually examines redevelopment scenarios for Westheimer Road in the City of Houston and Austin Parkway in the City of Missouri City.

The five-step process outlined on the following pages is aimed at modifying the typical development into a livable center in a series of steps that act to coordinate transportation and land use investments with market realities.

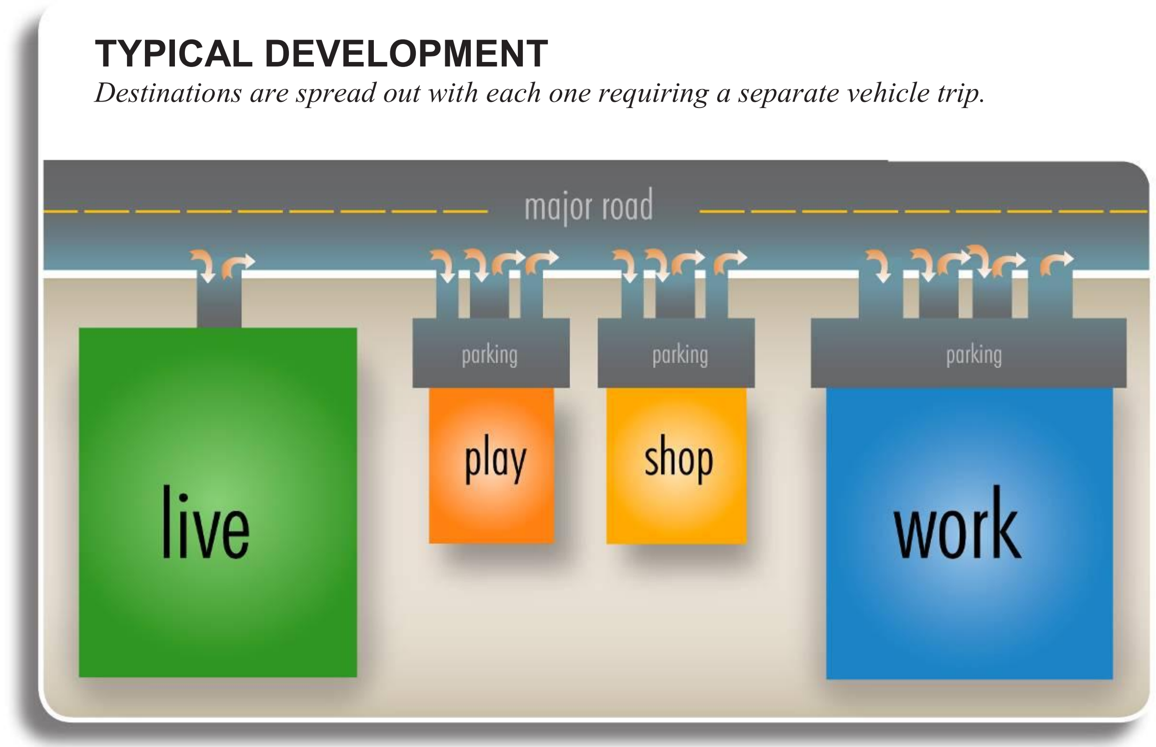


Figure 8-1: Typical Development

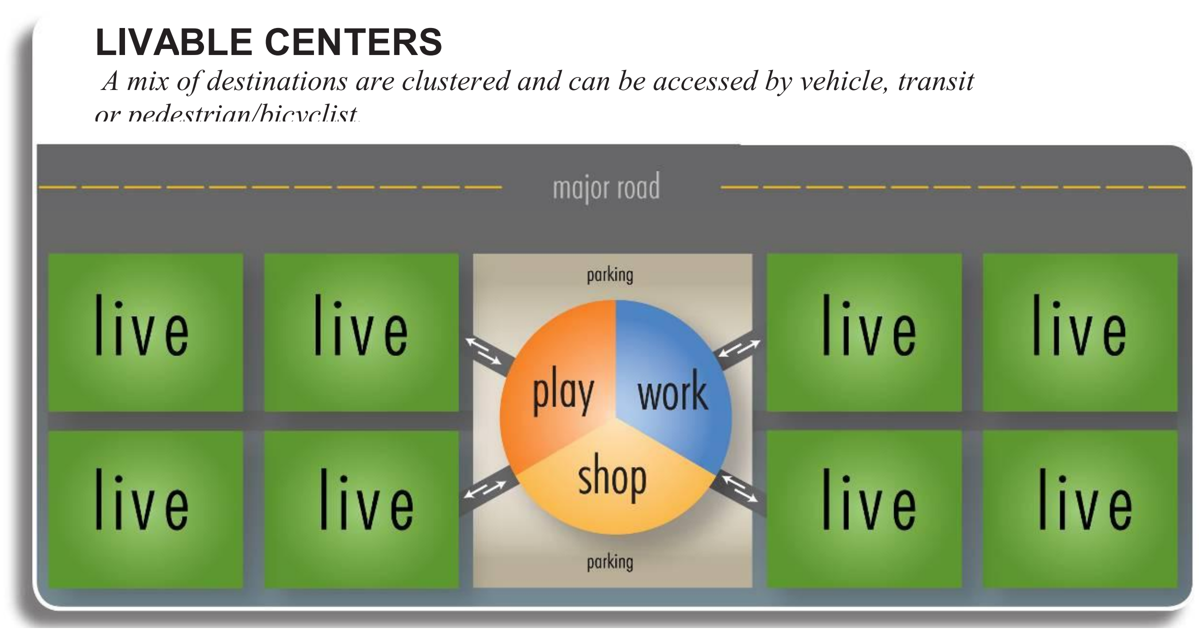


Figure 8-2: Livable Centers Development

8.1. Five Step Process to Livable Centers

The five step process refers to the phasing that needs to take place to implement the Livable Centers initiative along SH 6.

Step 1 - Existing Conditions and Property Owner Outreach

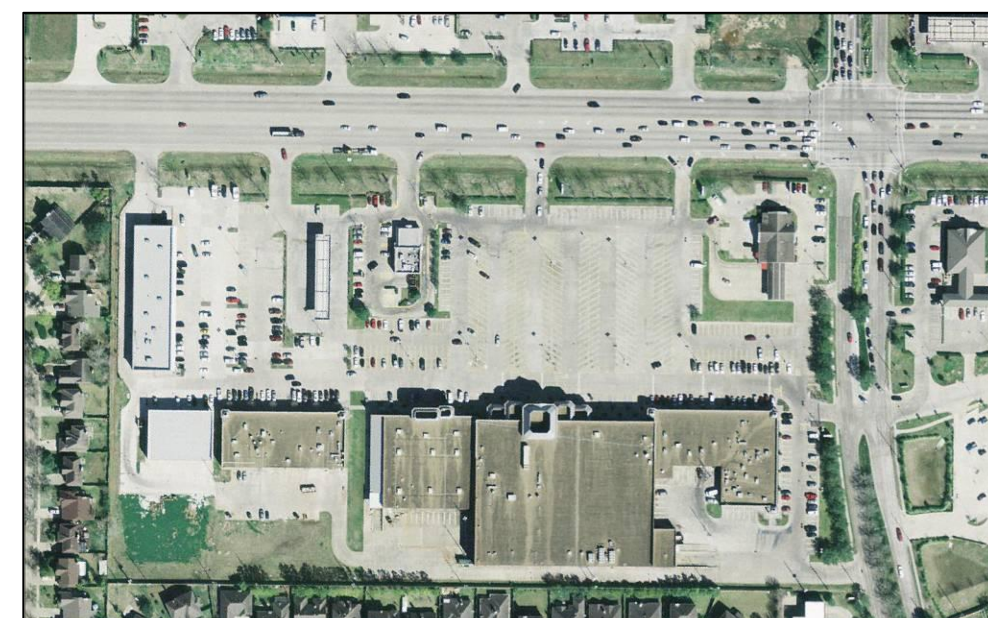
There are three important questions to ask when defining the existing conditions for any section of SH 6: what is the market potential for the commercial strips and shopping centers in the future, what are the traffic demands in the highway corridor, and what stage of development in the corridor.

1. *Relating Land Use to Market Potential*
   What is a reasonable estimate of commercial or retail development along the corridor in the next 10 to 25 years, and how does that estimate compare with the amount of land already zoned for commercial uses?
2. *Relating Land Use to Traffic Patterns and Highway Design*
   How do we balance the need to mitigate traffic congestion with the desire to provide prime access points for commercial and retail related land uses?
3. *Relating Land Use and Street Designs to Development Intensity*
   What stage has development reached along the corridor: a few commercial properties here and there, fully developed at low density, developed at low density and deteriorating, or redeveloping at almost urban densities?

These questions help form the market characteristic and can aid in convincing developers and property owners that by creating livable centers, greater profits can be generated from properties that have matured and plateaued in terms of return on investment. Property owner outreach should concentrate on how public-private partnerships can be formed to create livable centers out of underperforming strip shopping centers. The following explanation could be used to entice property owners and developers and define the base case for livable centers.

A majority of the development in the SH 6 corridor has occurred in an incremental fashion, near major roadway intersections, and without a binding architectural flavor. This is a common growth pattern that is beginning to change. Both communities and developers are beginning to create mixed-use, pedestrian- oriented districts in key locations. The motivating factor for this reinvention of housing and retail centers is the desire of cities to remain competitive in the emerging urban retail housing, and office markets and to provide quality of life. For the first time in 30 years, these markets have new options for site selection. There has been a revival of traditional street-front retail where it is possible to walk along a sidewalk from store to store, and where offices, apartments, and other destinations make for a livelier environment. This type of market is particularly well suited for areas which will be served by some sort of transit in the future.

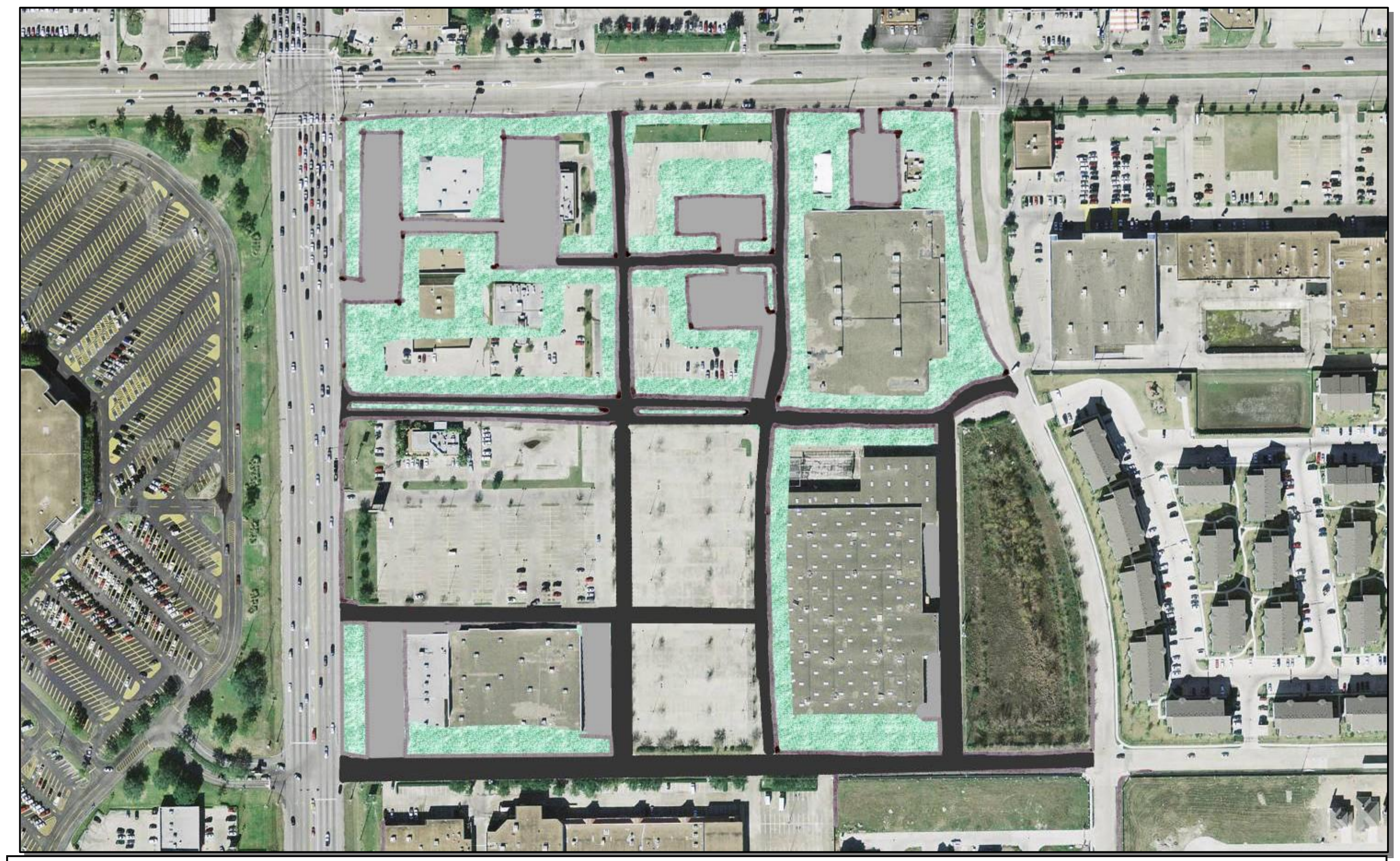
Existing condition of SH 6 and Westheimer Road intersection could be described as fully developed at low density with some aging and deteriorating retail uses.



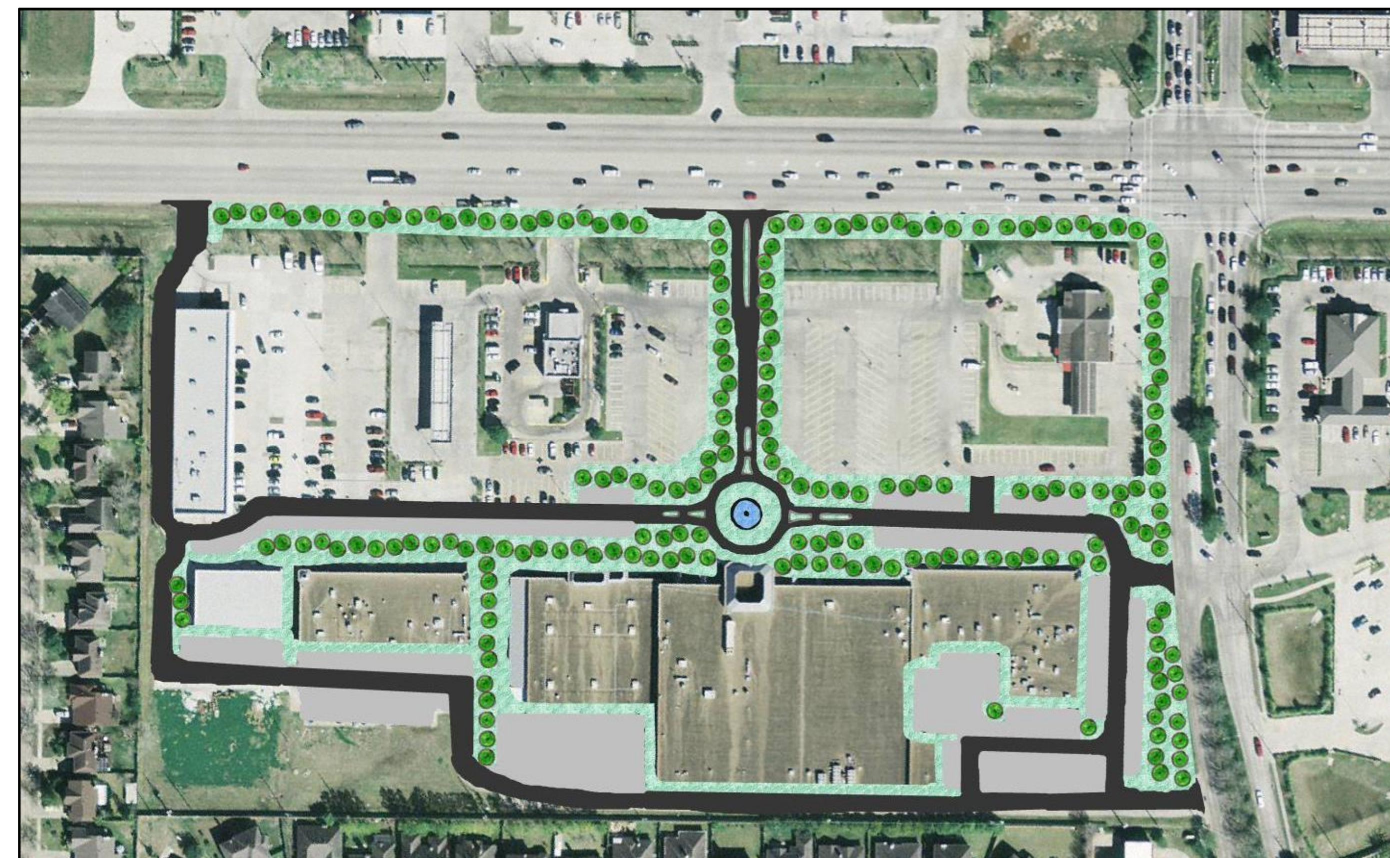
Existing condition of SH 6 and Austin Parkway intersection could be described as fully developed at low density with many aging and deteriorating retail uses.

Step 2 - Access Management Improvements

Implementing the access management strategies detailed in this plan is the first step to creating livable centers. Most access management improvements aid in pedestrian and bicycle mobility and improve transit service times, thus laying the foundation for creating livable centers. Additionally, access management treatments are mostly focused on the public realm of the landscape and can be done without private partnerships. However, they are a vital display to the private investor and citizen that change is occurring in the corridor.



Conceptual future conditions of the SH 6 and Westheimer Road intersection after access management and landscaping improvements have been applied.



Conceptual future conditions of the SH 6 and Austin Parkway intersection after access management and landscaping improvements have been applied.

Step 3 - Offer Many Choices of Movement

Development should contribute to the network of transit, streets, sidewalks, walkways, through-block passageways, trails, and bikeways. Techniques to retrofit existing properties include:

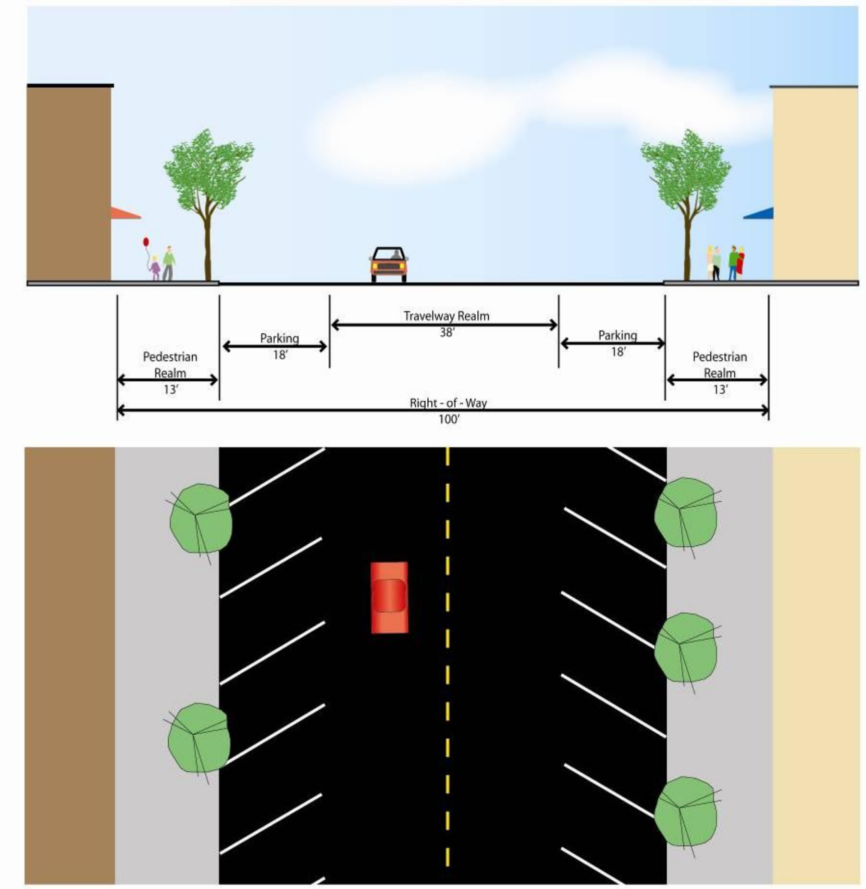
Walkway Through Parking

Transit Pavilion

Enhanced Crosswalks

Through-Block Passageway

Main Street
Two Lanes, Undivided



Fundamental to Step 3 is reconstruction of internal commercial streets to be “main streets”. This can be accomplished by making them into “main streets” or simply by adding a focal point such as a traffic circle.

Concepts in Step 4 will illustrate how these improvements to intercirculation streets can create new livable centers by establishing new build-to lines and calming site traffic.

Step 4 - Infill Development

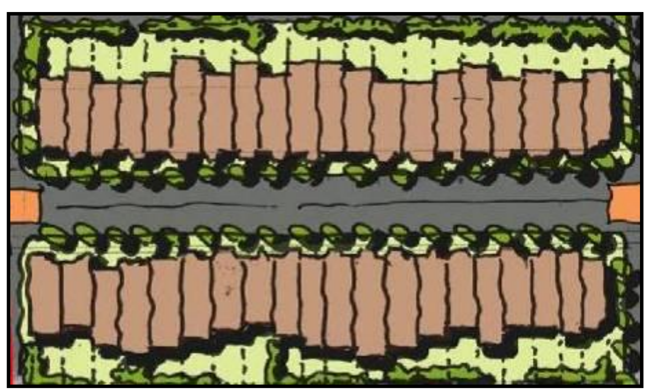
This step should build upon the private partnerships that have been created from the three prior steps to entice mixed use infill development. As mentioned in Step 1, the public sector has many influential powers that can be directed toward making mixed-use infill development viable. Beyond infrastructure improvements, the public sector can make mixed use attractive by:

- Master planning and performing preliminary site engineering / design on potential livable centers.
- Amending development regulations to reduce building set-backs and parking standards while increasing floor area ratios (FAR) and percent of frontage occupied.
- Providing for administrative approval of development permits provided they meet or exceed livable center infill development objectives.
- Public-private equity funding partnerships.

The building blocks of a livable center, when applied to key intersections, create a pedestrian-oriented development that can be well served by fixed-route transit.

BUILDING BLOCKS - TOWNHOUSE

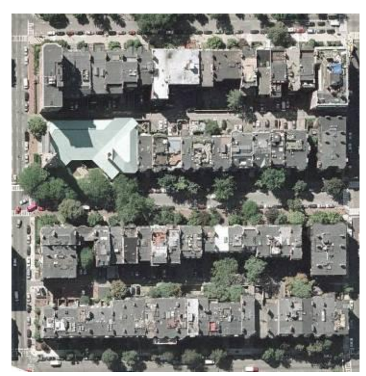
Plan Delineation



Recommended Development Criteria

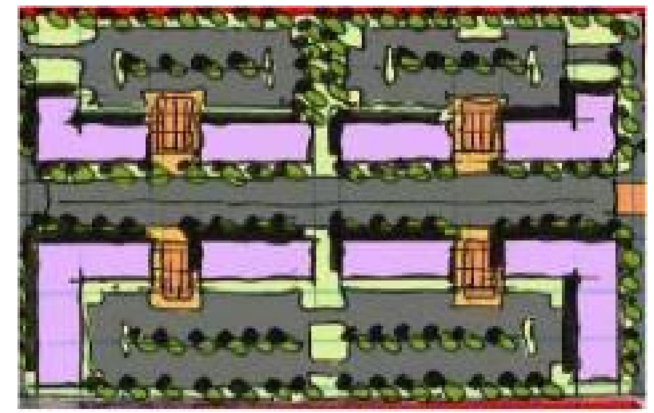
- *Max Ht. Single Use – 45' or 3 Stories*
- *Max Res. Density Single Use – 18 Units/Ac*

Built Form



BUILDING BLOCKS – Mixed Use A

Plan Delineation

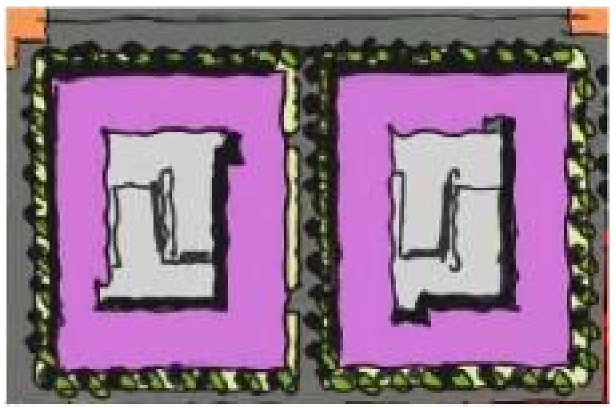


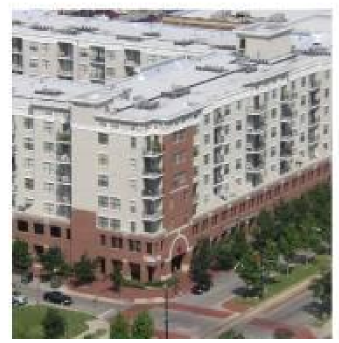
Development Criteria

- *Max Ht. Single Use – 60' or 5 Stories*
- *Max Res. Density Single Use – 60 Units/Ac*

BUILDING BLOCKS – Mixed Use B

Plan Delineation



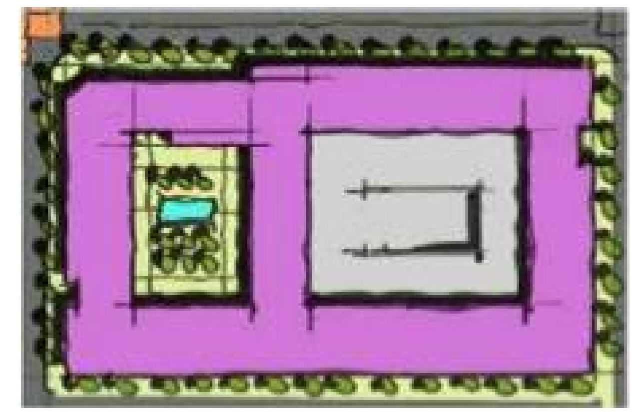


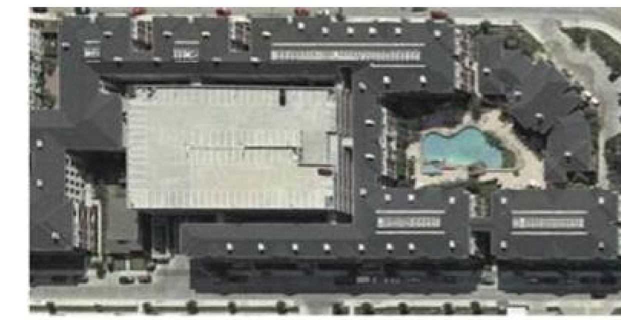
Development Criteria

- *Max Ht. Single Use – 60' or 5 Stories*
- *Max Res. Density Single Use – 60 Units/Ac*

BUILDING BLOCKS – Mixed Use C

Plan Delineation





Development Criteria

- *Max Ht. Single Use – 60' or 5 Stories*
- *Max Res. Density Single Use – 60 Units/Ac*

Step 4 - Infill Development, continued

Infill redevelopment in a major automobile-dominated urban corridor such as SH 6 is best accomplished in phases and should be coordinated with transit improvements and other public improvements.

How to Implement Infill Developments

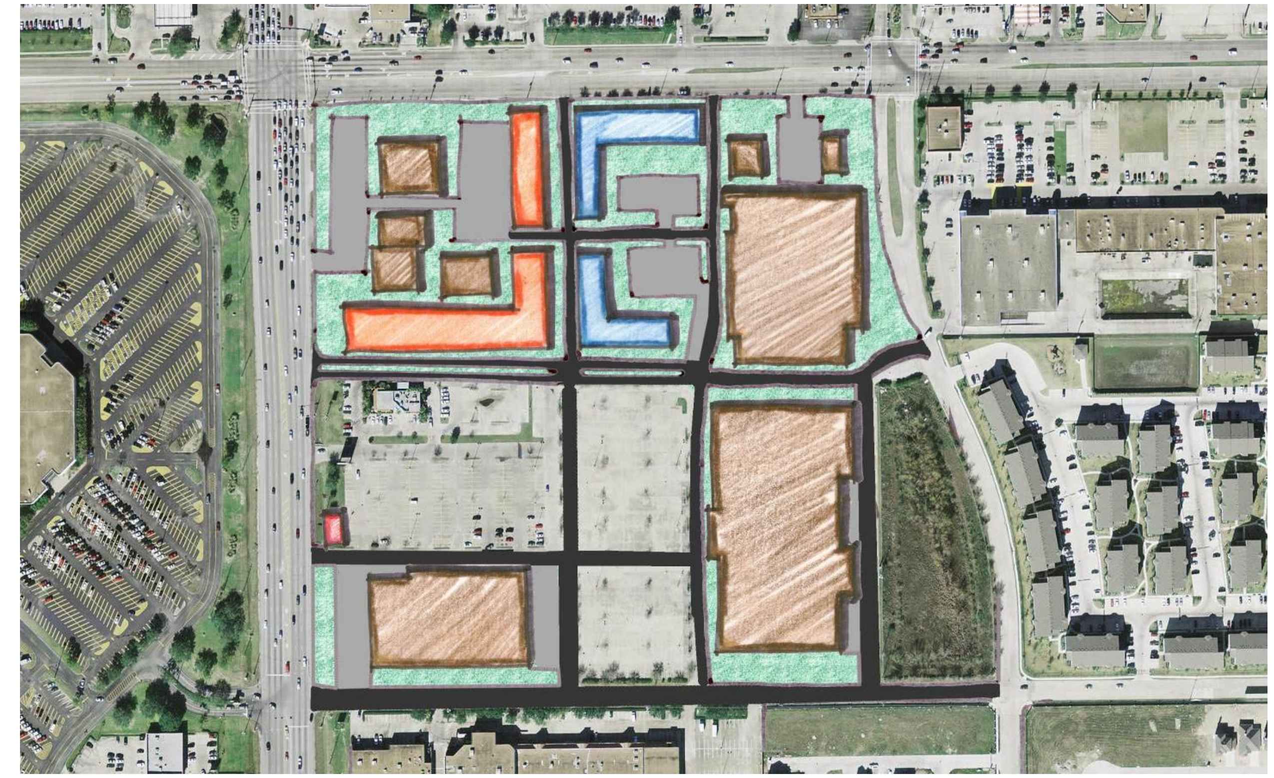
Public-private partnerships (P3s) are a powerful economic development mechanism for redeveloping areas that are going to be affected by transportation improvements. P3s are created when public-sector agencies join with private-sector entities and enter into a business relationship to share risk while pursuing a commonly shared goal linked to objectives of individual partners.

It is likely that the intersections of Westheimer Rd. and Bellaire Boulevard will be improved with an interchange. While this interchange will pose some impacts on business during construction, the new vehicular capacity and decreased traffic delay will provide for new economic conditions in the form of a larger market area for the adjacent commercial land. These greater market opportunities rely upon redevelopment of existing commercial areas into vibrant urban centers and reconstruction and beautification of existing streets into new main streets. These are lofty projects and will require a P3s approach between investors, land owners, developers, the City, and METRO.

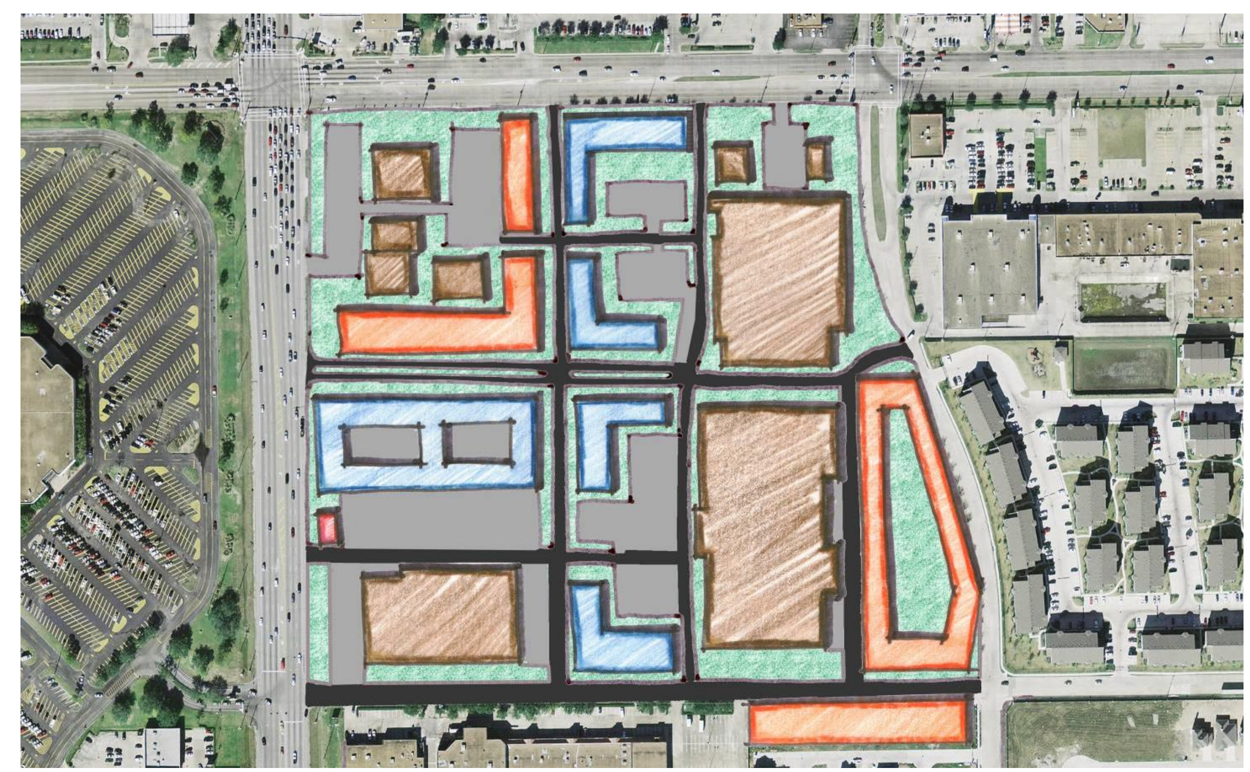
Steps to successful P3s:

1. Create an idea, a goal to work from (i.e. transit-oriented development or lifestyle center)
2. Define partners and introduce project
3. Receive input and consensus to move forward
4. Create a project list and perform a pro-forma
5. Formalize the partnership with a memorandum of understanding
6. Solicit developers and program public

Phase 1 - Westheimer Road
Maximize developable areas and introduce mixed-use
Phase 1 focuses on making use of underutilized parking areas and excessive building set-backs by using the new "main streets" as build-to lines for mixed-use developments. Parking is accomplished by placing it more strategically as on-street rather than in lots.



Phase 2 - Westheimer Road
Maximize developable areas and introduce mixed-use
Phase 2 is dependant on the availability of high-capacity, fixed-route transit within one-quarter mile of the intersection. Parking is accomplished by the addition of parking garages.



Phase 1 - Austin Parkway
Maximize developable areas and introduce mixed-use
Phase 1 focuses on making use of underutilized parking areas and excessive building set-backs by using the new traffic circle as a focal point. The circle also provides a new definition of the build-to line for development. Parking is accomplished by placing it more strategically as on-street rather than in lots.

Phase 2 - Maximize developable areas and introduce mixed-use
Phase 2 is dependant on the availability of high capacity fixed-route transit within one quarter mile of the intersection. Parking is accomplished by the addition of parking garages.

Step 5 High Capacity Transit

Transit is a key component to creating livable centers. Transit provides the missing element of a truly walkable community by reducing the dependence of the automobile and thus decreasing the need for parking and roadways, which take up valuable real-estate in a livable center. For livable centers to reach their full potential and reduce travel demand, they must be served by high-capacity transit such as, Bus Rapid Transit (BRT), Light Rail Transit (LRT), or some other transit technology that has the capacity and frequency to serve a high demand on loading and unloading volumes.

Recommended strategies for SH 6 to become more transit friendly include:

- Design and redesign areas to provide convenient access to transit systems.
- Encourage development of convenient and safe sidewalks, street crossings, bicycle, and pedestrian facilities to serve local and regional transit facilities.
- Promote pedestrian and bicycle connections between regional transit facilities and nearby neighborhoods.
- Encourage building design and placement, street improvements, parking standards, and other measures that encourage pedestrian access and use of local and regional transit.

High-capacity transit in the SH 6 Corridor will be critical for livable centers to be successful

8.2. Livable Centers on SH 6

As indicated in this chapter there are several opportunities to implement the livable centers strategies on SH 6. Westheimer and SH 6 in the City of Houston and Austin Parkway in Sugar Land are prime examples of how the livable centers process works. A key to making this program successful on SH 6 is linking transit with the development. The long-range transit recommendations for this corridor call for BRT and local bus service to be implemented. The goal of livable centers on SH 6 is to have the livable centers transit ready, so when the time comes to implement the transit service, the development and the transit service will combine to create walkable pedestrian-friendly environments.

Many other areas along SH 6 could be candidates for a livable center strategy. For instance, the Energy Corridor area near SH 6 and IH-10 would be an excellent candidate for a livable center. In this area, work has already begun to redevelop businesses, modify streets, and create an environment that blends with the existing neighborhoods. Local agencies are encouraged to find opportunities and then begin a public-private partnership to transform their neighborhoods and retail areas.

Appendix A: Public Meeting Summaries

Series 1 Public Meeting Summary

IH 10 WB to Memorial
- Pedestrian/Bike Improvement - loss of shoulders when bicycles come over the dam. There could be continuous connectivity by bike from Bear Creek Park, if shoulders were preserved and extended.
- Congestion Improvement - Better timing of lights at Park Row & Highway 6
- Add overpass
- Open more southbound lanes in morning, northbound in the evening
- Feeder flooding
- Pedestrian/Bike Improvement - Needs pedestrian crossing signal and detention near park
- Pedestrian/Bike Improvement - Need access to Grisby as many destinations are reachable via that road. Make access bike friendly. Connect to Hershey Park as well.
- Extend Grisby West to Barker Cypress
- Safety is critical near school, needs turn lane
- Turn lane needs to be extended.
- Bad signal timing of intersections.
- Extend turn lane
- Allow right turn only onto Memorial from the south; left from Wolfe to Memorial
- Pedestrian/Bike Improvement - Need access to Memorial
- Right turn lane on Memorial
- Congestion Improvement - Need light at Memorial / Addicks Howell
- Congestion Improvement - Close Addicks Howell - poor condition, should be closed between Highway 6 and Memorial
- Add Signal
- Sidewalk drop off – need new sidewalk
- No left-turns - would make signal timing worse
- Add Delivery truck parking
- Heavy congestion

Memorial Dr to Briar Hill Pkwy
- Pedestrian/Bike Improvement
- Congestion improvement – Heavy congestion
- Need sound wall to reduce traffic noise
- Business cut-through traffic
- Close this section of road - not used for anything but cutting across (agree)

Briar Hill Pkwy to Eagle Vista
- new independent living facility (lots of accidents)
- Suggest new traffic light

Briar Forest Dr to Chili's Plaza
- Too many business driveways feeding NB & SB traffic onto Hwy 6

Chili's Plaza to Piping Rock Lane
- Remove reflectors
- Traffic creating bike hazard
- Pedestrian/Bike Improvement
- Turn lanes out of BV

Briar Forest Dr to Piping Rock
- Add Turn Lane
- Congestion Improvement - Briar Forest Intersection needs two lanes to turn north and 2 to turn south
- Pedestrian/Bike Improvement
- Add Raised Median
- Possibly limit to only local traffic, no thru traffic allowed
- Pedestrian/Bike Improvement - bike access to neighborhood, retail could be useful
- Congestion Improvement - Street not at code

Piping Rock Lane to Westheimer
- Pedestrian/Bike Improvement - Reflectors in shoulder somewhere - bicycle hazard
- Add Raised median
- Add new turn lane
- Add turn lane near Taco Bell
- Pedestrian/Bike Improvement - shoulder squeezes to zero at Westheimer - bike hazard
- Congestion Improvement - lots of backup at Barker Oaks / Westheimer intersection
- Congestion Improvement - south of Barker Oaks / Westheimer intersection
- Timed traffic lights
- Look for alternative routes around Westheimer
- New turn lane from 6 to piping rock

Westheimer Rd to Park Hollow Dr
- Add turn lane
- Add raised median
- Congestion Improvement – Heavy congestion
- Retime traffic lights
- No overpass - not a solution, overpass based on out-of-date info

Bus stop

Park Hollow Dr to Richmond Ave
- Pedestrian crossing needed

Richmond Ave to Westhollow Dr
- Remove reflectors on shoulder - hazard to cyclists
- New to relieve congestion

Westhollow Dr to Westpark Dr
- Add turn lane
- Make a right turn lane for NB traffic- the shoulder is not allowed for use now

West Oaks Plaza to Westpark

- Pedestrian/Bike Improvement - reflectors in shoulder - Bike hazard

Westpark Drive to Bellaire
- Add Raised Median
- Heavy Congestion in this area
- Add Turn Lane
- Congestion Improvement - On-ramp needs to be widened and extended.
- Pedestrian/Bike Improvement - very tricky merge for cars and bicycles. Signal needed. On-demand by bikes?
- This is a bottleneck (the NB on-ramp)
- Better signage "Right lane must turn right @ Bellaire"

Bellaire Blvd to Empanada Dr
- Add raised median

Empanada Dr to Beechnut St
- Driveways-driveways-driveways – please reduce
- Add Red light camera (x4)

Beechnut St. to Parkesgate
- Raised Median

Parkesgate to Bissonnet
- Absolute mess
- Congestion improvement - has worsened since Bissonnet connected to FM 1464

Bissonnet to Old Richmond Rd
- Hard to turn left w/no timing on lights at Old Richmond and Bissonnet
- Add Raised median
- Bad signal timing
- People travel SB in suicide lane and cross intersection when facing traffic is trying to turn left

Old Richmond Rd to Bellfort Congestion improvement
- Bad signal timing
- Terrible - you take your life in your hands when turning left for Old Richmond please add turn lanes
- Remove grooves on asphalt shoulder
- Re-stripe for right turns
- Maintain reflective paint

Bellfort to West Airport
- Raised Median before Woodbridge Villages
- Pedestrian/Bike Improvement - Signals do not respond to bicycles. In-ground loop sensors don't work
- This asphalt is great in the rain

West Airport to Voss Raised median
- Too many driveways
- Heavy congestion

Voss to 90A WBFR
- This light cycles regardless of traffic volume
- Improve SB R/R crossing, even temporarily finishing hwy 6/alt 90A is a priority

90A WBFR – 90A EBFR
- Don't put message signs with no speed limit on them

90 EBFR - University Blvd.

University Blvd. - 1st Colony Blvd.

- From 1st colony to Kensington Dr. it was noted that on this side of Hwy 6 it is difficult to know when you are at an intersection. This whole area is a nightmare during rush hour. The lights don't max the traffic flow

1st Colony Blvd. - Lake Point
- Rt. Turn from North Bound 6 to Brooks allows people go straight and barge their way in during construction

Lake Point - Fluor Daniel Dr
- On-demand lights are terrible - They restrict flow
- Raised Median to Sugar Land Airport

Fluor Dr. - Medical Dr.
- Raised Median opposite side of street from CVS

Medical Dr. - Kensington Dr.

Kensington Dr. - US 59 SB
- Intersection is very congested – Please fix

US 59 SB - US 59 NB

US 59 NB - City Walk
- City Walk - Town Center Dr. Congestion Improvement. Getting worse and worse!

Town Center Dr. - Lexington Blvd
- Pedestrian/Bike Improvement – make area safer for pedestrians
- Congestion improvement – heavy traffic volumes here.
- Too many driveways
- Need access between businesses

Lexington Blvd. - Grants Lake Blvd.
- Congestion Improvement - Trek Express to Highway 6 / I-10 via Hwy 6 at peak times. No commuter service to I-10 or Hwy 6. 3 major O&G companies

Grants Lake Blvd. - First Crossing Blvd.

First Crossing Blvd. - Williams Trace Blvd.
- Congestion at signal – please improve timing

Williams Trace Blvd. - Settlers Way Blvd.
- Congestion improvement – improve intersection
- Raised Median after intersection

Settlers Way Blvd. - Frost Pass
- Pedestrian/Bike Improvement – Make area safer for pedestrians
- Sync traffic signals
- Add turn lanes
- Raised median
- Must stop in speed buttons to turn left into Cici's and night also very dark

Frost Pass - Austin Pkwy Blvd. / Dulles Ave.
- Too many driveways
- Raised median
- Ped. /Bike improvement – improve sidewalks etc.

Austin Pkwy Blvd. / Dulles Ave. - Colonial Lakes Dr.
- Raised median
- Please add Bike/Pedestrian access along 6 south of Sugar Land with a landscape barrier between walkway and highway like sugar Land

Gives more like a Blvd. feel
- Add turn lanes
- Too dark at night to see HEB driveway locations when turning left into HEB at night
- This space is opportunity to make a nice mixed use landscape area. Don't allow large strip center
- Allow left turn yield on green

Colonial Lakes Dr. - Riverstone Blvd.
- Pedestrian /Bike improvement – Needs to be safer
- Raised median
- Light to turn left onto Hwy 6 has short cycle length.

Riverstone Blvd. - Shops
- Add Raised median

Shops - Township Lane
- If you want to keep driveways use raised medians to control flow

Township Ln. - University Blvd. / Stafford De Walt Rd.(FM 1092)
- Very difficult to turn left with on coming traffic
- Add raised median

University Blvd. / Stafford DeWalt Rd (FM 1092) - Glenn Lakes Lane
- Left turn onto Hwy 6 are dangerous
- Add raised median

Glen Lakes Ln. - Lake Olympia Pkwy
- Add raised median - Please add more medians and trees to the corridor south of Sugar Land / Missouri city to slow people down.

Lake Olympia Parkway - Knight's Court
- Add raised median

Knight's Court - Oyster Creek Place Dr.
- Add Raised Median

Oyster Creek Place Dr. - Sienna Parkway
- Add turn lanes

Sienna Pkwy - Vicksburg Blvd.
- Sienna Congestion Improvement - need improvement along sienna pkwy.
- Add new signal
- Add raised median

Vicksburg Blvd. - Fort Bend Parkway Toll Rd. (on the frontage Roads)
- Congestion Improvement – rush hour high volumes and congestion.

Fort Bend Parkway Toll Rd. (on the frontage roads) - Darby Lane
- Dual rt. Turn lane
- Flooding issues
- Add turn lane
- Add raised median
- Better flow for traffic. More lanes to turn onto Ft. Bend Pkwy.

Darby Lane - Post Oak Blvd.

Post Oak Blvd. - FM 521
- Park -n-ride
- Radius not appropriate on frontage roads for 18 wheelers and other large vehicles

Series 2 Public Meeting Summary

The following bullet points refer to the input received during the public meetings held on September 25th and 27th. Additional information was also collected as part of a survey and will be documented separately. The information reads from the northern portion of the study area to the southeastern portion of the study area.

Grisby to Memorial
- Need signal
- Will there be a signal? Many W.B. Grisby drivers go southbound to Sugar Land here
- Some bike bridges
- Build shared use path
- I hear there is a bridge for pedestrian/bike here at culvert

- We have a lot of cut through traffic into Barker's landing - light?
- Question: How do 8000 more employees get out of here at 4:00 pm without going through our subdivision? Answer: Thru Grisby or Memorial or our school and neighborhood
- All Katy ISD school south of I-10 should be in Spring Branch ISD. Keep school buses off of I-10 twice a day
- Children walk in the street. Pedestrian and bicycle accommodations needed
- See video at youtube.com/AddicksHowell

Memorial Dr to Briar Hill Pkwy
- Need to allow left turn from school so people can go home down Memorial
- Close this ASAP (Addicks Howell) - it's just a way to bypass the light and increase traffic down Addicks Howell north of Memorial. People are ignoring the current right turn only sign
- Need a safe walkway over Memorial so the kids from Fleetwood South and West could walk to school

Piping Rock Lane to Westheimer
- Connect retail driveways
- Provide turn lanes

Westpark Drive to Bellaire
- Make sure to keep u-turn for access to Butler's Bridge
- Safety of U-turn
- No u-turn
- Only 1 ingress / egress to subdivision Butler's Bridge (west bend)
- Right turn lane

Bellaire to Rancho Mission
- Open up

Bellfort to West Airport
- Right turn on West Airport

Voss to US 90 WBFR
- Four lanes - traffic snag

US 59 SB - US 59 NB
- Triple left
- Sign to new interchange and mall

First Crossing Blvd. - Williams Trace Blvd.
- Dual lefts

Settlers Way Blvd. - Frost Pass
- Pedestrian / bike crossing over SH6 1) Wider sidewalks all along corridor in Sugar Land city limits. 2) Bike lanes all along corridor as part of roadway in Sugar Land city limits. 3) Trees along corridor between bike lanes and sidewalks. Solutions for greater pedestrian / bike accessibility in Sugar Land creating foundation also for transit/BRT serving livable centers. Start now as part of this project!
- Multi-modal corridor throughout Sugar Land
- Signal for this direction needs synchronization
- left-ins
- livable center
- Dual left on Dulles
- Pedestrian / bike crossing at Dulles - corridor lanes should be narrower if the only alternative is widening the road. Studies show safety is enhanced when context-sensitive solutions, including narrowing and slowing traffic are used.

Oyster Creek Place Dr. - Sienna Parkway
- Safety concern regarding right turn decel. need better striping (yellow)

Sienna Pkwy - Vicksburg Blvd.
- Future development
- Needed stoplight signal now
- Possible opening
- New entry

Vicksburg Blvd. - Fort Bend Parkway Toll Rd. (on the frontage Roads)
- Old road closed / new road open.

Fort Bend Parkway Toll Rd. (on the frontage roads) - Darby Lane
- left turns
- opening
- left-in
- future cross access

Darby Lane - Post Oak Blvd.
- New entry
- Move opening
- Left turn
- One owner
- Now opening

Post Oak Blvd. - FM 521
- Left turn
- New entry to Arcola City Hall

Additional comments were recorded separately for the intersections of Westheimer and Bellaire. These comments were documented in Appendix D.

Appendix B: Traffic Data Supplement

Elimination of "Split-Phased" Signal Sequences:
An intersection is said to be "split-phased" if all traffic from one direction moves during one phase followed by all traffic from the opposite direction moving during the next phase. The sequence in which the left-turn phases occur concurrently (if needed) followed the concurrent service of the opposing through movements is referred to as "quad-left" phasing.

In some cases, split-phasing is appropriate because of the unusual geometry of the intersection. As a general rule, however, split-phasing of the cross street should be avoided because of the following operational disadvantages:

In light traffic, substantially more major street red time is required to service the minor street traffic. As an example, consider the instance of only one vehicle being present on each minor street approach:

If the minor street is split-phased, both cross street phases must be served for a minimum time. Assuming a minimum green of about five seconds plus typical yellow and all-red times, the major street signals must be red for at least 20 seconds to accommodate these two cars.

In comparison, if the minor street has just a single phase, both cars could typically be accommodated during 10 – 12 seconds of major street red time.

An even greater problem stems from the accommodation of pedestrians crossing the major street. To accommodate one pedestrian, the controller must sequentially time the following intervals:

- A "Walk" interval of at least four seconds.
- "Flashing Don't Walk" pedestrian clearance interval, which must be long enough to allow pedestrian who has just started his or her crossing to reach the far side of the street. Assuming a walking speed of four-feet per second, the typical pedestrian clearance time to cross SH 6 is about 17 seconds. Although the vehicular yellow and all-red intervals can be timed concurrently with the last few seconds of the pedestrian clearance, usual practice is to time them following the pedestrian clearance.

Accordingly, about 26 seconds of major street red time is required to accommodate the crossing of just one pedestrian. Along arterial roadways such as SH 6, the pedestrian phases are typically actuated and the pedestrian intervals are timed only in response to a push button actuation.

Split-phasing creates the following problem if there happens to be need to serve a pedestrian call for crosswalks on both sides of the cross street:

- Since a green arrow cannot be displayed in conflict with a "Walk" or "Flashing Don't Walk" interval, the crosswalk on the west side of the intersection must be associated with the southbound vehicular phase and the crosswalk on the east side of the intersection must be associated with the northbound vehicular phase.
- Accordingly, if the intersection is split-phased, these pedestrian services must occur sequentially and 52-seconds or more of major street red time is required to accommodate the two pedestrians.
- In contrast, virtually any other phasing pattern would allow these two pedestrian services to be accommodated concurrently in only 26-seconds of major street red time.

To avoid these inefficiencies, it is recommended that split-phasing be avoided whenever other intersections are newly signalized. Also, as funding permits, it is recommended that the currently split-phased minor intersections be reconfigured to allow them to operate in a more efficient manner.

By adding one lane, each minor approach can be reconfigured to have a left-only lane, a straight-only lane, and a right-only lane, which would allow the following operational efficiencies:

- Pedestrians can be accommodated concurrently on the parallel north-south crosswalks.
- At intersections where the minor approaches have low left-turning volumes, all cross-street vehicular traffic can be accommodated during a single phase.
- Even if the minor approach left-turn volumes are high enough to need a protected phase, protected-permitted mode can normally be used. Accordingly, some of the left-turns can take place during the circular green, thereby minimizing the major street red time. Furthermore, during very light traffic periods, the cross street left turn phases can be omitted entirely, possibly allowing the use of a shorter signal cycle.

Protected-Only versus Protected-Permitted Left Turns:
Many of the signalized intersections along SH 6 currently have protected-only left turns. Especially in light traffic, the down side of this mode of operation is that a left-turning driver must wait for the green arrow even though there maybe many opportunities for left turns to be made safely on a permitted basis during the circular green.

On the other hand, one potential advantage of protected-only mode is that the lead-lag phase sequences can be used to optimize two-way progression without creating "yellow trap" issues. (If a lagging left turn occurs opposite a leading protected-permitted left turn, a "yellow trap" condition is said to occur because the left turning driver is facing a yellow signal even though opposing through traffic still has a green. Accordingly, a left turning driver waiting in the intersection does not have the opportunity to clear safely during the yellow).
Because of speeds and volumes, protected-only operation is probably appropriate at many of the intersections along SH 6. In any event, the progression benefits of being able to use lead-lag sequences should be evaluated prior to any decision to convert a particular location to protected-permitted mode.

Table 1: Corridor Annual Average Daily Traffic

IH 10 WB	IH 10 EB	51,000
IH 10 EB	Memorial Dr	39,900
Memorial Dr	Briar Hill Pkwy	53,700
Briar Hill Pkwy	Eagle Vista	49,600
Eagle Vista	Briar Forest Dr	53,500
Briar Forest Dr	Chili's Plaza	46,600
Chili's Plaza	Piping Rock Ln.	44,600
Piping Rock Ln.	Westheimer Rd (FM 1093)	38,300
Westheimer Rd (FM 1093)	Park Hollow Dr.	40,200

Park Hollow Dr.	Richmond Ave	42,100
Richmond Ave	Westhollow Dr.	48,100
Westhollow Dr.	Westpark Dr	44,500
Westpark Dr	Bellaire Blvd	43,200
Bellaire Blvd	Empanada Dr.	41,800
Empanada Dr.	Beechnut St.	35,400
Beechnut St.	Charlmont Dr./Parksgate Dr.	36,800
Charlmont Dr./Parksgate Dr.	Bissonnet St	29,100
Bissonnet St	Old Richmond Rd	28,400
Old Richmond Rd	Bellfort	29,500
Bellfort	Woodbridge villages Ln.	31,000
Woodbridge villages Ln.	W Airport Blvd.	23,300
W Airport Blvd.	Voss Rd	33,900
Voss Rd	1st Colony Blvd	27,800
1st Colony Blvd	Lake Point	21,350
Lake Point	Fluor Daniel Dr.	39,400
Fluor Daniel Dr.	Medical Dr.	40,900
Medical Dr.	Kensington Dr.	36,800
Kensington Dr.	US 59 SB	54,000
US 59 SB	US 59 NB	47,300
US 59 NB	Town Center Dr.	42,700
Town Center Dr.	Lexington Blvd	31,400
Lexington Blvd	Grants Lake Blvd.	32,100
Grants Lake Blvd.	Williams Trace Blvd	31,900
Williams Trace Blvd	Settlers Way Blvd	36,800
Settlers Way Blvd	Frost Pass	41,100
Frost Pass	Austin Pkwy Blvd./Dulles Ave.	33,700
Austin Pkwy Blvd./Dulles Ave.	Colonial Lakes Dr.	34,650
Colonial Lakes Dr.	Riverstone Blvd.	34,600
Riverstone Blvd.	Shops	35,500
Shops	Township Ln.	35,900
Township Ln.	University Blvd./Stafford DeWalt Rd (FM 1092)	27,250
University Blvd./Stafford DeWalt Rd (FM 1092)	Glenn Lakes Ln.	30,850
Glenn Lakes Ln.	Lake Olympia Parkway	28,200
Lake Olympia Parkway	Knight's Court / Flat Bank	31,800
Knight's Court / Flat Bank	Oyster Creek Place Dr.	27,000
Oyster Creek Place Dr.	Sienna Parkway	22,900
Sienna Parkway	Vicksburg Blvd.	18,200
Vicksburg Blvd.	Darby Ln. or Teal Bend Blvd.	17,500
Darby Ln. or Teal Bend Blvd.	Post Oak Blvd	18,900
Post Oak Blvd	FM 521 EB	18,900
FM 521 EB	FM 521 WB	18,900

Appendix C: Cost Estimates

Cost estimates were calculated using TxDOT bid averages from November 2007.

Houston Medians:

ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL COST
0100-2002	PREPARING ROW	STA	175	$1,000.00	$175,000.00
0105-2060	REMOVING STAB BASE & ASPH PAV(15"-20")	SY	13225	$6.00	$79,350.00
0110-2001	EXCAVATION (ROADWAY)	CY	2203.703704	$5.00	$11,018.52
0132-2006	EMBANKMENT (FINAL)(DENS CONT)(TY C)	CY	4407.407407	$4.00	$17,629.63
0260-2006	LIME TRT (EXST MATL) (6")	SY	39666.66667	$2.00	$79,333.33
0260-2012	LIME (HYD,COM OR QK)(SLRY)OR QK(DRY)	TON	535.5	$120.00	$64,260.00
0276-2224	CEM TRT(PLNT MX) (CL N)(TY E)(GR 4)(6")	SY	39666.66667	$6.00	$238,000.00
0340-2063	D-GR HMA(METH) TY-C SAC-A PG76-22	TON	2181.666667	$75.00	$163,625.00
0360-2003	CONC PVMT (CONT REINF-CRCP)(10")	SY		$30.00	$0.00
0360-2018	CURB (TYPE II)	LF	33500	$3.50	$117,250.00
0432-2001	RIPRAP (CONC)(4 IN)	CY	1468.988889	$325.00	$477,421.39
0500-2001	MOBILIZATION	LS	10%		$147,358.41
0502-2001	BARRICADES, SIGNS AND TRAFFIC HANDLING	MO	6.628787879	$5,000.00	$33,143.94
0666-2036	REFL PAV MRK TY I (W) 8" (SLD)(100MIL)	LF	8450	$0.70	$5,915.00
0666-2042	REFL PAV MRK TY I (W) 12" (SLD)(100MIL)	LF		$2.00	$0.00
0666-2048	REFL PAV MRK TY I (W) 24" (SLD)(100MIL)	LF	348	$4.00	$1,392.00
0666-2054	REFL PAV MRK TY I (W) (ARROW) (100MIL)	EA	37	$100.00	$3,700.00
0666-2096	REFL PAV MRK TY I (W) (WORD) (100MIL)	EA	37	$125.00	$4,625.00
0677-2001	ELIM EXT PAV MRK & MRKS (4")	LF	37	$0.30	$11.10
0678-2003	PAV SURF PREP FOR MRK (8")	LF	8450	$0.10	$845.00
0678-2004	PAV SURF PREP FOR MRK (12")	LF		$0.20	$0.00
0678-2006	PAV SURF PREP FOR MRK (24")	LF	348	$0.40	$139.20
0678-2007	PAV SURF PREP FOR MRK (ARROW)	EA	37	$10.00	$370.00
0678-2018	PAV SURF PREP FOR MRK (WORD)	EA	37	$15.00	$555.00
	SWPPP	LS			$116,003.79
	SIGNING	LS			$99,431.82
	SIGNALIZATION	LS			$90,000.00
SUBTOTAL					$1,926,378.13
20% CONTINGENECY					$385,275.63
TOTAL					**$2,311,700.00**

Harris County Medians:

ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL COST
0100-2002	PREPARING ROW	STA	260	$1,000.00	$260,000.00
0105-2060	REMOVING STAB BASE & ASPH PAV(15"-20")	SY	17400	$6.00	$104,400.00
0110-2001	EXCAVATION (ROADWAY)	CY	2888.888889	$5.00	$14,444.44
0132-2006	EMBANKMENT (FINAL)(DENS CONT)(TY C)	CY	5777.777778	$4.00	$23,111.11
0260-2006	LIME TRT (EXST MATL) (6")	SY	52000	$2.00	$104,000.00
0260-2012	LIME (HYD,COM OR QK)(SLRY)OR QK(DRY)	TON	702	$120.00	$84,240.00
0276-2224	CEM TRT(PLNT MX) (CL N)(TY E)(GR 4)(6")	SY	52000	$6.00	$312,000.00
0340-2063	D-GR HMA(METH) TY-C SAC-A PG76-22	TON	2860	$75.00	$214,500.00
0360-2003	CONC PVMT (CONT REINF-CRCP)(10")	SY		$30.00	$0.00
0360-2018	CURB (TYPE II)	LF	54800	$3.50	$191,800.00
0432-2001	RIPRAP (CONC)(4 IN)	CY	1925.733333	$325.00	$625,863.33
0500-2001	MOBILIZATION	LS	10%		$200,605.57
0502-2001	BARRICADES, SIGNS AND TRAFFIC HANDLING	MO	9.848484848	$5,000.00	$49,242.42
0666-2036	REFL PAV MRK TY I (W) 8" (SLD)(100MIL)	LF	11400	$0.70	$7,980.00
0666-2048	REFL PAV MRK TY I (W) 24" (SLD)(100MIL)	LF	300	$4.00	$1,200.00
0666-2054	REFL PAV MRK TY I (W) (ARROW) (100MIL)	EA	48	$100.00	$4,800.00
0666-2096	REFL PAV MRK TY I (W) (WORD) (100MIL)	EA	48	$125.00	$6,000.00
0677-2001	ELIM EXT PAV MRK & MRKS (4")	LF	48	$0.30	$14.40
0678-2003	PAV SURF PREP FOR MRK (8")	LF	11400	$0.10	$1,140.00
0678-2006	PAV SURF PREP FOR MRK (24")	LF	300	$0.40	$120.00
0678-2007	PAV SURF PREP FOR MRK (ARROW)	EA	48	$10.00	$480.00
0678-2018	PAV SURF PREP FOR MRK (WORD)	EA	48	$15.00	$720.00
	SWPPP	LS			$172,348.48
	SIGNING	LS			$147,727.27
	SIGNALIZATION	LS			$60,000.00
SUBTOTAL					$2,586,737.04
20% CONTINGENECY					$517,347.41
TOTAL					**$3,104,100.00**

Sugar Land Medians:

ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL COST
0100-2002	PREPARING ROW	STA	100	$1,000.00	$100,000.00
0105-2060	REMOVING STAB BASE & ASPH PAV(15"-20")	SY	11400	$6.00	$68,400.00
0110-2001	EXCAVATION (ROADWAY)	CY	1888.888889	$5.00	$9,444.44
0132-2006	EMBANKMENT (FINAL)(DENS CONT)(TY C)	CY	3777.777778	$4.00	$15,111.11
0260-2006	LIME TRT (EXST MATL) (6")	SY	34000	$2.00	$68,000.00
0260-2012	LIME (HYD,COM OR QK)(SLRY)OR QK(DRY)	TON	459	$120.00	$55,080.00
0276-2224	CEM TRT(PLNT MX) (CL N)(TY E)(GR 4)(6")	SY	34000	$6.00	$204,000.00
0340-2063	D-GR HMA(METH) TY-C SAC-A PG76-22	TON	1870	$75.00	$140,250.00
0360-2003	CONC PVMT (CONT REINF-CRCP)(10")	SY		$30.00	$0.00
0360-2018	CURB (TYPE II)	LF	26100	$3.50	$91,350.00
0432-2001	RIPRAP (CONC)(4 IN)	CY	1259.133333	$325.00	$409,218.33
0500-2001	MOBILIZATION	LS	10%		$119,075.66
0502-2001	BARRICADES, SIGNS AND TRAFFIC HANDLING	MO	3.787878788	$5,000.00	$18,939.39
0666-2036	REFL PAV MRK TY I (W) 8" (SLD)(100MIL)	LF	5650	$0.70	$3,955.00
0666-2042	REFL PAV MRK TY I (W) 12" (SLD)(100MIL)	LF		$2.00	$0.00
0666-2048	REFL PAV MRK TY I (W) 24" (SLD)(100MIL)	LF	156	$4.00	$624.00
0666-2054	REFL PAV MRK TY I (W) (ARROW) (100MIL)	EA	23	$100.00	$2,300.00
0666-2096	REFL PAV MRK TY I (W) (WORD) (100MIL)	EA	23	$125.00	$2,875.00
0678-2003	PAV SURF PREP FOR MRK (8")	LF	5650	$0.10	$565.00
0678-2004	PAV SURF PREP FOR MRK (12")	LF		$0.20	$0.00
0678-2006	PAV SURF PREP FOR MRK (24")	LF	156	$0.40	$62.40
0678-2007	PAV SURF PREP FOR MRK (ARROW)	EA	23	$10.00	$230.00
0678-2018	PAV SURF PREP FOR MRK (WORD)	EA	23	$15.00	$345.00
	SWPPP	LS			$66,287.88
	SIGNING	LS			$56,818.18
	SIGNALIZATION	LS			$0.00
SUBTOTAL					$1,432,938.30
20% CONTINGENECY					$286,587.66
TOTAL					**$1,719,500.00**

Missouri City Medians:

ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL COST
0100-2002	PREPARING ROW	STA	385	$1,000.00	$385,000.00
0105-2060	REMOVING STAB BASE & ASPH PAV(15"-20")	SY	34000	$6.00	$204,000.00
0110-2001	EXCAVATION (ROADWAY)	CY	5629.62963	$5.00	$28,148.15
0132-2006	EMBANKMENT (FINAL)(DENS CONT)(TY C)	CY	11259.25926	$4.00	$45,037.04
0260-2006	LIME TRT (EXST MATL) (6")	SY	101333.3333	$2.00	$202,666.67
0260-2012	LIME (HYD,COM OR QK)(SLRY)OR QK(DRY)	TON	1368	$120.00	$164,160.00
0276-2224	CEM TRT(PLNT MX) (CL N)(TY E)(GR 4)(6")	SY	101333.3333	$6.00	$608,000.00
0340-2063	D-GR HMA(METH) TY-C SAC-A PG76-22	TON	5573.333333	$75.00	$418,000.00
0360-2003	CONC PVMT (CONT REINF-CRCP)(10")	SY		$30.00	$0.00
0360-2018	CURB (TYPE II)	LF	72000	$3.50	$252,000.00
0432-2001	RIPRAP (CONC)(4 IN)	CY	3752.711111	$325.00	$1,219,631.11
0500-2001	MOBILIZATION	LS	10%		$362,701.69
0502-2001	BARRICADES, SIGNS AND TRAFFIC HANDLING	MO	14.58333333	$5,000.00	$72,916.67
0666-2003	REFL PAV MRK TY I (W) 4" (BRK)(100MIL)	LF		$0.30	$0.00
0666-2012	REFL PAV MRK TY I (W) 4" (SLD)(100MIL)	LF		$0.30	$0.00
0666-2036	REFL PAV MRK TY I (W) 8" (SLD)(100MIL)	LF	13750	$0.70	$9,625.00
0666-2042	REFL PAV MRK TY I (W) 12" (SLD)(100MIL)	LF		$2.00	$0.00
0666-2048	REFL PAV MRK TY I (W) 24" (SLD)(100MIL)	LF	384	$4.00	$1,536.00
0666-2054	REFL PAV MRK TY I (W) (ARROW) (100MIL)	EA	59	$100.00	$5,900.00
0666-2096	REFL PAV MRK TY I (W) (WORD) (100MIL)	EA	59	$125.00	$7,375.00
0666-2105	REFL PAV MRK TY I (Y) 4" (BRK)(100MIL)	LF		$0.30	$0.00
0666-2111	REFL PAV MRK TY I (Y) 4" (SLD)(100MIL)	LF		$0.30	$0.00
0672-2012	REFL PAV MRKR TY I-C	EA		$3.00	$0.00
0672-2015	REFL PAV MRKR TY II-A-A	EA		$3.00	$0.00
0677-2001	ELIM EXT PAV MRK & MRKS (4")	LF	59	$0.30	$17.70
0677-2003	ELIM EXT PAV MRK & MRKS (8")	LF		$0.30	$0.00
0677-2005	ELIM EXT PAV MRK & MRKS (12")	LF		$0.75	$0.00
0677-2007	ELIM EXT PAV MRK & MRKS (24")	LF		$1.50	$0.00
0677-2008	ELIM EXT PAV MRK & MRKS (ARROW)	EA		$30.00	$0.00
0677-2018	ELIM EXT PAV MRK & MRKS (WORD)	EA		$30.00	$0.00
0678-2001	PAV SURF PREP FOR MRK (4")	LF		$0.05	$0.00
0678-2003	PAV SURF PREP FOR MRK (8")	LF	13750	$0.10	$1,375.00
0678-2004	PAV SURF PREP FOR MRK (12")	LF		$0.20	$0.00
0678-2006	PAV SURF PREP FOR MRK (24")	LF	384	$0.40	$153.60
0678-2007	PAV SURF PREP FOR MRK (ARROW)	EA	59	$10.00	$590.00
0678-2018	PAV SURF PREP FOR MRK (WORD)	EA	59	$15.00	$885.00
	SWPPP	LS			$255,208.33
	SIGNING	LS			$218,750.00
	SIGNALIZATION	LS			$90,000.00
SUBTOTAL					$4,553,676.96
20% CONTINGENECY					$910,735.39
TOTAL					**$5,464,400.00**

FORT BEND MEDIANS:

ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL COST
0100-2002	PREPARING ROW	STA	70	$1,000.00	$70,000.00
0105-2060	REMOVING STAB BASE & ASPH PAV(15"-20")	SY	5400	$6.00	$32,400.00
0110-2001	EXCAVATION (ROADWAY)	CY	888.8888889	$5.00	$4,444.44
0132-2006	EMBANKMENT (FINAL)(DENS CONT)(TY C)	CY	1777.777778	$4.00	$7,111.11
0260-2006	LIME TRT (EXST MATL) (6")	SY	16000	$2.00	$32,000.00
0260-2012	LIME (HYD,COM OR QK)(SLRY)OR QK(DRY)	TON	216	$120.00	$25,920.00
0276-2224	CEM TRT(PLNT MX) (CL N)(TY E)(GR 4)(6")	SY	16000	$6.00	$96,000.00
0340-2063	D-GR HMA(METH) TY-C SAC-A PG76-22	TON	880	$75.00	$66,000.00
0360-2003	CONC PVMT (CONT REINF-CRCP)(10")	SY		$30.00	$0.00
0360-2018	CURB (TYPE II)	LF	12800	$3.50	$44,800.00
0432-2001	RIPRAP (CONC)(4 IN)	CY	592.5333333	$325.00	$192,573.33
0500-2001	MOBILIZATION	LS	10%		$58,866.48
0502-2001	BARRICADES, SIGNS AND TRAFFIC HANDLING	MO	2.651515152	$5,000.00	$13,257.58
0666-2036	REFL PAV MRK TY I (W) 8" (SLD)(100MIL)	LF	2250	$0.70	$1,575.00
0666-2042	REFL PAV MRK TY I (W) 12" (SLD)(100MIL)	LF		$2.00	$0.00
0666-2048	REFL PAV MRK TY I (W) 24" (SLD)(100MIL)	LF	24	$4.00	$96.00
0666-2054	REFL PAV MRK TY I (W) (ARROW) (100MIL)	EA	9	$100.00	$900.00
0666-2096	REFL PAV MRK TY I (W) (WORD) (100MIL)	EA	9	$125.00	$1,125.00
0678-2003	PAV SURF PREP FOR MRK (8")	LF	2250	$0.10	$225.00
0678-2006	PAV SURF PREP FOR MRK (24")	LF	24	$0.40	$9.60
0678-2007	PAV SURF PREP FOR MRK (ARROW)	EA	9	$10.00	$90.00
0678-2018	PAV SURF PREP FOR MRK (WORD)	EA	9	$15.00	$135.00
	SWPPP	LS			$46,401.52
	SIGNING	LS			$39,772.73
	SIGNALIZATION	LS			$0.00
SUBTOTAL					$733,705.48
20% CONTINGENECY					$146,741.10
TOTAL					**$880,400.00**

Appendix D: Analysis of Westheimer and Bellaire Intersections

The study team was asked to do an independent analysis of the Westheimer and Bellaire intersections. The following chapter describes the existing conditions and findings from the analysis of thee two chapters.

INTRODUCTION

In 2005, TxDOT received safety funding for both the SH 6/Westheimer (FM 1093) and the SH 6/Bellaire intersections. This money was earmarked for grade separations to be built in place of the existing at-grade intersections. Most of the time, plans or projects under construction are treated as the base condition (as if they are already in place). In the case of SH 6/Westheimer and SH 6/Bellaire, the Transportation Policy Council (TPC) asked H-GAC to look further into the safety and operational issues surrounding these two intersections.

The following sections detail the existing intersection operations and safety issues and discuss the Design Concepts.

WESTHEIMER EXISTING CONDITIONS AND DESIGN CONCEPTS

Existing Conditions

The following section describes the existing lane configuration, traffic volumes, and crash data for Westheimer.

Lane Configuration

The intersection of SH 6/Westheimer is currently an at-grade signalized intersection with the following lane assignments:

- Both approaches on SH 6 (which runs north-south) have six approach lanes – two left-only, three straight-only, and one right-only.
- Both approaches on Westheimer (which runs east-west) have five approach lanes – one left-only, one left-or-straight, two straight-only, and one right-only

Traffic Volumes and Turning Movements

In conjunction with the SH 6 Access Management Plan, turning movement counts were made. Due to the extremely high volumes observed on Westheimer, an additional count was made. Figures 1 through 3 depict the observed peak hour volumes at both SH 6/Westhiemer and SH 6/Bellaire.

At Westheimer, particularly for the eastbound-to-northbound left-turn movement during the AM peak hour, this intersection has extremely high turning volumes. An initial turning movement count was made at SH 6/Westheimer by C. J. Hensch & Associates, Inc. (CJH) on Wednesday, January 10, 2007. Based on that count, the eastbound-to-northbound volume during the AM peak was 1,251 vehicles per hour (VPH).

Other left-turn movements that are also high include:

- During the AM and PM peaks, the southbound-to-eastbound left-turn movement has a volume of about 500 VPH.
- During the PM peak, the westbound-to southbound left turn has a volume of about 500 VPH.

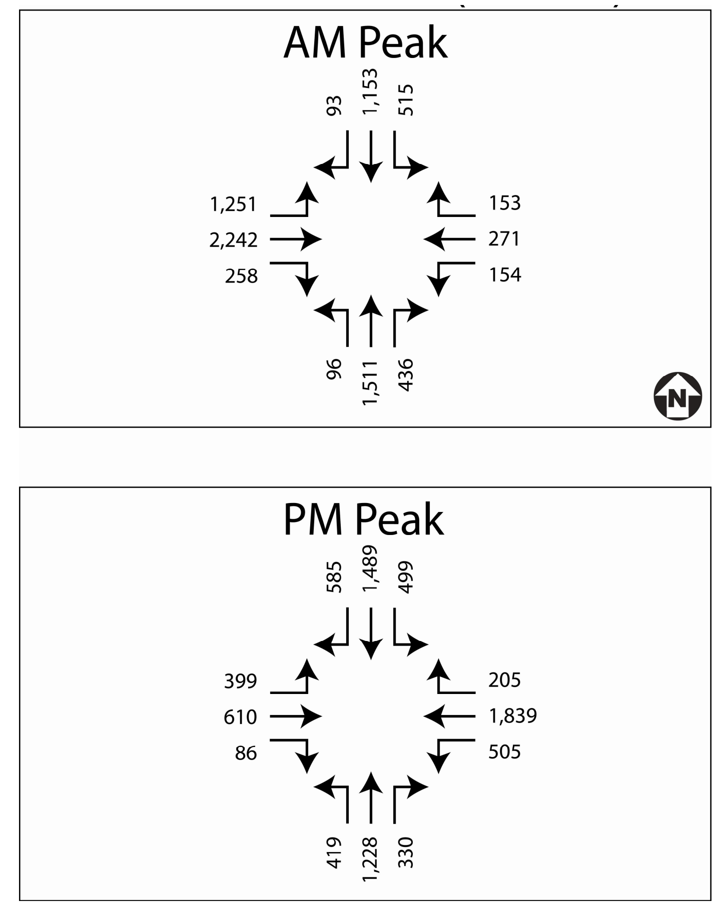


Figure 1 Original Westheimer Turning Movement Counts (01-10-07)

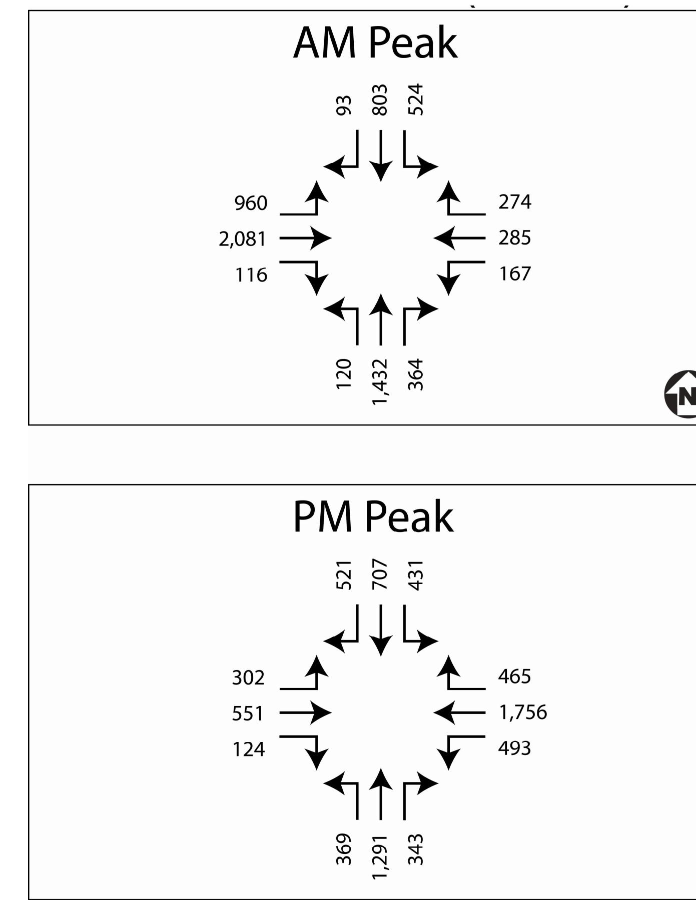


Figure 2 Second Westheimer Turning Movement Count (06-28-07)

EXISTING OPERATIONS

In both directions on SH 6, the left turns operate in protected-only mode (i.e. left turns can be made only during the green arrow of the protected turn phase). However, the left turns and the opposing through movements can be independently timed as part of a dual-ring traffic signal sequence.

On Westheimer, a split-phased traffic signal sequence has to be used since left turns are allowed from a shared lane. All traffic in the eastbound direction moves while all westbound traffic faces a red signal and all traffic in the westbound direction moves while all eastbound traffic faces a red signal.

As compared with a dual-ring sequence, a split-phased signal sequence has several disadvantages. With respect to vehicular traffic, the left-turn and straight-through movements have to receive the same amount of green signal time regardless of their respective volumes. The accommodation of pedestrians is substantially less efficient because a "walk" signal cannot be displayed at the same time on the parallel crosswalks.

As previously noted, the left turns from Westheimer onto SH 6 have just one dedicated "left-only" lane plus one shared "left or straight" lane. As such, a left-turn volume of 1,251 VPH seemed extremely high. As modeled in Synchro™, the volume-to-capacity (v/c) ratio for the eastbound approach would be on the order of 1.4. Because of this, it was decided that a second turning movement count should be made. CJH made the recount on Thursday, June 28, 2007, as shown above in Figure 2.

CRASH DATA

Since the grade separations were proposed using safety funding and the crash data were from 1999-2001, it was asked if the problem still existed. Although both intersections were included as part of the team's "hot spot" analysis, additional crash data were gathered from June 2002 to June 2007.

During this time period, 388 confirmed crashes were reported on SH 6 within one-half mile north and south of Westheimer. This resulted in a very high crash rate of 5.00 per million vehicle miles traveled where as the average for the corridor is 1.86 per million vehicle miles traveled.

Crash types and severity

As shown in Figure 3, 22% (or 85) of the crashes were major injury, 70% (or 272) were minor injury, and 8% (or 31) were of unknown severity. The types of crashes were as follows:

- 20% were driveway crashes (vehicles entering or exiting)
- 23% were right-angle crashes
- 48% were rear-end crashes

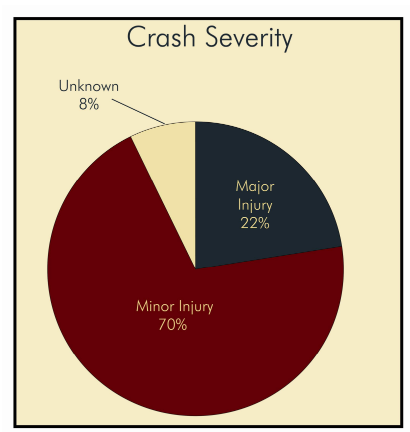


Figure 3: Westheimer Crash Severity

This rear-end collision type often tells a story of congestion, however the large amount of injuries may be linked to speeding or right-angle "driveway" related collisions.

Crashes By Time of Day

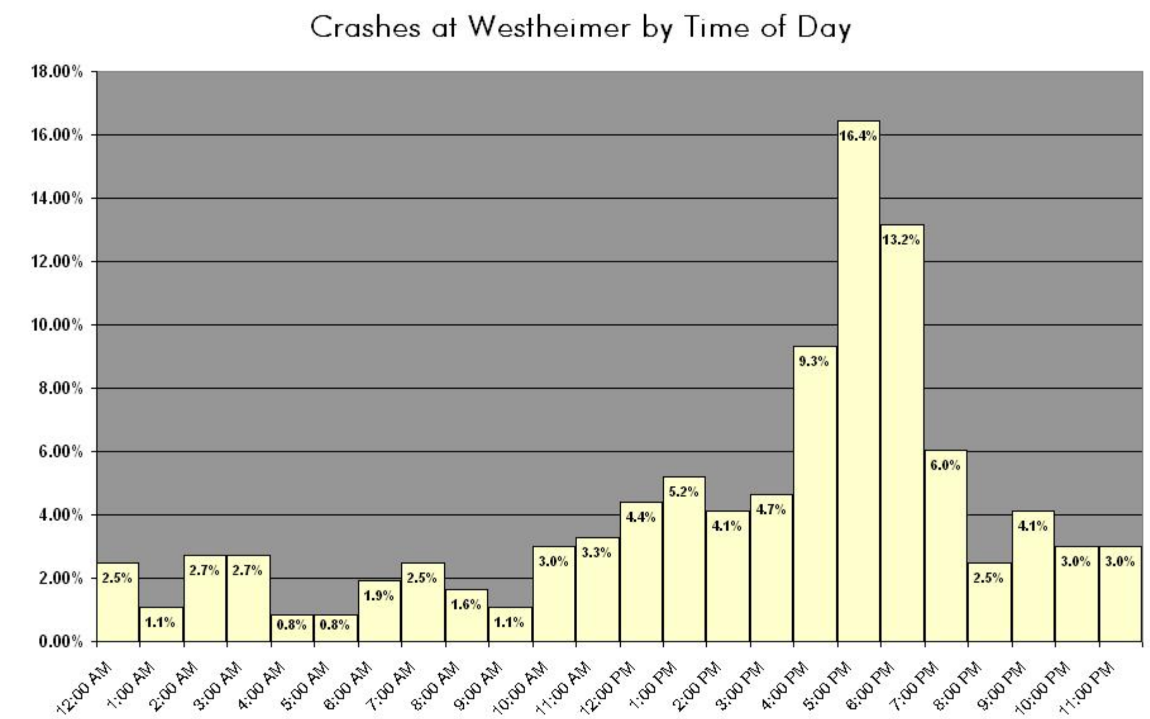


Figure 4 Westheimer Crashes by Time of Day

Crash locations

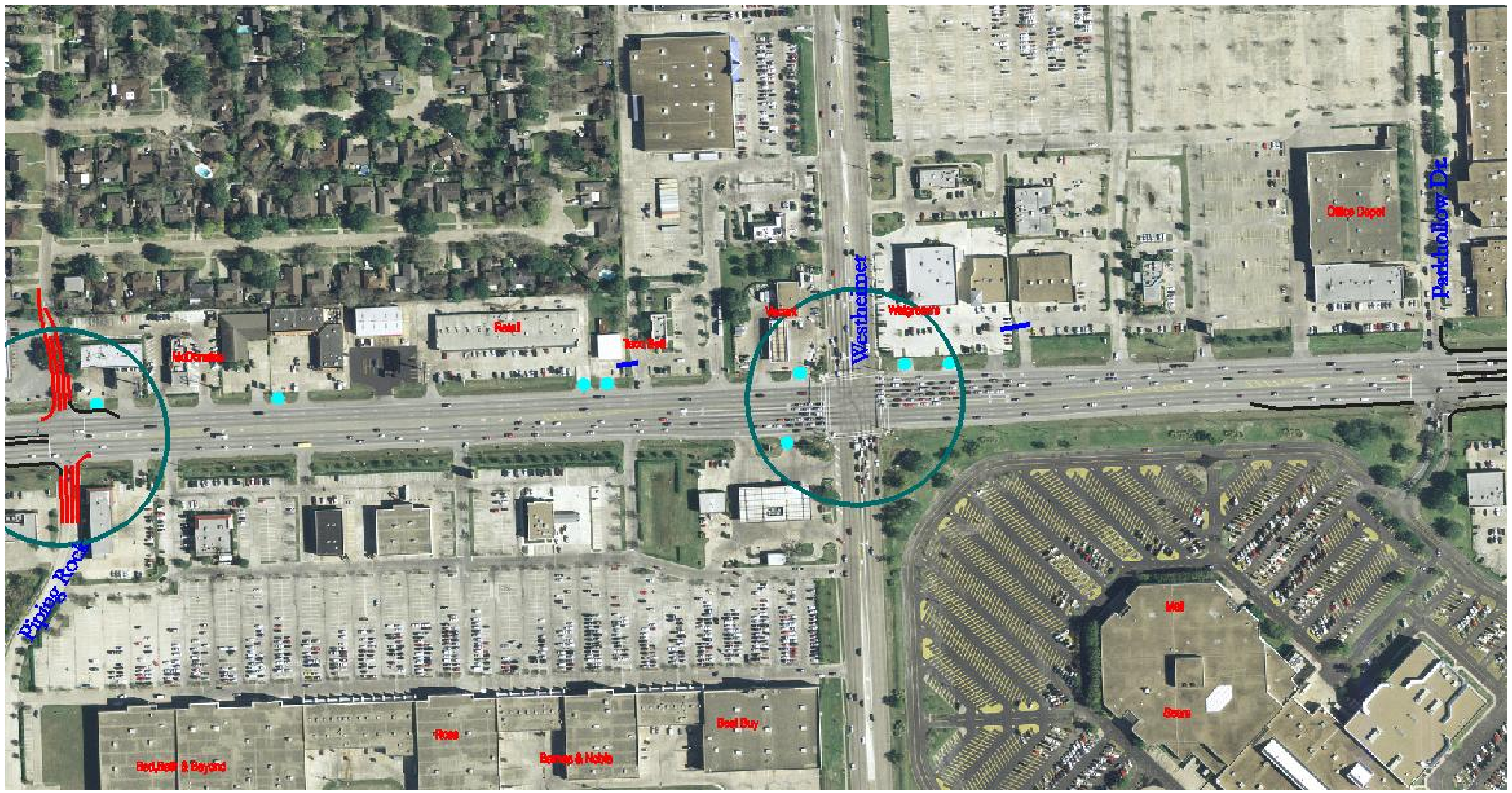
Of the 388 crashes that occurred at Westheimer, 21% (or 82) crashes occurred in the intersection and 55% (or 213) crashes occurred within a one block radius of the intersection.

Some collisions that occur outside of the intersection itself may still be intersection related, such as a rear end that occurred because of queuing at the traffic signal.

Design Concepts

Three design concepts were evaluated for their ability to reduce the number of crashes while also reducing congestion. These concepts are (1) no-build, (2) designing and constructing raised medians to mitigate the crash experience, and (3) adding a grade separation. We will discuss each design concept in terms of traffic operations and crash mitigation ability for each intersection. The Synchro™ signal timing optimization software was used to perform an operational assessment at all of the corridor's signalized intersections. For these two intersections, this analysis was taken further to test alternative intersection designs to achieve a preferred level of service.

Westheimer No-Build



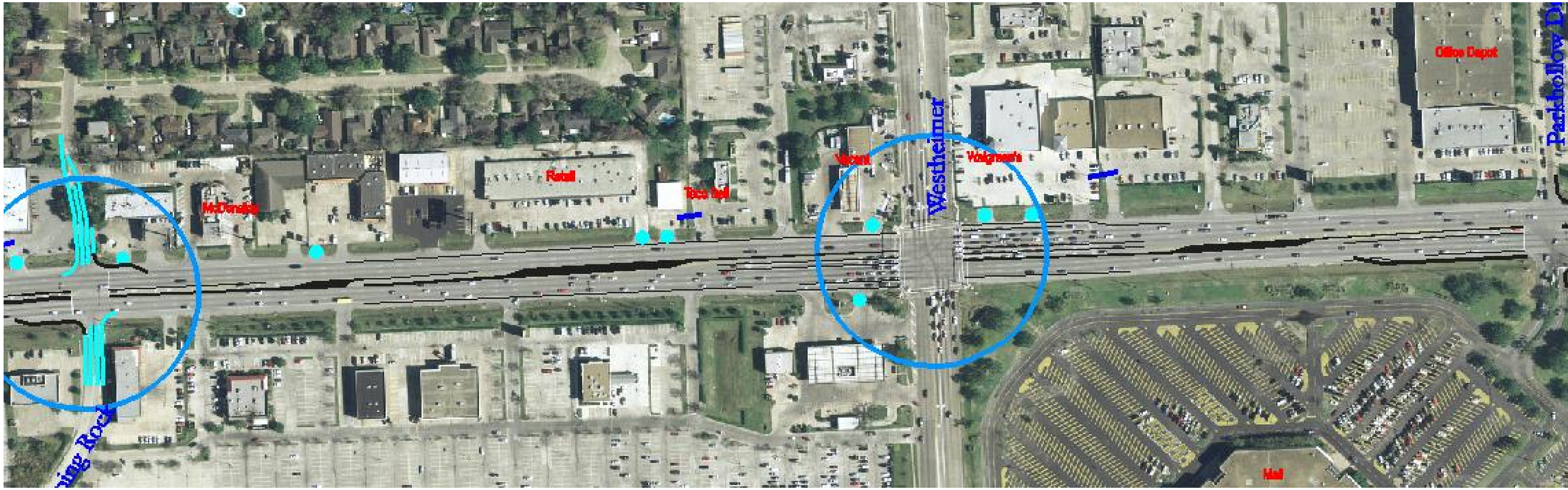
Operations

The intersection is currently operating at a level of service of F in the AM and F in the PM. The volume to capacity ratios as modeled in Synchro are 1.52 and 1.24 respectively.

Safety

No crashes are mitigated.

Westheimer Median Concept



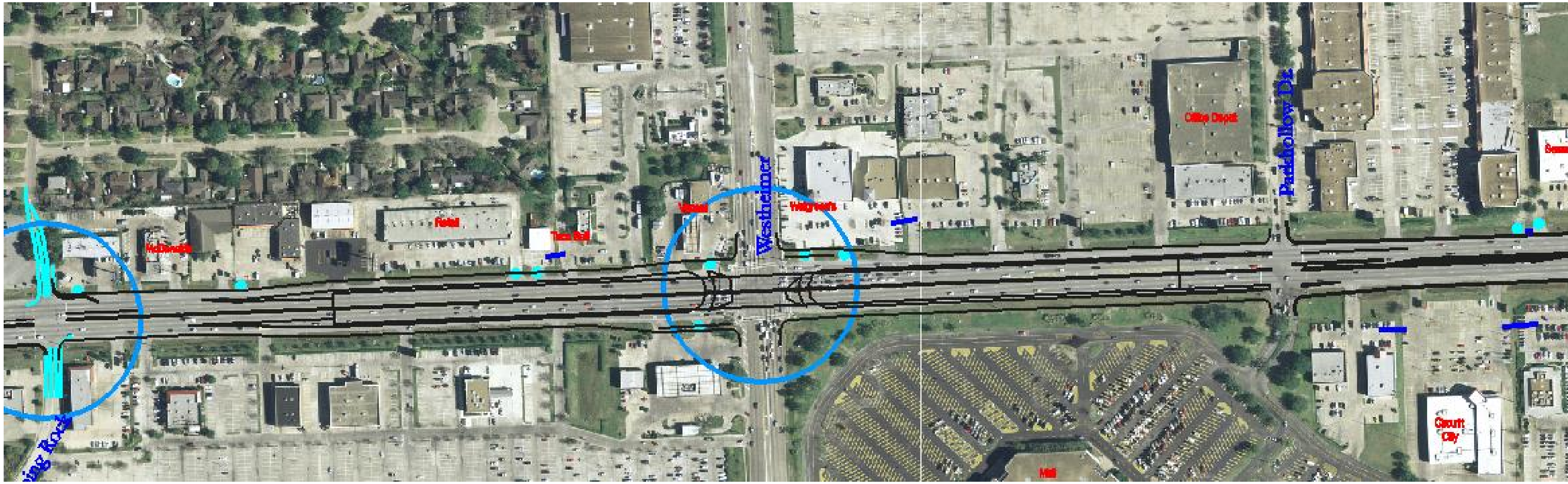
Operation

If the at grade intersection were widened to maximize capacity through the expansion of six lanes of traffic (two left-only, three through-only, and one right-only) the level of service still be F in the AM but improve to E in the PM. In both cases, the V/C ratios become lower (1.22 and 1.11 respectively).

Safety

This concept could potentially mitigate 54 crashes. To calculate the improvement of adding medians the team used the National Cooperative Highway Research Program (NCHRP) Report that concluded by constructing a median rather than a two way left turn lane, crash rates can be reduced by a minimum of 14% along a roadway segment. Therefore, the consultant team used a reduction of 14% for the entire one mile segment analyzed.

Westheimer Grade Separation Concept



Operations

Based on this modified design, the Synchro™ analyses can be summarized as follows:

- For the AM peak hour, the v/c ratio for the eastbound through movement will be 1.03 based on the original count and 0.95 based on the recount. The estimated signal delay will be 62.5 vehicle-hours based on the original count and 54.1 vehicle-hours based on the recount.
- For the PM peak hour, the v/c ratio for the westbound through movement would still be 1.02 based on the original count and 0.94 based on the recount. The estimated signal delay will be 69.1 vehicle-hours based on the original count and 55.2 vehicle-hours based on the recount.

As seen from the high v/c ratios, this design concept will improve operations for some time, but some type of innovative intersection design will be needed as a long-range solution to handle the traffic demands. Examples may include direct connectors, a Single Point Urban Interchange (SPUI), and other techniques.

Safety

The types of crashes that will be reduced by a grade separation are largely intersection related. By removing volume from the existing intersection, research tells us that crash frequency will reduce in the following categories: right-angle, rear-end, and failure to yield (turning movements). Under this design concept 144 crashes could be mitigated.

Bellaire Existing Conditions and Design Concepts

Existing Conditions

The following section describes the existing lane configuration, traffic volumes, and crash data for Bellaire.

Lane Configuration

The intersection of SH 6/Bellaire is also currently an at-grade signalized intersection with the following lane assignments:

- Both approaches on SH 6 have five approach lanes – one left-only, three straight-only, and one right-only.
- Both approaches on Bellaire have three approach lanes – one left-only, one straight-only, and one straight-or-right.

Traffic Volumes and Turning Movements

For Bellaire we used traffic volumes that were collected in September 2004. The 24-hour volumes provide historical traffic growth data to allow us to be confident that these numbers are reasonable. Even without applying a growth rate to these numbers, this intersection experiences delays in the peak periods.

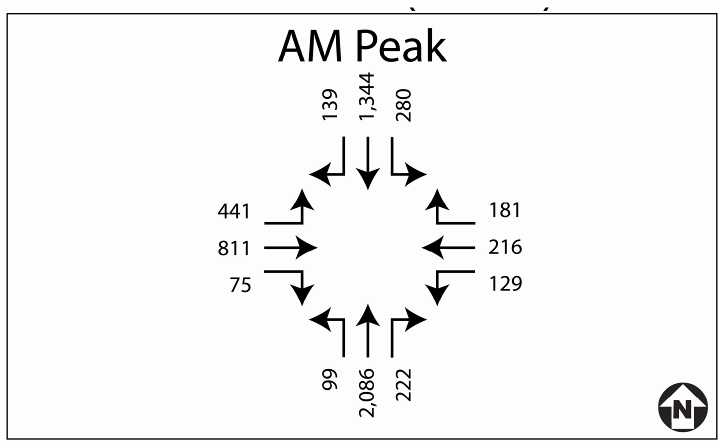


Figure 5 Bellaire AM Counts (09-01-04)

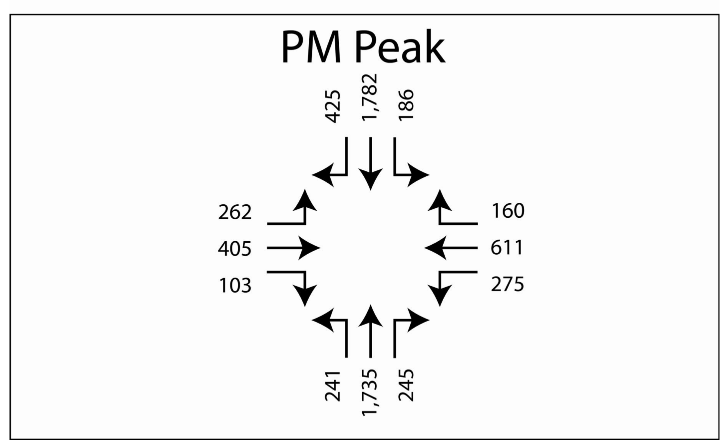


Figure 6 Bellaire PM Counts (09-01-04)

Existing Operations

At Bellaire, a split-phased signal sequence is used for the eastbound and westbound approaches. Because of moderate traffic volumes, this intersection does not present as severe of operational constraints as Westheimer. However, the intersection does reflect a V/C ratio greater than 1.0, which is considered failing.

Crash Data

Information was also collected for the SH 6/Bellaire intersection for the same time period (June 2002 – June 2007). During that time, 479 crashes were reported on SH 6 within one-half mile north and south of Bellaire. Again, this resulted in a very high crash rate of 6.56 per million vehicle miles traveled, while the corridor average crash rate was 1.86 per million vehicle miles traveled. Although the historic data demonstrated that Westheimer experienced more collisions, the new data gave a different story. This largely has to do with the data itself. The data for the Bellaire intersection were received with specific location information. As such, there was no reason to exclude any of the collisions from the data set. The major types of collisions were the following:

- 39% were driveway crashes (vehicles entering or exiting)
- 33% were right-angle crashes
- 25% were rear-end crashes

Fifty-five percent of the accidents occurring at this location were property damage only (PDO). This location has less severe crashes than Westheimer, but is still problematic from a crash rate perspective.

Crashes by time of day

Crash locations

Of the 479 crashes that occurred at Bellaire, 14% occurred in the intersection and 45% occurred within a one block radius of the intersection (inclusive of the intersection crashes, 33% without the intersection crashes).

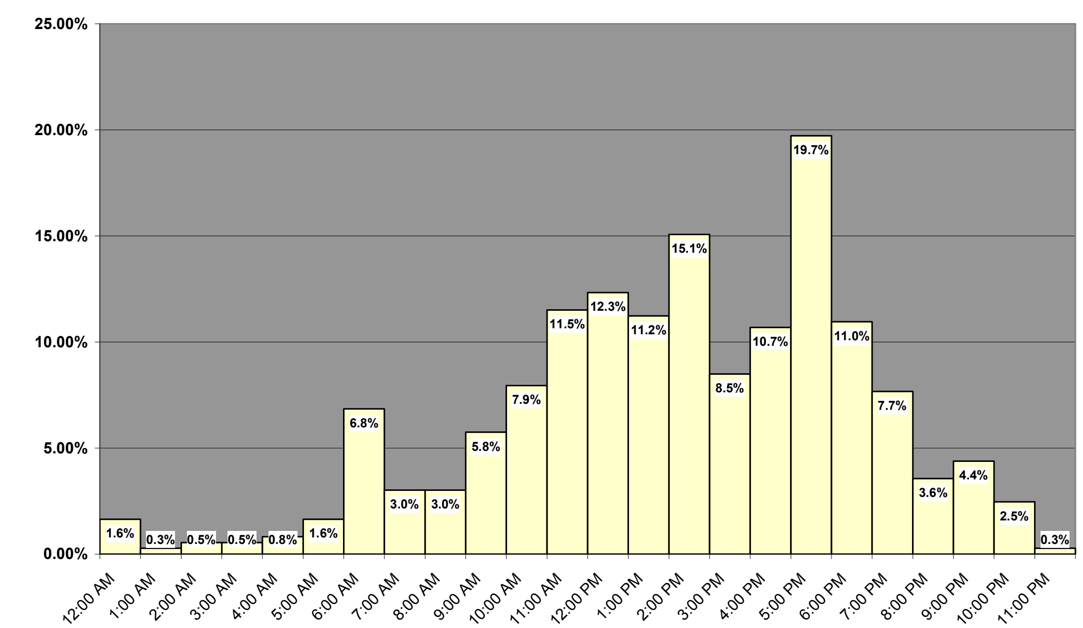


Figure 7 Bellaire Crashes by Time of Day

Bellaire Design Concepts

Three design concepts were evaluated for their ability to reduce the number of crashes while reducing congestion. The concepts were (1) no-build, (2) designing and constructing raised medians to mitigate the crash experience, and (3) adding a grade separation. We will discuss each design concept in terms of traffic operations and crash mitigation ability for each intersection. The Synchro™ signal timing optimization software was used to perform an operational assessment at all of the corridor's signalized intersections. For these two intersections, this analysis was taken further to test alternative intersection designs to achieve a preferred level of service

Bellaire No-Build

Operations

The intersection is currently operating at a level of service of F in the AM and E in the PM, with a V/C ratio of 1.16 and 1.10 respectively.

Safety

No crashes are mitigated.

Bellaire Median Concept

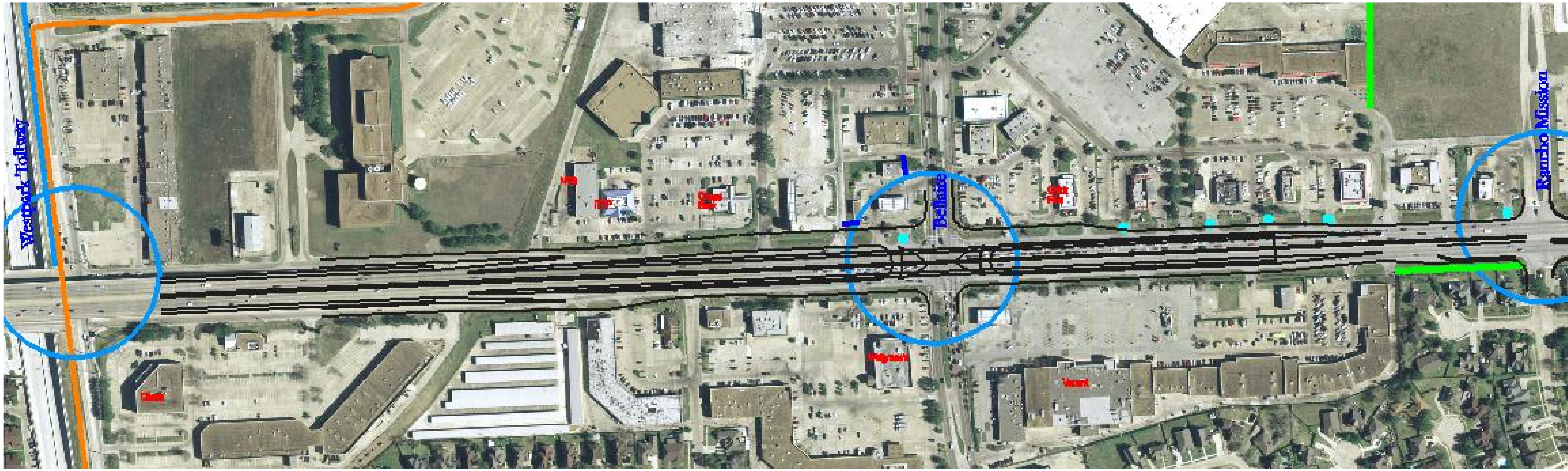
Operations

If the intersection were built at-grade to maximize the capacity, including dual left turn lanes at all approaches, the level of service improves to D in the AM and D in the PM, with V/C ratios of 0.98 and 0.92 respectively. While the levels of service are reduced in this concept with a 3% annual growth in traffic volumes, this concept will only operate effectively for a short period of time.

Safety

This concept could potentially mitigate 67 crashes. To calculate the improvement of adding medians the team used the National Cooperative Highway Research Program (NCHRP) Report that concluded by constructing a median rather than a two way left turn lane, crash rates can be reduced by a minimum of 14% along a roadway segment. Therefore, the consultant team used a reduction of 14% for the entire one mile segment analyzed.

Bellaire Grade Separation Concept



Operations

This concept produced a level of service of D in the AM and D in the PM, with V/C ratios of 0.86 and 0.83 respectively.

Safety

The types of crashes that will be reduced by a grade separation are largely intersection related. By removing volume from the existing intersection, research tells us that crash frequency will reduce in the right-angle, rear-end, and failure to yield (turning movements) categories. Under this design concept, 258 crashes could be mitigated. To calculate the effects of the grade separation the team assumed that the crash rate would remain constant at the intersection, but that the grade separation would remove 80% of the through volume from State Highway 6. Therefore when calculating the improved crash frequency, the consultant team adjusted their at grade traffic volume, but continued to use the high, conservative, crash rate. Research was available that suggests that up to 80% of the collisions occurring at an intersection could be relieved through the construction of a grade separation. However, the consultant team felt that a more conservative site specific analysis should be completed due to the complexity of the collisions at these intersections.

Conclusions

With more than 388 confirmed crashes at Westheimer and 479 crashes at Bellaire, these two intersections have the highest concentration of crashes in the entire corridor. It is apparent that some improvement needs to be made to reduce the frequency and severity of the crashes at both of these intersections. The challenge becomes to find the best solution at these intersections.

As discussed in this section, the operational challenges are particularly challenging at Westheimer. Other than optimizing the timing by eliminating the eastbound and westbound split-phases, the at-grade options are limited and provide only modest relief. At Bellaire, some widening can occur and would provide noticeable congestion relief for sometime.

As stated in the introduction of this section, most planned and funded improvements are taken and used as our baseline condition. In this case, the situation is more complex with business and neighborhood concerns for loss of business and neighborhood integrity. To further complicate the situation, TxDOT has already been awarded funding to build both grade separations.

From a purely technical standpoint, building the grade separations would provide for the highest levels of congestion relief, as can been seen in Figures 8 and 9. Also, in terms of crash mitigation, the grade separations remove the greatest amount of crashes (see Figures 10 and 11). If the safety money for the grade separations is at all flexible, working with the businesses and neighborhoods to come up with the best possible solution would be desirable. This might entail looking at several other options such as an underpass, additional ramps to access businesses, and direct connectors for the left turn movements, just to name a few.

Throughout this segment of SH 6, it was observed that some drivers are using roadside shoulders as acceleration/deceleration lanes, regardless of whether the shoulder is striped or not. At some driveways, it was observed that exiting drivers will pull out into the shoulder area to have greater sight distance of oncoming traffic. For right turns from SH 6 main lanes, some drivers use the existing shoulder as a right turn lane, while others turn from the main lanes. Based on these observations, it is recommended that designated right-turn lanes be striped for major intersections along this segment, including at Piping Rock Lane, Park Hollow Drive, and Richmond Avenue. In addition, designated right turn lanes should be striped for entrances into major shopping centers.

Transportation Policy Council (TPC) Ruling

On November 16th 2007 the TPC elected to not go with staff recommendation of implementing the grade separations. Instead, raised medians plus at-grade intersection improvements will be developed.

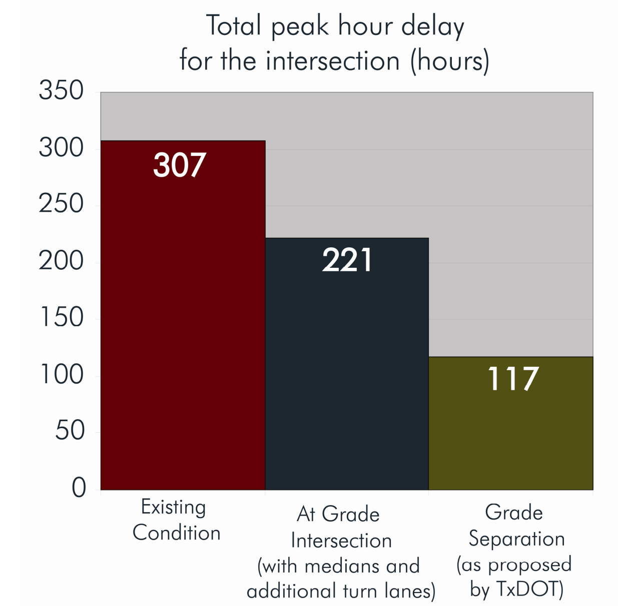


Figure 8 Westheimer Peak Hour Total Intersection Delay

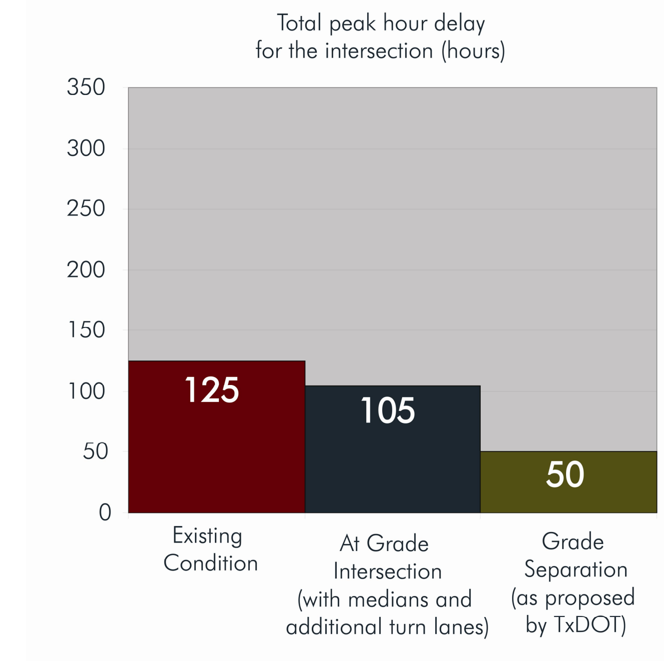


Figure 9 Bellaire Peak Hour Total Intersection Delay

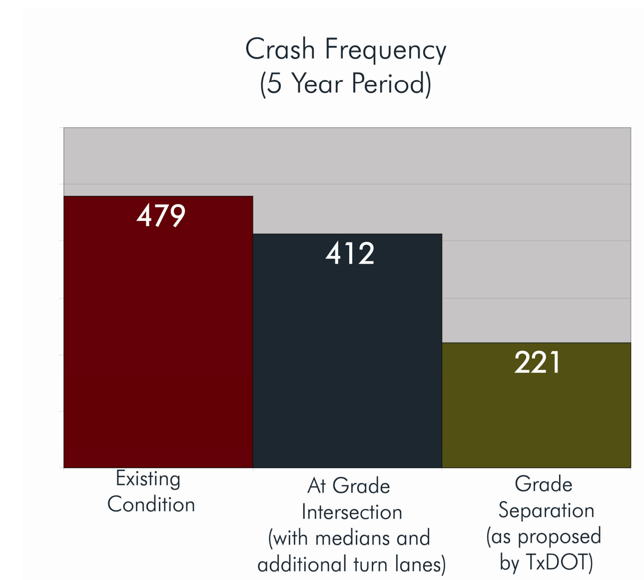


Figure 10 Potential Bellaire Crash Reductions

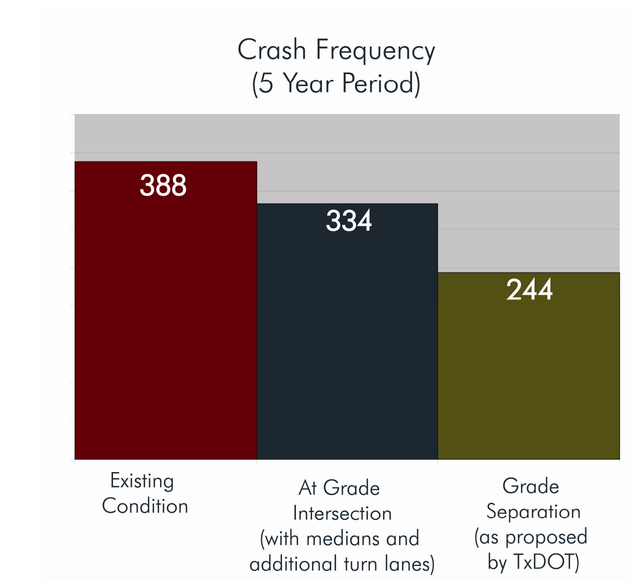


Figure 11 Potential Westheimer Crash Reductions