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of Transportation  
**Federal Highway  
Administration**

**Texas Division**

December 12, 2018

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In Reply Refer To:  
HTA-TX

City of Houston Pedestrian and Bicycle Road Safety Audit

Mr. Jeffrey S Weatherford, P.E., PTOE  
Director of Transportation & Drainage Operations  
Houston Public Works  
City of Houston  
611 Walker St 25th Floor, Houston TX 77002

Dear Mr. Weatherford:

Enclosed for your use is the City of Houston Pedestrian and Bicycle Road Safety Audit conducted by the Federal Highway Administration (FHWA) with assistance from the Houston Public Works and other partners. The report includes recommendations for improving pedestrian and bicyclist safety at six intersections from Mayor Turner's Safer Street Initiative. The remaining six intersections of the Safer Street Initiative will be addressed in a future Road Safety Audit.

When Houston Public Works has completed its response to the recommendations, please retain both documents in your associated files, and provide me with a copy. If needed, FHWA is available to provide further technical assistance to help implement the recommendations. We look forward to continuing to work with the City of Houston to advance pedestrian and bicyclist safety.

If you should have any questions or concerns, please call me at (512) 536-5924.

Sincerely yours,

Stephen Ratke, P.E. (NV)  
Safety Engineer

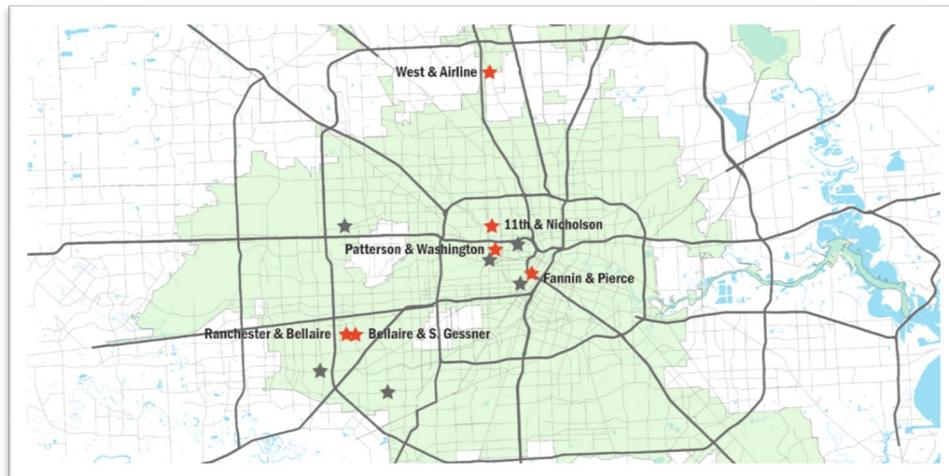
Enclosure

cc: Ian Hlavacek, P.E., Houston Public Works

**Houston Safer Streets Initiative  
Top 12 Intersections  
Pedestrian/Bicycle Road Safety Audit  
First Six Locations**

Conducted:  
**September 24 - 28, 2018**

At the Request of:  
**City of Houston**



Facilitated By:  
**Stephen Ratke – Safety and Traffic Operations Specialist  
FHWA Texas Division  
&  
Keith Sinclair - Transportation Specialist  
FHWA Resource Center  
Safety and Design Technical Service Team**

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## Background

At Bike to Work Day on May 18, 2018 and again at the State of Mobility address on May 24, Mayor Sylvester Turner invited BikeHouston and fellow advocates to help the City of Houston identify the ten highest priority intersections for improving pedestrian and bicyclist safety. LINK Houston partnered with BikeHouston to respond to Mayor Turner's request and provided the City with two lists of potential high priority intersections.

LINK Houston analyzed motor vehicle crashes involving pedestrians and bicyclists from January 1, 2013 to December 31, 2017 to equitably identify priority intersections across Houston. The underlying crash data was from the Texas Department of Transportation Crash Records Information System. Crash injury severity and death were weighted based on U.S. Department of Transportation Value of Statistical Life guidance (e.g., the value of preventing a death is \$9.6 million) and then attributed to intersections. Intersections were ranked based on the cumulative impacts to pedestrian and bicyclists over the five-year period. Analysis of the ten highest priority intersections was presented to the City of Houston and Mayor Turner prioritized the seven bolded intersections:

- 1. Fanning & Pierce**
- 2. Rancheater & Bellaire**
3. Westheimer & S Dairy Ashford (TxDOT Facility)
- 4. Long Point & Gessner**
5. Westpark Dr. & U.S. 59 South (TxDOT Facility)
6. Old Spanish Trail & U.S. 288 South (TxDOT Facility)
- 7. Fondren & West Bellfort**
- 8. Bissonnet & Wilcrest**
- 9. West & Airline**
- 10. Bellaire & Gessner**

BikeHouston used a member survey to ascertain where cyclists feel unsafe crossing Houston's streets. Survey findings were presented to the City of Houston and Mayor Turner prioritized the five bolded intersections:

1. Sunset & Main & Fannin\*
- 2. Shepherd & Allen Pkwy & Kirby**
- 3. Taylor & Spring & MKT Trail**
- 4. 11th St & Nicholson**
5. West 610 & Woodway & Arbor Trail
6. Houston & Spring & MKT Trail\*
- 7. Hawthorne & Spur 527 & Holman**
- 8. Patterson & Washington**
9. Waugh/Heights & Memorial
10. Wesleyan & Westpark/US 59
11. Morningside & Bellaire

*\* The City and partners have current projects to address known safety concerns at these locations.*

In July 2018, Mayor Turner prioritized twelve intersections for the Safer Street Initiative by selecting seven intersections put forward by LINK Houston and five intersections put forward by BikeHouston.

Mayor Turner then directed City of Houston staff to investigate corrective measures at the twelve locations. Potential corrective measures were to include infrastructure repairs or improvements, but also more effective law enforcement and public education. With the recommendation of advocates, the City reached out to the Federal Highway Administration to invite their assistance to perform a multi-disciplinary Road Safety Audit (RSA). This RSA considered the first six locations of the top 12 intersections list, and the remaining six will be studied in a later effort.

The Federal Highway Administration's (FHWA) Office of Safety established RSAs to improve the overall safety performance of roadways. A RSA is a comprehensive formal safety performance evaluation on an existing or future road segment or intersection performed by an independent and multidisciplinary team. RSAs are a low-cost proactive approach to safety which considers all road users and identifies opportunities to enhance safety and reduce the number and severity of crashes. A pedestrian and bicyclist focused Road Safety Audit is a specialized type of RSA intended to focus on pedestrian and bicyclist safety issues. In addition to pedestrian and bicyclist safety, the RSAs documented here also consider safety and operational conditions for motor-vehicles, and transit vehicles and users.

### Road Safety Audit Team:

- Houston Public Works (HPW)
  - Ian Hlavacek, P.E.
  - Ahmad Ahadi, P.E.
- Houston Police Department
  - Capt. Kevin Deese
- Houston METRO
  - Gary Scott
- Texas Department of Transportation (TxDOT)
  - Isaiah Mora
- LINK Houston
  - Jonathan Brooks
- BikeHouston
  - Jessica Wiggins
- Federal Highway Administration (FHWA)
  - Stephen Ratke, P.E. (TX Division Office)
  - Keith W. Sinclair (Resource Center)



Figure 1: RSA Team discussing during the review.

## RSA Project Location:

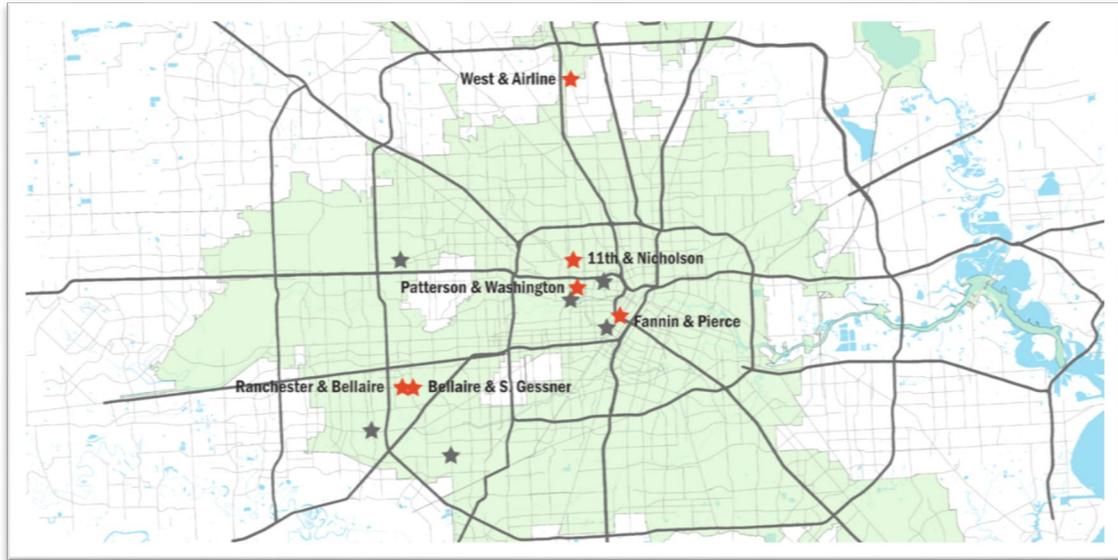


Figure 2: Top 12 Pedestrian and Bicycle Intersections. Selected locations for this RSA are highlighted with red stars.

## Kick Off Meeting

The RSA kickoff meeting was held at the Houston TranStar office. The kick off meeting included City of Houston Planning and Development Department staff, TxDOT Houston District staff, FHWA staff, LINK Houston, BikeHouston, and the RSA team (see Appendix A for a list of attendees). After initial introductions Stephen Ratke of FHWA presented the eight steps of a RSA and introduced the RSA team. Ian Hlavacek then presented an overview of Mayor Turner's Safer Streets Initiative and the six locations chosen for this RSA. The meeting concluded with comments from attendees for the team to consider while conducting the review.



Figure 3: Kick off meeting (LINK Houston)

## Site Visits

The RSA team visited the intersections on the following days and times:

- West at Airline:
  - 9/24: 5:30pm – 6:30pm (PM peak)
  - 9/25: 6:00am – 7:30am (night, AM peak, school arrival)
  - 9/26: 2:30pm – 3:30pm (school dismissal)
- Fannin at Pierce:
  - 9/25: 9:45am – 10:30am (midday)
  - 9/25: 7:45pm – 8:00pm (night drive through)
  - 9/26: 4:00pm – 4:45pm (PM peak)
- Bellaire at Ranchester and Bellaire at Gessner (conducted jointly as a corridor)
  - 9/25: 1:30pm – 4:30pm (midday, school dismissal, PM peak)
  - 9/26: 7:30pm – 8:30pm (night)
- Washington at Patterson:
  - 9/24: 7:30pm – 8:15pm (night)
  - 9/25: 10:45am – 11:30am (midday)
- 11<sup>th</sup> at Nicholson:
  - 9/26: 6:30am – 7:15am (night / AM peak)
  - 9/27: 2:00pm – 2:45pm (midday)

## Close Out Meeting

A close out meeting was held with City of Houston Planning and Development Department staff, City of Houston Public Works staff, TxDOT Houston District staff, and the RSA team on September 28<sup>th</sup> at Houston TranStar. The RSA team presented initial findings from the previous four days' work and received feedback from attendees. Conclusions from the close out meeting along with additional information received after the RSA work are reflected in this report.

## The Positives

The RSA team observed many positive features at the six intersection sites. The City of Houston, METRO, and others (e.g., management districts) are already delivering projects to improve pedestrian and bicycle accommodations at many of the locations. The existing intersections are pedestrian accessible with varying levels of accommodation. Pedestrian countdown signals and Accessible Pedestrian Signal (APS) pushbuttons are present at the signalized intersections. Sidewalks are in place along most of the approach legs and on both sides of the street. Street lighting is generally good



Figure 4: Pedestrian and bicycle activity at West and Airline.

at all sites. Crash data and traffic volumes are available for all of the sites and was used to help formulate the recommendations in this report. People are present on the streets throughout the day, which reflects the demand for pedestrian accommodations and safety; and there are connections to walking generators such as schools, bus stops and transfers, restaurants, shops, hotels, and apartment complexes. Most of the sites had frequent, well-used bus services with stops located near the intersection. The Bellaire corridor features a regular bus route and an enhanced service, limited-stops bus route to serve the high volumes of users on the corridor.

## Primary Concerns

The six locations studied by this RSA team represent a diverse set of conditions throughout the City of Houston from downtown one-way streets to core neighborhoods to more suburban areas further away from the city's core. All six of the locations were identified as having some concern over the safety and ease of use for pedestrians and bicyclists, using a combination of crash data, feedback from BikeHouston and LINK Houston, and other sources. Most of the sites have frequent bus routes with strong bus ridership, along with the associated need to cross the street for access to transfers, businesses, schools, or residences nearby. Most of the locations had nearby commercial developments that generated additional pedestrian and bicycle use, particularly between the commercial activity and the bus stops. All of the locations had noted concerns with motor vehicle travel speeds. Two of the locations were considered critical points of crossing as part of regional bicycle networks or planned networks. Three locations had nearby high schools that affected the operations and the type of roadway users during the before and after school periods of each day. Three of the locations with signals included protected signal phasing for left turns and overlap phases for some right turns. Motor vehicle drivers were frequently aggressive in making turning movements including entering the intersection on yellow (and red) and making right turns without yielding to pedestrians (see Figure 5). Pedestrians observed during the study

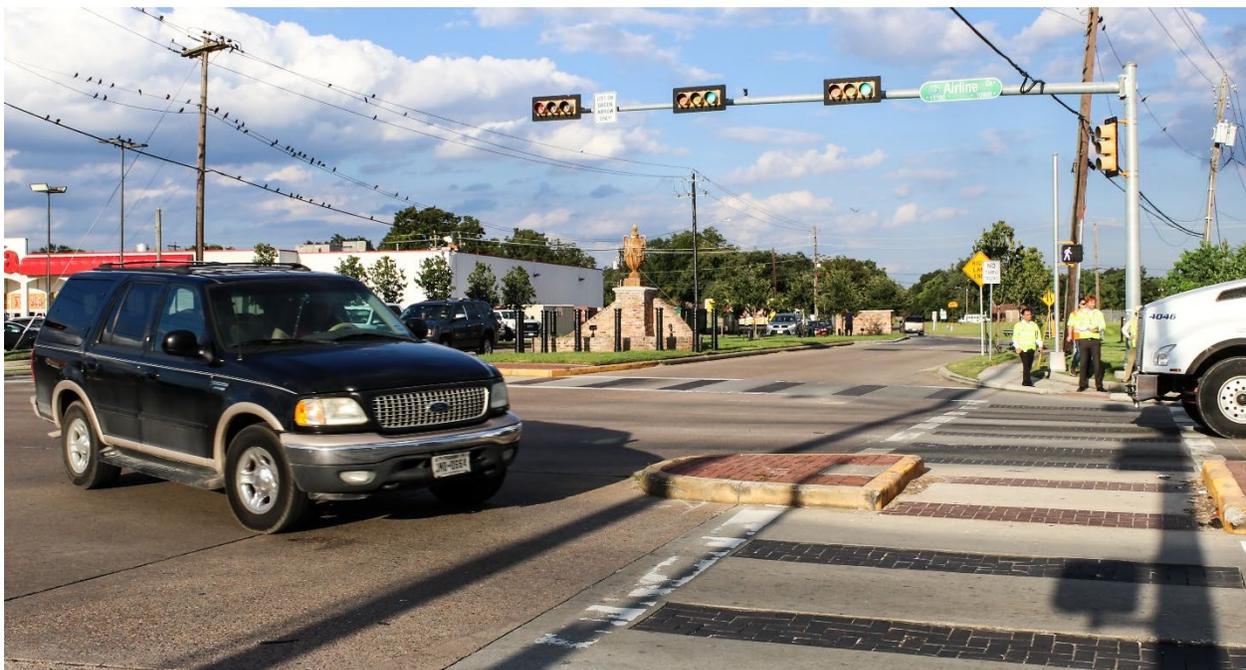


Figure 5: A vehicle travels through the intersection after the start of the opposing green signal and walk indication start.

rarely used the pushbuttons and frequently crossed to a median during left turn phases that don't conflict with the half of the roadway being crossed. Other than the trail crossing location in the Heights, there were no bicycle facilities at the six locations, and bicyclists routinely rode on the sidewalk.

## General Recommendations

### Americans with Disabilities Act (ADA)

Multiple concerns with accessibility were noted at each of the locations. Where pedestrian push buttons were provided, APS buttons had been installed, but in many cases the pushbuttons should be relocated to meet ADA/Texas Accessibility Standards (TAS) accessibility guidelines. Most frequently pushbutton locations were not within the proper reach distance of a level landing pad. Signal timing and phasing should be reviewed and adjusted to ensure that adequate crossing times are given. Curb ramps were a mixture of single and dual ramp designs, even though dual ramp designs are preferred for their ability to direct pedestrians who are blind or visually impaired in a desired direction. Ramp alignment and width could be improved in most locations, and many locations lacked level landing pads.

- Recommendation: All signal timings should be verified to ensure adequate Texas Manual on Uniform Traffic Control Devices (TMUTCD) recommended pedestrian crossing times.
- Recommendation: Upgrade intersections for ADA/TAS compliance:
  - curb ramp alignment and landing pads (see Figure 5),
  - pedestrian pushbutton location,
  - additional ramp width.

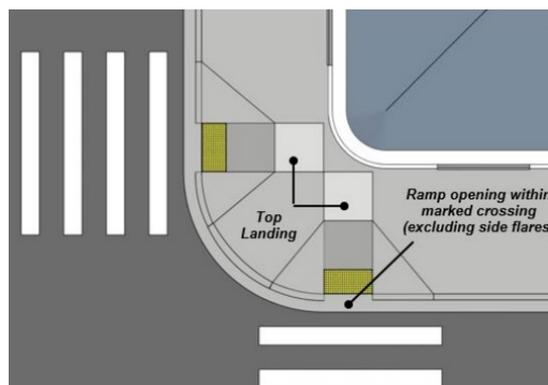


Figure 6: Two ramp corner design (US Access Board)

### Crosswalks

Only one location included high-visibility crosswalk markings, and several made use of pavers that had faded, settled, or otherwise don't contribute to conspicuity of people crossing or ease of use. High-visibility crosswalk markings provide additional information for where drivers should expect to see people walking and are more visible under all conditions (See Figure 7 below). Pavers in crosswalks tend to fade over time and provide little information to drivers in dark conditions, and therefore cannot be used in place of proper pavement markings. Additionally, some pavers were settling within the crosswalk, which may become tripping hazards or present a challenge to someone using a wheelchair.

- Recommendation: All signalized crosswalks should be marked per the TMUTCD.
- Recommendation: At intersections with identified pedestrian safety concerns, high-visibility crosswalk markings should be used.

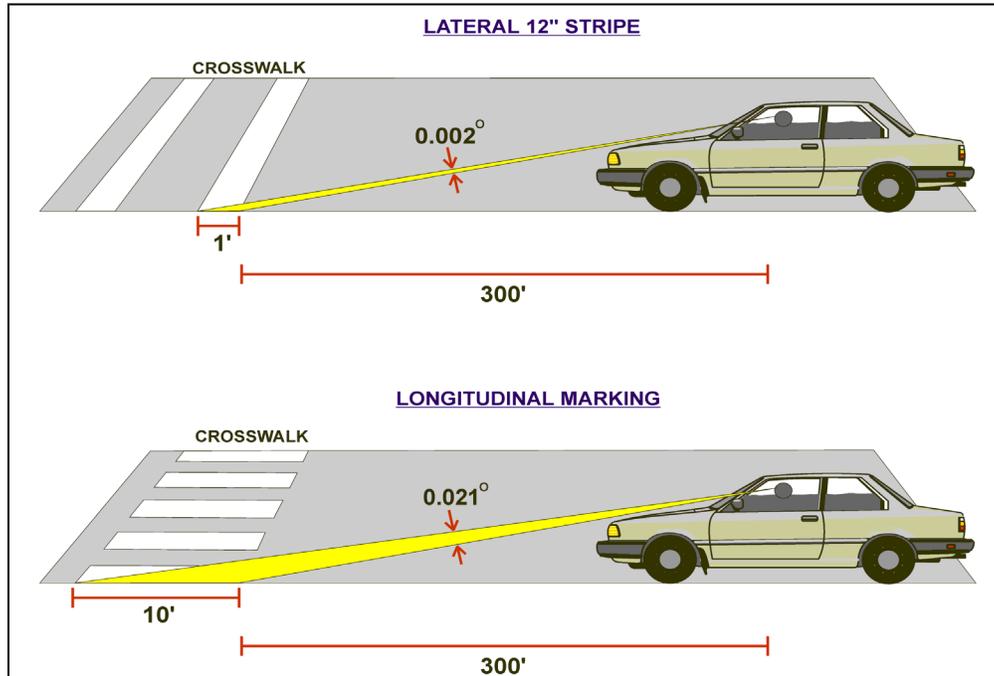


Figure 7: Traditional vs. high-visibility crosswalk markings (FHWA).

### Aggressive Driving and Speed Management

At all locations the RSA team identified concerns with motor vehicle speeds and conflicts between vehicles and pedestrians and bicyclists. At the signalized intersections many drivers were aggressive when making turning movements and created additional conflicts with pedestrian movements. The RSA team observed multiple drivers entering the intersection at high speeds under the yellow and red phases of a protected left turn. In some cases, the left turn movements were associated with queues that did not completely dissipate during each cycle (see Figure 8), so retiming the signal phases may ease some of the aggressive driving behaviors. Drivers were observed turning right at the intersections between groups of people walking, failing to look right before turning right on red, and proceeding into the intersection when the turn was blocked by pedestrians. In several cases, drivers honked their horns or made rude gestures at pedestrians and bicyclists who had the legal right of way in front of the driver. Speed was a noted concern at most locations and was a particular concern for the unsignalized crossings reviewed. City of Houston 311 call logs noted several complaints about vehicle speeds and the difficulty in crossing the street in those locations. Increased speeds are associated with increased injury severities in crashes for



Figure 8: A left turn queue that extended beyond the left turn lane.

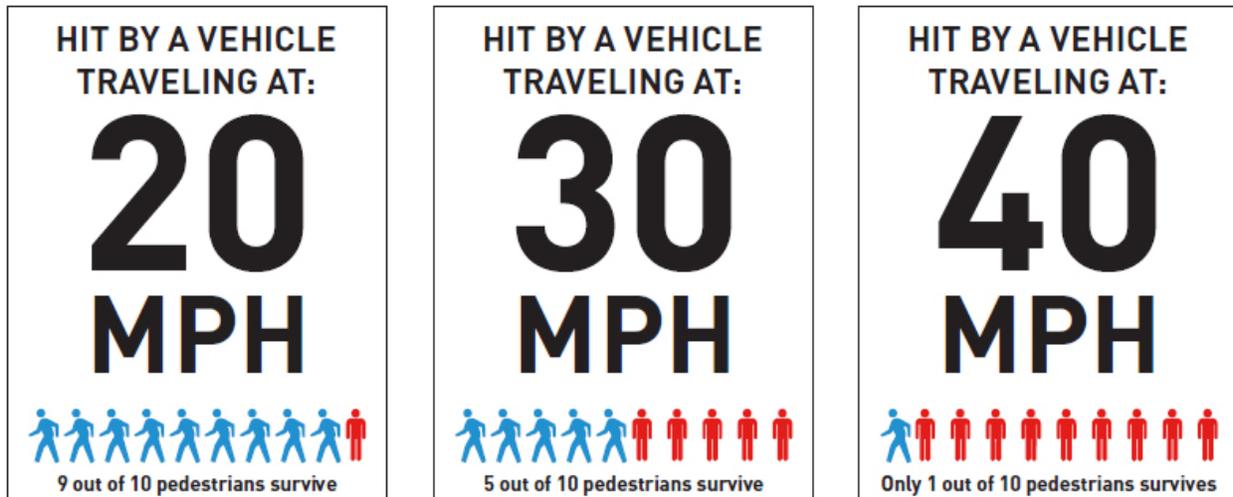


Figure 9: Chance of pedestrian fatality at various impact speeds (Seattle DOT)

pedestrians and bicyclists (see Figure 9), so speed management should be considered as part of any strategy to reduce pedestrian and bicyclist fatalities and serious injuries.

- Recommendation: Re-time signals for clearance of left turn movement queues which may reduce the perceived need to drive aggressively.
- Recommendation: Combine enforcement activities with the completion of other changes at each intersection to reset driver behavior.

### Night Time Sign and Signal Visibility

All of the locations reviewed had roadway lighting, but many of the locations had issues with the visibility of signs. Current headlight standards cast very little to no light upwards, so signs mounted above the standard pole mounting height have very little light to reflect back to the driver. Visibility of signs on signal mast arms is also affected by the background light conditions. On large intersections this is compounded with the legibility of signs from a distance. All of these factors can make it harder for roadway users to read and abide by the instructions of the signs. In the downtown core, one-way signs mounted under the signal face had lights to provide illumination but the lights were either not turned on or not operational on the night observed.

Supplemental one-way signs were mounted high on the signal mast arms outside of the headlight view for most vehicles. The team also noted issues with the visibility and legibility of street name signs and the visibility of no turn on red signs.

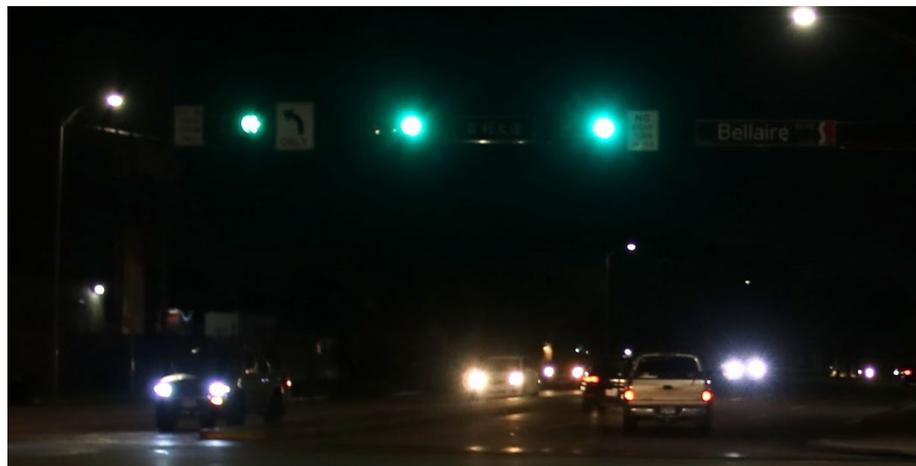


Figure 10: Visibility of overhead signs

Signals were generally visible at the reviewed locations but may benefit from the use of retroreflective bordered backplates. The addition of retroreflective borders to a signal backplate provides additional conspicuity from background light and helps color blind users to identify the position of the illuminated phase.

- Recommendation: Evaluate the placement of one-way signs in the downtown core for headlight visibility and implement changes as other work is performed.
- Recommendation: Evaluate street name sign size and placement for large intersections, and consider the use of internally illuminated signs.
- Recommendation: Install retroreflective border backplates at signalized intersections with safety concerns as a low-cost first step.

## Sidewalks

Sidewalks are present at most locations reviewed, but vary in terms of width, cross slope, condition, and set-back from the curb. Connections from the sidewalk to businesses are typically through parking lots with no dedicated path or indicated preferred path. Some sidewalks were obstructed by trees with low hanging limbs, bushes, or poles that reduce the usable width for walking. In some locations, the interaction of roadway lighting and vegetation left some areas of the sidewalks dark.

- Recommendation: Conduct routine maintenance to trim vegetation that is obstructing sidewalks.
- Recommendation: Emphasize comfort and safety in future sidewalk upgrades:
  - Utilize buffer between curb and sidewalk whenever possible.
  - Ensure pedestrian connections to businesses and other destinations.
- Recommendation: Ensure future redevelopment includes pathways from sidewalk to building entrances, with an emphasis on desired paths between bus stops and building entrances.

## Location Specific Issues and Recommendations

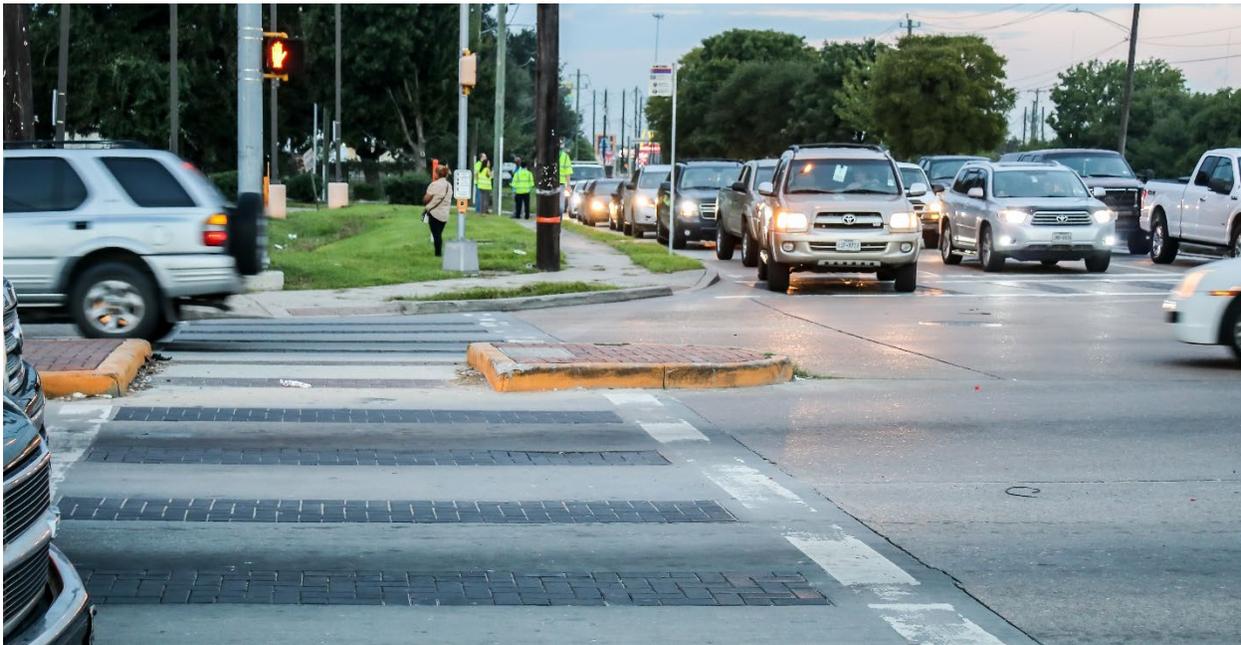
### Location: West at Airline

#### Observations and Issues:

The intersection of West and Airline in north Houston is adjacent to Aldine High School and several commercial developments. Nearby neighborhoods have above average levels of poverty compared to the city. The area is served by a high frequency bus route along Airline and a lower frequency route on West that turns and follows Airline south of the intersection. Many pedestrians were observed during all periods. Pedestrian traffic was primarily school age children during the morning and afternoon periods, and adults moving between the businesses and connecting to the bus stops at all times. There were consistently long queues of motor vehicles for turning movements, and signal timing that did not clear the queues may be contributing to aggressive driver behaviors (see Figure 8 and Figure 5). Bicyclists that were observed were walking bikes or riding on the sidewalks. Pedestrians in the area crossed both at and away from the crosswalks, and few used the pushbuttons to request a walk indication. Pedestrians

were routinely observed to cross to the median during a non-conflicting left turn phase, and completing the crossing during the next parallel green through phase.

The crosswalks were marked with transverse lines only, and the markings are faded underneath the wheel paths of the through traffic. Pavers were used between the transverse lines but had started to settle in some places and were located primarily in the wheel paths (see Figure 11). The medians included bull noses on the near side of the crosswalk, adding some additional protection for those waiting in the median to cross. Two corners had single ADA curb ramps that are not the preferred design, and both were narrow relative to travel in the direction of the crosswalk because of the angle they were installed. The pushbuttons had been upgraded to APS, but most could use location adjustments to have level landing pads adjacent and better aligned with the crosswalks.



**Figure 11: Crosswalk pavers and markings conditions.**

The school has significant impact on the operation of the intersection. During the morning drop off period, vehicles leaving the drop off area are limited by the signal timing of southbound traffic on Airline, resulting in long queues north on Airline and onto the school property (see Figure 12). The commercial parking lots along the east side of the roadway are frequently used as pick up and drop off points for students, which results in students crossing midblock to and from the school. During the morning arrival period, this occurred during darkness with unpredictable movements at the driveways due to the queue backup from the signal, and students moving between stopped cars at varying points along the road (see Figure 13). During the afternoon pickup period, there are fewer queues in the school driveway. Students leaving the school going east used a single sidewalk to gain access to the sidewalk along Airline, and many students crossed the street there despite the lack of a marked crosswalk and walking between vegetation in the median.

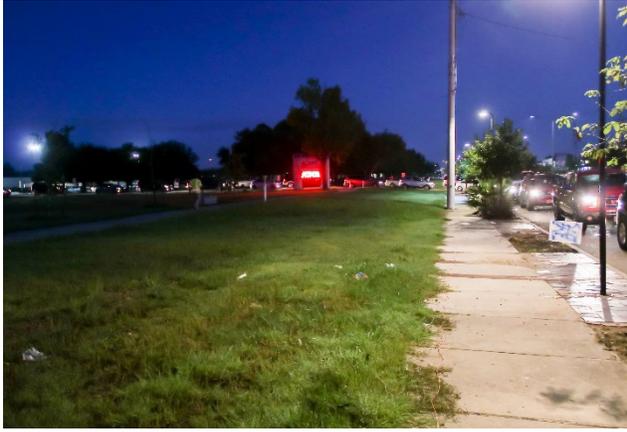


Figure 13: Morning drop off queues.



Figure 12: Students crossing between cars.

The Fiesta grocery store is a significant generator of pedestrian traffic. However, the parking lot lacks designated walking areas between the street and the store entrance. At the northeast corner of the intersection, there is a small curb between the sidewalk and parking lot that cuts off a possible access route between the bus stops and the store. Many people walking were observed walking directly west from the store's exit to the driveway along Airline and cross midblock at that location (see Figure 14), even though most then walked south to the bus stop which was immediately adjacent to the near side of the intersection.



Figure 15: View from corner to grocery store.



Figure 14: frequent crossing point for patrons of the grocery store.

### Recommendations:

#### **Short Term (up to 12 months)**

- Recommendation: Add high visibility white crosswalk markings between pavers in the crosswalks and consider wider transverse stripes (see Figure 11).
- Recommendation: Evaluate and update signal timing for all time periods (see Figure 8).
  - Eastbound left turn is short during school dismissal period.
  - Additional southbound green time to flush out AM Peak traffic
  - Northbound left turn is short during all observed periods.

- Recommendation: Pilot and evaluate adding pedestrian recall phases:
  - Across Airline during peak pedestrian periods such as school arrival/dismissal, PM peak.
  - Across West for all time periods.
- Recommendation: Request HPD enforcement, particularly towards aggressive turning traffic pushing yellow and red indications and failing to yield to pedestrians (see Figure 5).

**Medium to Long Term (1+ years)**

- Recommendation: Coordinate with the school and school Police for potential improvements to crossings at school driveways. Work with school to determine a preferred safe crossing point across Airline.
  - Consider using a Pedestrian Hybrid Beacon (PHB) at that identified location (see Figure 16).
  - Reconfigure sidewalk outside of main entrance/exit of school building to lead directly to the preferred crossing location.



Figure 16: Pedestrian Hybrid Beacon (PHB).

- Recommendation: Coordinate with the school to develop a safety educational campaign. Work with school, HPD, and TxDOT; potentially work with student government. Consider the Teens in the Driver’s Seat or any similar program with focus on pedestrian or bike safety.
- Recommendation: Fill in the grass buffer area at the corners where vehicle off-tracking has created ruts and holes between the curb and sidewalk (see Figure 17).
- Recommendation: Work with shopping center to make a ramp to the intersection and striped walkway across parking lot (see Figure 15).



Figure 17: Worn down area from truck tracking over curb.

## Location: Fannin at Pierce

### Observations and Issues:

The intersection of Fannin and Pierce is in the southern portion of the downtown core, close to the METRO headquarters, the Downtown Transit Center, and the Main Street light rail line. Pierce connects the downtown one-way grid to the I-45 Gulf Freeway HOV lanes and main lanes headed southeast from downtown and has considerable PM Peak volumes. Several bus lines utilize Pierce, but bus stop usage is light because of the proximity to the Downtown Transit Center. There are currently no buses on Fannin approaching Pierce. There is a significant concentration of homeless people in the area primarily below the adjacent elevated section of I-45. There are other businesses, parking lots, and churches in the area as well.

The intersection is typical of downtown one-way grid intersections. Fannin and Pierce both have five lanes. Both streets have one bus-only lane; Fannin has an additional shared HOV/bus lane during peak periods. The signal system is slightly dated with only two faces per approach while newer intersections have three faces per approach. Vertical one-way signs are mounted on the right near side and left far side signal masts, and a horizontal one-way sign is mounted underneath the right signal face. There is a light to illuminate the one-way sign below the signal face, but it was not observed to be working. The other one-way signs are mounted above the 7' standard mounting height and can be difficult to see at night as they are above the headlight's vertical cutoff for modern cars.



Figure 18: Sign and signal head placement on Fannin.

The street name sign for Pierce is on the left near-side corner and is difficult to see. Roadway lighting is adequate, although trees on the southeast corner along Pierce make that stretch of sidewalk darker than other areas of sidewalk nearby. In the southwest corner near the property line between I-45 and the McDonald's there is a short stretch of missing sidewalk that should be filled in.

The existing lane configuration along Fannin includes five lanes total, with a left turn only lane, a combined left-through lane, a through lane, a through lane with peak-hour HOV restrictions, and a bus lane. The dual left configuration appears to not be needed for the existing turning volumes, and several concerns were noted by the review team about the dual left. The dual left is currently indicated only by pavement markings and lacks the regulatory lane control signs that are required (see Figure 19). An existing dotted line extension marking ("cat tracks") through the intersection for the left turn movement starts from the wrong lane line of the Fannin approach, which should be marked between the left turn lanes. Several vehicles were observed to proceed through the intersection from the left turn lane, as there is a receiving lane marked on the far side of the intersection.



Figure 20: Dual left turn lane configuration.



Figure 19: Lane assignment on Fannin.

Pierce was observed to have high volumes of motor vehicle traffic during the PM peak that is metered by the previous intersection at Main and its interaction with the light rail line. Off-peak volumes were lower along Pierce, and that may contribute to crashes in the off-peak periods being more severe than crashes during the peak periods. Motor vehicle volumes on Fannin were lighter than those on Pierce during all periods observed. An initial review of volume data suggests that one lane could be repurposed to another use, which could help control vehicle speeds and allow for shorter crossings (see Figure 20). The additional space could be used for a bicycle facility, parking, or other needs identified by the City and stakeholders.

#### Recommendations:

##### **Short Term (up to 12 months)**

- Recommendation: Consider strategic tree trimming to improve roadway lighting of the sidewalk in the southeast corner along Pierce.

- Recommendation: Replace pavement markings for southbound left turn striped between wrong lane. Add lane control signage (see Figure 20).
- Recommendation: Install high visibility crosswalks.
- Recommendation: Repair the sidewalk on west side of Fannin south of Pierce.

### Medium to Long Term (1+ years)

- Recommendation: Provide a bulb-out on the southeast corner into Fannin to restrict through movement from the southbound left turn only lane (see Figure 21).
- Recommendation: Remove the double left turn lane configuration.
- Recommendation: Study and pilot repurposing one lane along Fannin that may not be needed to accommodate traffic demands (see Figure 19).
  - Options for utilizing space: Possible bike facility, parking, wider sidewalk; work with stakeholders to identify a long-term solution.
  - The outside diamond lane is not currently used by any METRO buses, and there are no right turns onto Pierce, so this lane cannot currently be legally used by anyone. This space could also be repurposed for other uses.



Figure 21: Receiving lane across dedicated left turn lane.

- Recommendation: Conduct additional analysis related to Bike Plan implementation on Pierce. This may have safety, utility, and accessibility benefits at the intersection by reducing number of lanes to cross.
- Recommendation: Implement visibility and illumination improvements of one-way signs and street name signs in downtown such as revised mounting heights and use of internally illuminated signs.
- Recommendation: New signal mast arm with additional signal head to have three signal faces for all intersection approaches.

### Location: Washington at Patterson

#### Observations and Issues:

The intersection of Washington and Patterson is located a few miles west of the downtown core. Washington is a street with many popular restaurants and bars with a mixture of residential housing types north and south of the street. Patterson has been identified as a key north-south link for the bicycle network, as it connects Buffalo Bayou to the south to White Oak Bayou to the north, with crossings of the Union Pacific Railroad tracks and I-10 on lighter volume streets. It also provides access

to Center Street, which is used by many bicyclists to travel parallel to Washington Avenue. The current intersection has two-way stop control with no marked crosswalks. Washington Avenue has five lanes including a center two-way left turn lane (see Figure 22). There are bus stops for both directions of travel along Washington located just west of the intersection with Patterson. The intersection is approximately 1,000 feet from the nearest signalized crossing to the west and 2,400 feet to the next signalized crossing to the east. There is steady foot traffic along and across Washington during peak restaurant and bar hours from the businesses to parking on neighborhood streets and residences.



Figure 22: Existing conditions.

Patterson south of Washington is typical of area streets with narrow widths and open storm drainage ditches. North of Washington the street has been widened and includes curb, gutter, and sidewalk. Several issues with drainage and condition of sidewalks and curb ramps were noted, including broken up sidewalk on Washington west of Patterson on the south side, dirt and gravel accumulating at the bottom of the curb ramps in all corners, and sidewalk that wasn't draining on the north side of Washington west of Patterson. On the northbound approach, vegetation partially blocked visibility of the stop sign and street name sign (see Figure 23), and a fence limited visibility of approaching traffic headed eastbound. The west side of Patterson south of Washington had vegetation blocking the roadway lighting, but other roadway lighting was generally good.



Figure 23: Signing approaching Washington.

The team performed an initial evaluation of options to improve the safety and comfort of pedestrian and bicycle movements across Washington Avenue. Left turn and through movements from Patterson are generally low and could be rerouted on the neighborhood street grid, so the team recommends a full median closure that allows for bicycle and pedestrian movements and only right turns for vehicular movements. This should be undertaken with consideration of the larger bicycle network. South of Washington streets are narrow, and bicycles can easily share streets with motor vehicles. North of Washington, Patterson is wider, and the city should work with stakeholders to identify an appropriate bicycle facility for the segment connecting to White Oak Bayou Trail.

Recommendations:

**Short Term (up to 12 months)**

- Recommendation: Trim the tree and raise the stop sign to a standard height at the northbound Patterson approach (see Figure 23).
- Recommendation: Clean out and maintain sidewalks, especially west of Patterson along Washington on both sides.
- Recommendation: Clean out and maintain curb ramps.
- Recommendation: Clean out drainage on Patterson to ensure Washington drains correctly and correct slope to ensure water run-off transports particles past sidewalk ramps.
- Recommendation: Consider adding a street light on west side of Patterson near Washington to address dark area.

**Medium to Long Term (1+ years)**

- Recommendation: Provide a median refuge for pedestrians and bicyclists crossing Washington. A full median closure is preferred, but raised medians that allow some movements may also achieve the goal of improving the pedestrian and bicycle crossing movements (see Figure 24).



Figure 24: Possible median closure with pedestrian and bicycle crossing.

- Recommendation: Consider ways to reduce the width of Patterson north of Washington to reduce turning speeds and improve the bicycle network.
  - Option: Add bulb-outs on Patterson to slow right turns but do not impede bicycle travel.
  - Option: Construct a bicycle facility on Patterson (bike lanes, cycle track, bicycle boulevard, or other) consistent with stakeholder input and safety needs.



Figure 25: Possible bulb-out on Patterson.

## Location: 11<sup>th</sup> at Nicholson

### Observations and Issues:

The intersection of 11<sup>th</sup> and Nicholson is located a few miles northwest of downtown Houston in the Houston Heights neighborhood. 11<sup>th</sup> is a four-lane undivided street, and Nicholson is a residential street with two-way stop control. The Heights Bike Trail runs parallel to Nicholson on a former rail line. To the south the bike trail connects to the MKT Trail with access to the bayous and downtown. The immediate area is primarily residential with some small businesses along 11<sup>th</sup>. There is a low frequency bus route along 11<sup>th</sup> with near side stops for the eastbound and westbound directions. Few drivers were observed to be yielding to trail users attempting to cross.



Figure 26: Existing 11th street approach to crossing.

The City has added several enhancements to the crossing in the past few years to address concerns of area stakeholders. These improvements include additional advance warning signs, extended high visibility crosswalk markings, and green pavement markings for bicycle designation (see Figure 26). The crossing is somewhat elevated from the previous elevation of the rail crossing, but not designed to reduce speeds along 11<sup>th</sup>. Some signs along 11<sup>th</sup> were leaning, turned away from the roadway, or partially blocked by vegetation and should be adjusted (see Figure 27).



Figure 27: Leaning or blocked signs on 11th street.

Additionally, the raised elevation makes the pavement markings more parallel to the driver's eye, reducing effective visibility. A log of 311 events note many concerns about speed of traffic along 11<sup>th</sup> street even after the most recent changes implemented by the City. The crossing is signed as a multi-use path, but did not have truncated domes across the trail. Truncated domes were also missing from the northeast and southeast corners.

#### Recommendations:

##### **Short Term (up to 12 months)**

- Recommendation: Install speed hump markings to bring attention to hump and encourage slower speeds, especially for westbound approach.
- Recommendation: Repair street light outage (a request was submitted, and street light has been repaired since the RSA).
- Recommendation: Install truncated domes on Heights Trail and all corners.
- Recommendation: Perform sign maintenance along 11<sup>th</sup> to realign signs as necessary.

##### **Medium to Long Term (1+ years)**

- Recommendation: Address the ease of crossing 11<sup>th</sup> for bicycles and pedestrians through physical controls.
  - Preferred option: Lane reconfiguration along 11<sup>th</sup>. A 4-to-3 lane conversion with bike lanes along 11<sup>th</sup> St, which would slow vehicle speeds for the entire segment and allow for a median refuge to break the crossing into two stages (see Figure 28).
    - The location should be evaluated for need of a Rapid Rectangular Flashing Beacon or PHB if there is a continued need for additional protection after the installation of a raised median and lane reconfiguration.

- Secondary option: Add a PHB or toucan crossing. These options would provide a protected crossing for bicyclists and pedestrians, but not control speeds along the segment of 11<sup>th</sup>.

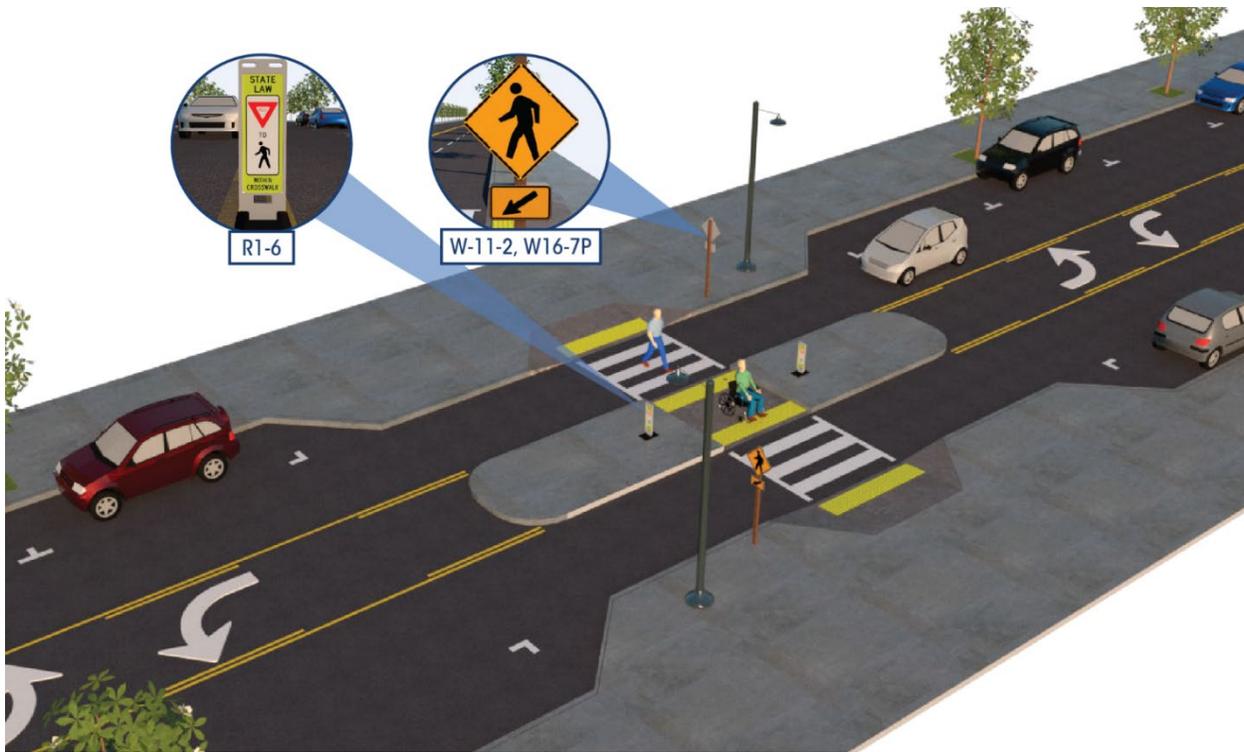


Figure 28: Potential lane reconfiguration and pedestrian refuge.

### Location: Bellaire from Ranchester to Gessner

#### Observations and Issues:

The Bellaire corridor from Ranchester to Gessner is a major east-west thoroughfare between I-69 and the Sam Houston Parkway toll road in the Chinatown neighborhood. The corridor connects to the Texas Medical Center to the east. METRO’s Quickline limited stop service runs from Ranchester to the Texas Medical Center, and there is also a high frequency local route on Bellaire, along with service on Gessner for north-south routes. The area south of Bellaire is mainly lower to middle income single-family residential and some multi-family residential, while the north side of Bellaire is primarily commercial (with multi-family housing abutting in the rear) and two private schools. Businesses along the corridor generate significant motor vehicle traffic and pedestrian and bicycle traffic. The private high schools within the corridor generated relatively less walking activity than expected during the observed days and times. The school dismissal included operation of a main intersection by law enforcement officers and appeared to work well with minimal additional impact to travel along Bellaire.

The corridor includes setback sidewalks, wide raised medians, and trees between the curb and sidewalk creating an overall comfortable walking environment despite the high volumes and travel speeds on Bellaire. Driveways are mostly well designed to slow traffic crossing the sidewalk. The two driveways at

St. Agnes Academy have lowered sidewalks that feel more like intersections and are less likely to encourage yielding to people using the sidewalk. The trees provided shade and separation from motor vehicle traffic, but in several spots were partially blocking road signs, including the school zone warning sign on the eastbound approach to St. Agnes Academy (see Figure 30). At one location two DO NOT ENTER signs in the median were faded and need to be replaced (see Figure 29). On the northside of Bellaire near the creek a guywire crossed the sidewalk at a potentially hazardous height (see Figure 30).



Figure 29: Faded sign.



Figure 30: Low guywire, partially blocked sign.

At the intersection of Bellaire and Pella one pushbutton was missing (see Figure 31), and several were at inaccessible locations (see Figure 32). Truncated domes at this intersection did not align with the intended crossing direction (see Figure 31). A school crossing warning sign and plaque needed to be

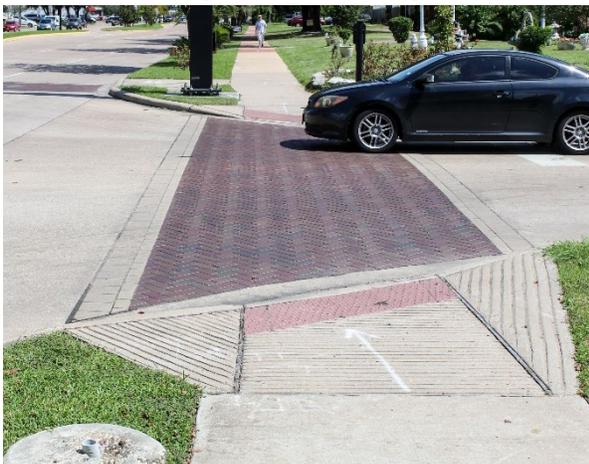


Figure 31: Missing pushbutton and misaligned truncated domes.



Figure 32: Inaccessible pushbutton location.

fixed at the Pella intersection. Bus stops along the corridor had lighting, but the lights were either not turned on or not operational on the night observed.

The Bellaire corridor includes four lanes for westbound traffic and three lanes for eastbound traffic. Traffic volumes are unbalanced with heavier westbound travel, but the travel counts provided may not warrant the need for four through lanes throughout the corridor. Given the frequency of buses and high levels of ridership, the westbound outside lane could be considered for a bus only / right turn lane which may improve bus service along the route.



Figure 33: Quickline bus service on Bellaire.

With seven through lanes and added left and right turn lanes at many intersections, the minimum crossing times for pedestrians are long. Subsequently, the signals are timed for pedestrians to cross half of Bellaire (see Figure 34). There is a pedestrian button located in the median and walkers are expected to wait for the next cycle to complete crossing. The review team observed a multitude of pedestrians crossing the roadway. None waited in the median to initiate a two-stage crossing. Pedestrians either crossed the whole roadway or crossed part of the roadway during a non-conflicting left turn phase. If crossing halfway is intended to remain, truncated domes should be provided in the median. The City should investigate the impact of providing crossing time to cross the entire roadway to be consistent with actual use and reduce conflicts between new phases and pedestrians still in the crosswalks. The



Figure 34: Median pushbutton and crossing timing to cross half way per cycle.

City should also investigate the use of newer technologies that can detect pedestrians remaining in the crosswalk and extend the phase only when needed. Crosswalks at the signalized intersections utilized pavers that were generally in good condition but lacked the TMUTCD minimum white transverse line markings.

#### Recommendations:

##### **Short Term (up to 12 months)**

- Recommendation: Replace DO NOT ENTER signs for south median east of Ranchester (see Figure 29).
- Recommendation: Relocate CenterPoint guywire at bridge sidewalk (potential hazard) on north sidewalk (see Figure 30).
- Recommendation: Relocate School sign blocked by tree or trim tree (see Figure 30).
- Recommendation: Increase crossing time to enable full crossing of Bellaire.
- Recommendation: Replace missing pedestrian pushbutton and pole in SW corner of the Pella intersection (see Figure 31).
- Recommendation: Fix lighting at bus stops throughout the corridor.
- Recommendation: Add white transverse lines for all crosswalks. Evaluate the need for high-visibility crosswalk markings to enhance visibility (see Figure 31 - Figure 34).
- Recommendation: Fix improperly oriented school crosswalk sign at Pella intersection.

##### **Medium to Long Term (1+ years)**

- Recommendation: At Bellaire and Pella intersection:
  - Relocate accessible pushbuttons next to level landing pads and within reach of paved area (see Figure 32).
  - Replace truncated domes that are misaligned.
- Recommendation: Evaluate usage of the 4<sup>th</sup> westbound through lane for possible conversion to a bus and right turn only lane (see Figure 33).
- Recommendation: Consider installing microwave or other sensor to detect pedestrians in crosswalk across Bellaire to extend time only when needed.
- Recommendation: Add truncated domes in median if pedestrians are expected to cross in two stages (see Figure 34).

## Location: Bellaire at Ranchester

### Observations and Issues:

The intersection of Bellaire and Ranchester is at the western end of the corridor described previously. It is a large signalized T intersection with many restaurants and other businesses to the north and residential to the south. The Quickline bus service terminates at Ranchester and turns around here, utilizing a westbound to northbound right and a southbound to east bound left to begin eastbound service on Bellaire. The westbound bus stop is located on the near side of the intersection, while the east bound bus stop is located far side to facilitate the bus routing from Ranchester. A marked crosswalk is not provided across the east leg of Bellaire despite being the closest to the bus stops and desired crossing paths.

The review team noted several concerns at the intersection that affect pedestrian and bicycle accommodation and safety. The placement of the signal controller cabinet is perpendicular to motor vehicle traffic on Bellaire and blocks visibility of pedestrians crossing in the crosswalk across Ranchester (see Figure 35).



**Figure 35: Blocked visibility of crosswalk, dark area in advance of intersection.**

On the westbound approach there was no near side roadway lighting unlike the other corners, leaving the corner nearest to the bus stop darker than other areas of the intersection (see Figure 35). There was a piece of plastic conduit sticking up a few inches from the sidewalk creating a potential trip hazard. Dotted line extension markings (“cat tracks”) for the dual left from Ranchester align to the outside two

lanes on Bellaire, which creates a conflict with the bus stop located just east of the intersection (see Figure 36).



Figure 36: Dotted line extension markings (“cat tracks”) through intersection aligned to outside lanes of Bellaire.

The only traffic heading northbound on Ranchester are a single eastbound left-turn lane and a single westbound shared through/right-turn lane; therefore, incoming traffic onto Ranchester is capacity-constrained and may not require two lanes for motor vehicles (see Figure 37). One lane could potentially be repurposed for a bicycle facility. The south side of Bellaire includes two driveways near the intersection which may be creating additional conflicts.



Figure 37: Northbound Ranchester lane configuration.

Recommendations:

**Short Term (up to 12 months)**

- Recommendation: Replace southbound left turn dotted line extension markings (“cat tracks”) to align with lanes 2/3 instead of 1/2 to reduce conflicts with buses.
- Recommendation: Add leading pedestrian interval across Ranchester to increase visibility around traffic signal controller box (see Figure 35).
- Recommendation: Consider increasing crossing time to enable full crossing of Bellaire in one cycle (see Figure 34).

- Recommendation: Investigate possibility of adding street light on Centerpoint pole on northeast corner.
- Recommendation: Cut off conduit piece on northeast corner (see Figure 38).
- Recommendation: Add pedestrian phase recall across Ranchester.



Figure 38: Conduit protruding above the sidewalk level.

**Medium to Long Term (1+ years)**

- Recommendation: Relocate traffic signal controller box at the northeast corner to improve westbound approaching vehicles ability to see pedestrians in the crosswalk (see Figure 35).
- Recommendation: Assess pedestrian pushbutton locations and relocate to ensure ADA compliance and general usability.
- Recommendation: Northbound Ranchester may need only one lane for departing traffic; explore uses of that space for:
  - Bulb-out on the NE corner. Increases pedestrian visibility around signal box, reduces pedestrian crossing time.
  - Implement a two-way cycle track on existing outside lane on northbound Ranchester or other types of bicycle facility consistent with the bike plan.

- Recommendation: Reestablish east side crosswalk to serve crossings related to bus stops.
- Recommendation: Close driveways on south side of Bellaire on either side of Ranchester to reduce conflicts at the intersection (see Figure 39).



Figure 39: Driveway close to signalized intersection.

## Location: Bellaire at Gessner

### Observations and Issues:

The intersection of Bellaire and Gessner is at the eastern end of the corridor described previously. It is a large signalized intersection with many restaurants and other businesses to the north and residential to the south. There is high frequency bus service along Bellaire and along Gessner. The Bellaire bus stops are located on the far side of the intersection, while the Gessner bus stops are located on the near side of the intersection. Bellaire has dedicated right and left turn lanes resulting in 9 lanes to be crossed on the east and west legs of the intersection. The northeast corner has a large flattened area of sidewalk which appears to be caused by restricted right of way and lack of space to fit in standard curb ramps at the corner. This results in pushbuttons that are too far away from the respective crosswalks, and there are likely issues with truck tracking onto the sidewalk (see Figure 40 and Figure 41).



Figure 41: Pushbutton away from beginning of crosswalk.

Figure 40: Flattened area of sidewalk at corner.

There are posted no right turn on red signs facing both Gessner approaches, although the team observed these signs being routinely ignored (see Figure 42). The Bellaire right turn lanes include an overlapping phase with left turns from Gessner onto Bellaire.

The team observed many pedestrian movements through all parts of the intersection. Many were associated with transfers between bus routes, and connections between the bus stops and nearby business including the Fiesta grocery store. The crossing of Bellaire is timed to cross in two cycles, but no pedestrians were observed to wait for the full cycle in the median (a legal crossing was timed and required about 3 minutes 55 seconds). Few pedestrians were observed to use the pushbutton, and many crossed half of the roadway during non-conflicting left turn phases or during gaps in traffic. In the northeast corner the entire curb radius area has been lowered because standard curb ramps could not fit within the existing right of way. The pushbutton for the southbound crossing of the east leg is located away from the crosswalk; pushbuttons in other locations lack level landing areas or are otherwise inaccessible. On the southeast corner, the signal mast arm and aesthetic treatment blocks the view of pedestrians in the crosswalk from right turning vehicles.

The team also observed other conditions that could improve safety and walking and biking comfort and enhance driver understanding. In the northwest corner, part of the sidewalk along Gessner has become overgrown and only a narrow path is clear of vegetation. On the eastbound approach leg, an advance school crosswalk sign is potentially confusing for drivers, as the intended crosswalk for the sign is a few hundred feet east of Gessner, but the sign is in advance of Gessner. The bus stops on Gessner have a design that results in unused space behind the sitting area, taking up additional sidewalk space but without providing an amenity to bus users (see Figure 42).



Figure 42: No right turn on red sign and bus stop placement on Gessner.

### Recommendations:

#### **Short Term (up to 12 months)**

- Recommendation: Provide leading pedestrian interval on east crosswalk to improve visibility of people walking (signal pole currently limits visibility) (see Figure 43).
- Recommendation: Consider increasing crossing time to enable full crossing of Bellaire in one cycle.
- Recommendation: Perform maintenance on sidewalk on west side of Gessner, north of Bellaire.
- Recommendation: Relocate school crossing sign on eastbound Bellaire to the east side of Gessner.



Figure 43: Visibility of crosswalk across Bellaire.

**Medium to Long Term (1+ years)**

- Recommendation: Assess pedestrian pushbutton locations and relocate to ensure ADA compliance and general usability (see Figure 44).
- Recommendation: Partner with METRO to improve bus stops on Gessner to better utilize sidewalk space (see Figure 42).
- Recommendation: Remove dedicated westbound right turn lane and reconstruct northeast corner to include wider sidewalks, standard dual curb ramps, improved pedestrian pushbutton locations, and improved visibility of crosswalks beyond the mast arm base (see Figure 45).



Figure 44: Pushbutton not located next to level landing.



Figure 45: Possible removal of dedicated right turn lane.

## Appendix A

Kick Off - Sign in list of attendees

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