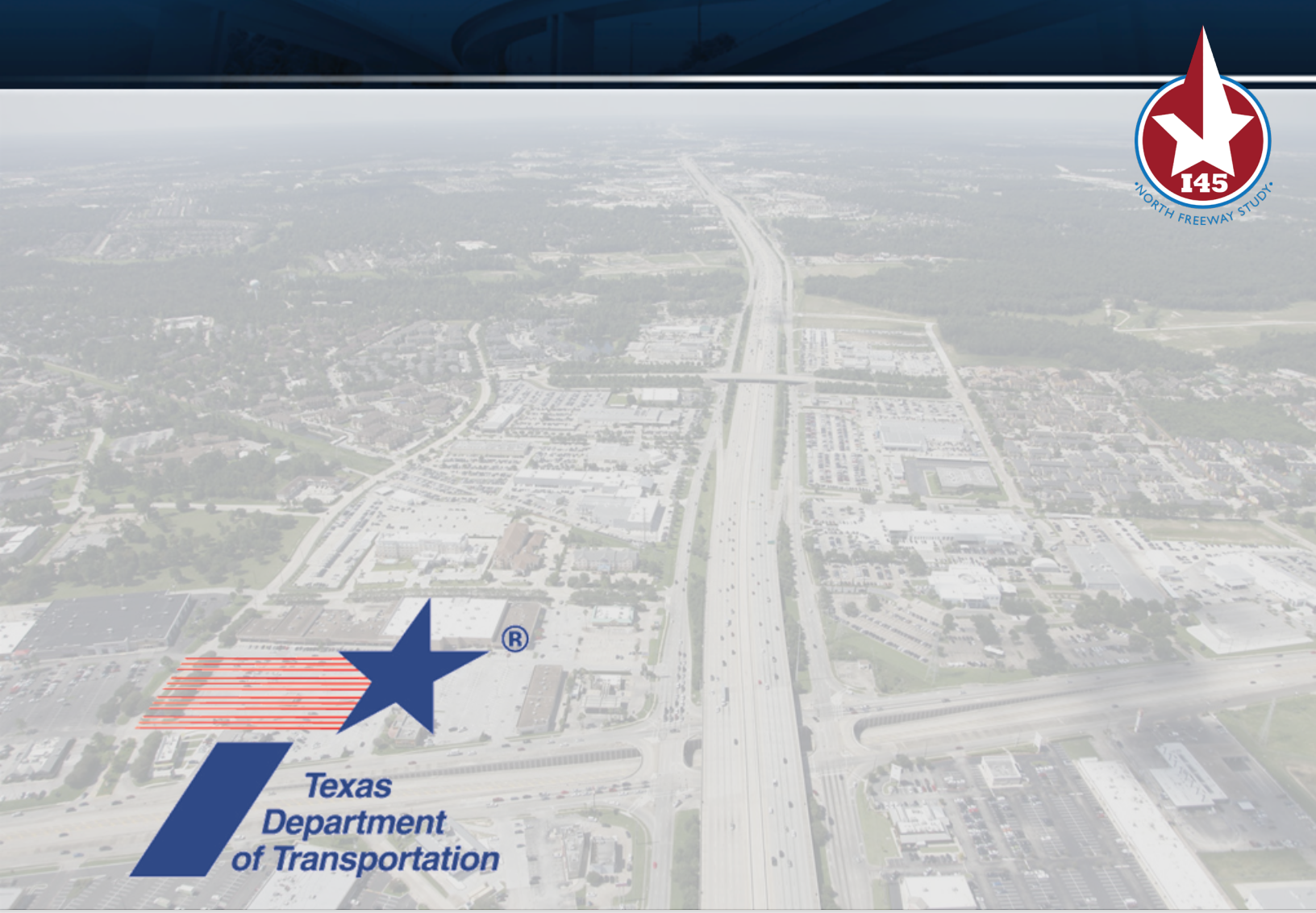

Study Needs and Goals Memorandum

I-45N: Beltway 8 North to Loop 336 South (Conroe)

Planning and Environmental Linkages (PEL) Study

February 2020

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1 EXECUTIVE SUMMARY

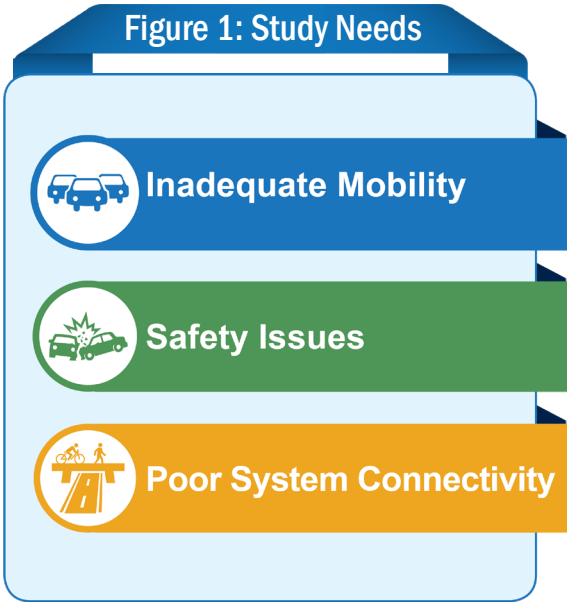
The Texas Department of Transportation (TxDOT) is conducting a Planning and Environmental Linkages (PEL) study for Interstate Highway 45 North (I-45N) between Beltway 8 North (Beltway 8N) and Loop 336 South (Loop 336S) (Conroe). The Purpose and Need identifies the transportation deficiencies of a study area and outlines a set of objectives that would address the transportation deficiencies.

1.1 *Need for Improvement*

Transportation improvements are needed to address the following problem (Figure 1):

- **Inadequate Mobility:** Existing congestion along the I-45N mainlanes and frontage roads causes delays and unreliable travel times for users along the corridor. Traffic congestion and travel times are projected to further deteriorate in the future, resulting in longer daily commutes and increased transportation costs for freight companies.
- **Safety Issues:** During the five years from 2012 to 2016, the crash rates along the I-45N corridor were higher than the statewide average for similar interstate facilities.
- **Poor System Connectivity**: I-45N has limited accessibility and connections to the local roadway network, parallel facilities, and alternative modes of transportation. Many existing interchanges are inadequate to handle existing traffic effectively and safely, a situation that is expected to worsen in the future.

Figure 1: Study Needs



1.2 *Study Goals and Objectives*

The purpose of the I-45N PEL Study is to identify solutions to address the existing and future transportation needs of the I-45N corridor by improving mobility for all users and goods, reducing crashes, and enhancing local and regional accessibility and connections between transportation modes.

The I-45N PEL Study can also benefit from the identification of a set of "Goals and Objectives" to support the Purpose and Need. Figure 2 lists the "Goals and Objectives" which guide the development of alternatives to address study needs.

Figure 2: Study Goals and Objectives

- Improve mobility and travel time reliability
- Improve system connectivity and accessibility:
  - Enhance east-west connections
  - Improve interchanges and access to/from the I-45N mainlanes
  - Improve connections to parallel facilities
- Improve bicycle and pedestrian facilities
- Enhance economic development and strong regional economic competitiveness
- Maximize use of existing right-of-way
- Reduce roadway flooding
- Maintain and preserve existing I-45N infrastructure
- Incorporate cost-effective solutions
- Reduce frequency and severity of crashes
- Improve transit accessibility and connections to I-45N
- Improve accommodation of freight traffic
- Minimize impacts to natural and built environments
- Accommodate future technology to promote sustainability
- Improve functionality and resiliency of I-45N as a hurricane and emergency evacuation route
- Identify and prioritize short-term solutions for quicker implementation of improvements
- Achieve active stakeholder and public participation throughout study

2 INTRODUCTION

TxDOT is conducting a PEL study for I-45N from Beltway 8N to Loop 336S (Conroe). This 24 mile study corridor extends from north Houston to south Conroe and traverses Harris and Montgomery Counties. This report documents the need for improvements within the corridor, purpose of the PEL study, and outlines the study goals and objectives that will guide the next step of the project: the development of alternatives. Most importantly, the purpose and need will function as a reference to assist TxDOT and other involved agencies and stakeholders in decision-making for the transportation planning process. The information provided by this study aims to promote collaboration and communication among area stakeholders in the development of a consistent, long-term vision for the I-45N corridor.

As the primary roadway connection between Houston and Dallas, the largest metropolitan areas in Texas, the I-45N corridor plays a key role in the long-term economic health of the region. Planning initiatives such as this PEL Study allow for a review of potential issues along the corridor and identification of improvements that can be implemented to enhance the safety, operations and economic vitality within the corridor.

2.1 *Study Area*

The study area, shown in Figure 3, includes a 24-mile corridor from Beltway 8N (southern study limits) to Loop 336S (northern study limits). The northern half of the corridor is located in Montgomery County while the southern portion is located within Harris County. Municipalities within the corridor include Houston, Spring, The Woodlands, Oak Ridge North, Shenandoah, and Conroe.

Figure 3: I-45N Study Area

3 PROJECT BACKGROUND

I-45 is an important national route that extends from the Gulf of Mexico near Galveston, Texas to Dallas, Texas, as shown in Figure 4. This interstate route is part of the National Highway System, and is located entirely within the state of Texas. I-45 is the shortest major primary interstate in the country and the only major primary interstate to be located within one state. Major primary interstates are routes that end in a 0 or a 5, and commonly stretch from border to border or coast to coast across the United States.

I-45N is a major north-south commuter route serving the northern section of the Houston metropolitan area. The route also provides local mobility for residents in the numerous communities located along the corridor. I-45N is a major hurricane evacuation route, and with its connection to the Gulf of Mexico and major intermodal facilities and developments, it also serves as a major freight corridor for the Houston area, state of Texas, and United States.

Figure 4: I-45 Route Importance

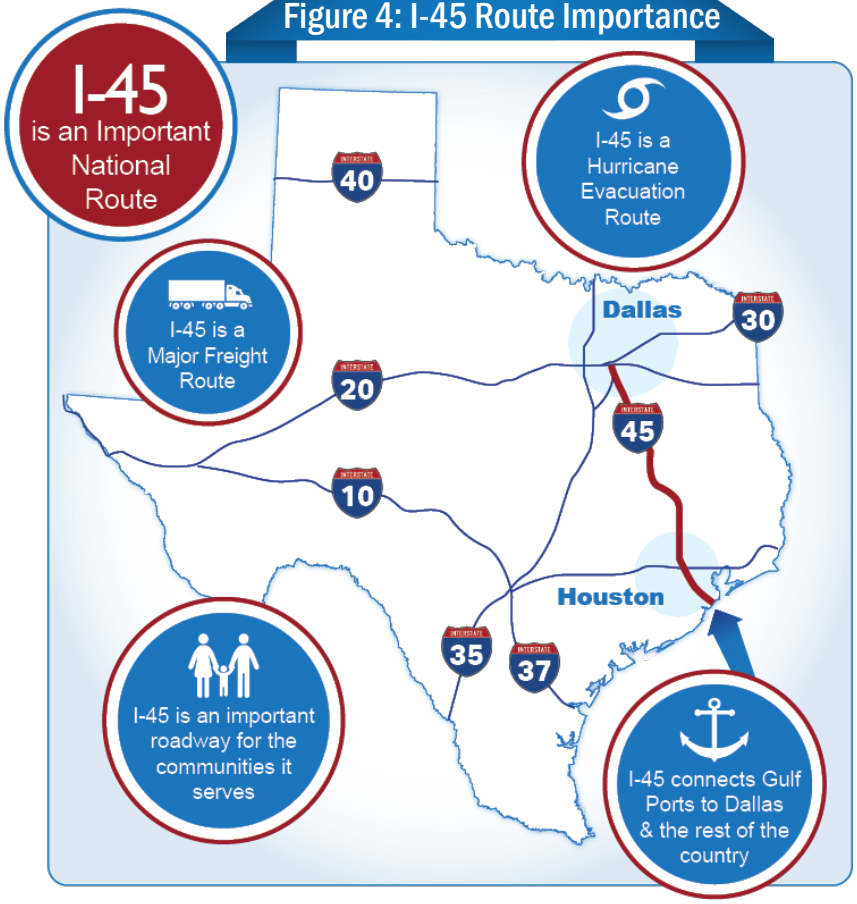
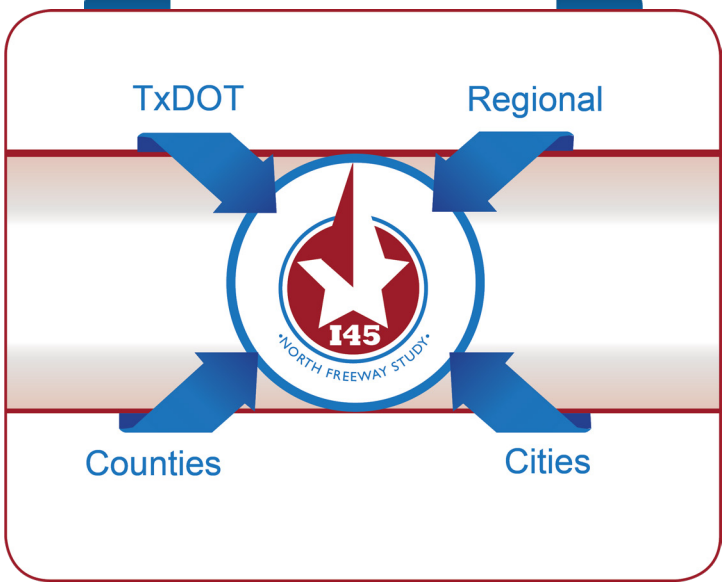


Figure 5: I-45N PEL Builds on the Work of Others



3.1 *Regional Planning Context*

The I-45N PEL study follows guidelines, plans, and policies established by state, regional, and local planning organizations (Figure 5). It is important this study to consider input from stakeholders in order to ensure that any resulting transportation improvements are feasible and beneficial not only to the public, but to agencies and stakeholders as well.

3.2 State Planning

TxDOT has implemented high-level performance measures to assess how transportation goals are being met. The topics covered by the performance measures include optimizing system performance, delivering the right projects, promoting safety, preserving assets, focusing on the customer, valuing employees, and fostering stewardship.[1] The needs of the I-45N corridor have been developed with these performance measures and potential study evaluation criteria in mind.

3.3 Regional Planning

The Houston-Galveston Area Council (H-GAC) serves as the Metropolitan Planning Organization for its 13-county service region. H-GAC is responsible for the long-range transportation planning in the region, with the Houston-Galveston 2040 Regional Transportation Plan (RTP) being the most recent documentation. As part of the RTP, H-GAC has developed goals and performance measures for the region (Figure 6) based on 2040 population and employment projections.

Figure 6: H-GAC 2040 Regional Transportation Plan Goals

Additionally, H-GAC has identified strategies that guide transportation investment priorities, including:

- Improve System Management and Operations
- Enhance State of Good Repair
- Expand the Multimodal Network
- Coordinate Development

[1] TxDOT Performance Measures; http://www.dot.state.tx.us/dashboard/optimize-system-performance.htm

Based on these goals, performance measures and strategies, the 2040 RTP lists the prioritized investments in transportation projects through the year 2040. The RTP includes over 1,450 individual projects, totaling approximately $88 billion, which are managed by 61 public agencies. I-45N is identified in the RTP as a corridor in need of transportation improvements.

Overall, H-GAC provides a useful framework of goals and demographic data for planning studies like the I-45N PEL study. H-GAC has estimated that the population and economy in the Houston area are anticipated to grow substantially by 2040, leading to increased pressure on the regional transportation system.

The H-GAC Congestion Management Process (CMP) is a systematic process of identifying congestion and causes, applying congestion mitigation strategies to improve system performance and reliability, and evaluating the effectiveness of implemented strategies. The CMP identifies goals and actions that are consistent and support the vision, goals and objectives from the RTP. Because I-45N serves as a regional corridor for providing mobility and accessibility, it is critical to develop and evaluate effective strategies and alternatives to meet the Study's Purpose and Need while maintaining consistency with the RTP and CMP.

The Metropolitan Transit Authority of Harris County (METRO) is another regional planning agency, serving as the primary transit service provider in the Houston area. METRO operates bus, light rail, and paratransit services throughout Harris County, with several bus routes operating within the southern portion of the I-45N corridor. METRO is currently developing a new Regional Transit Plan, METRONext, to analyze the future needs of the regional transit system and identify major transit investments through the year 2040.[2] The goals guiding METRONext include:

- Improve mobility
- Enhance connectivity
- Support vibrant communities
- Ensure a return on investment

Brazos Transit District (BTD) is another major transit service provider in east-central Texas, serving 16 counties across the Brazos Valley, including Montgomery County. BTD operates bus, trolley, and paratransit services, with several transit routes operating in the northern portion of the I-45N corridor. The Brazos Valley Council of Governments released the Brazos Valley Coordinated Transportation Plan Update in February 2017, which describes the vision and mission for health and human service transportation in the Brazos Valley Region and outlines solutions and funding priorities to address the region's transportation needs. Although the Coordinated Transportation Plan Update has a regional-level focus that extends beyond BTD and Montgomery County, one of the main objectives relating to BTD is to encourage and develop the possible enhancements of services in the Brazos Valley Region.[3]

Coordination with METRO and BTD will be important throughout the I-45N PEL Study to ensure that transit needs continue to be accommodated and adverse impacts to existing and future transit service and facilities be minimized.

The H-GAC RTP and the CMP were incorporated in the I-45N PEL Study to guide the identification and development process of the Purpose and Need. Further, both plans will be used to develop the Universe of Alternatives during the alternative development phase and to assess if alternatives are consistent with the regional plans in the alternative evaluation process.

2 http://metronext.org/about/

3 https://www.regionalserviceplanning.org/texas_regions/coordination_plans/13-brazos-valley/coord-plan-2017.pdf

3.4 *Local Planning*

Local governments play an important role in guiding transportation projects, often serving as the experts on study areas and corridors. All published local government plans involving the study area will be considered as part of the I-45N PEL study. The following counties and cities are engaged in the I-45N PEL Study process:

- Harris County
- Montgomery County
- Houston
- Conroe
- Shenandoah
- Oak Ridge North
- The Woodlands

3.5 *Previous Studies*

The I-45N PEL Study builds on information from previous studies, including plans developed by the entities listed in the previous section, to gain a better understanding of the corridor history. The *Summary of Previous Studies* Report (July 2019) provides a high-level review of 45 previous studies that relate to the I-45N study area. The I-45N PEL Study will incorporate information from these previous studies throughout the study process.

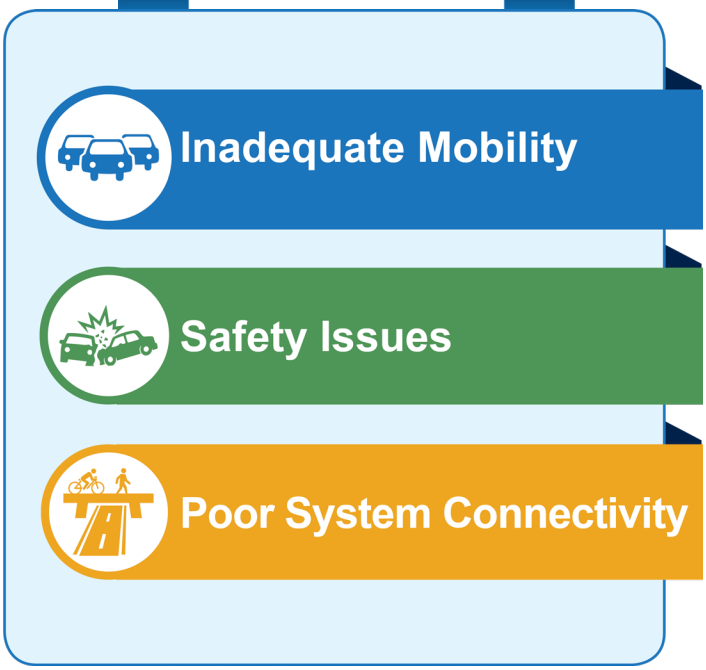
A consistent finding across the studies is that the Houston region is anticipated to experience population and economic growth (Figure 7). As a result of these considerable increases in the number of residents and jobs in the region, congestion issues are expected to worsen. As a major north-south transportation route, I-45N regularly experiences high traffic volumes and congestion. Several studies recommend mobility improvements for the corridor, including improving direct connectors, adding high occupancy vehicle (HOV) lanes and/or managed lanes, augmenting transit service, expanding bikeways, and applying various other methods to address congestion issues within the I-45N corridor.

Figure 7: Future Growth in the Houston Area

4 NEED FOR IMPROVEMENT

The needs identified for this study are based on quantitative measures, such as traffic volumes, traffic operations, roadway level of service, crash data, freight connectivity, multi-modal connectivity, and travel time measures. As shown in Figure 8, the three project needs for this study include:

Figure 8: Study Needs



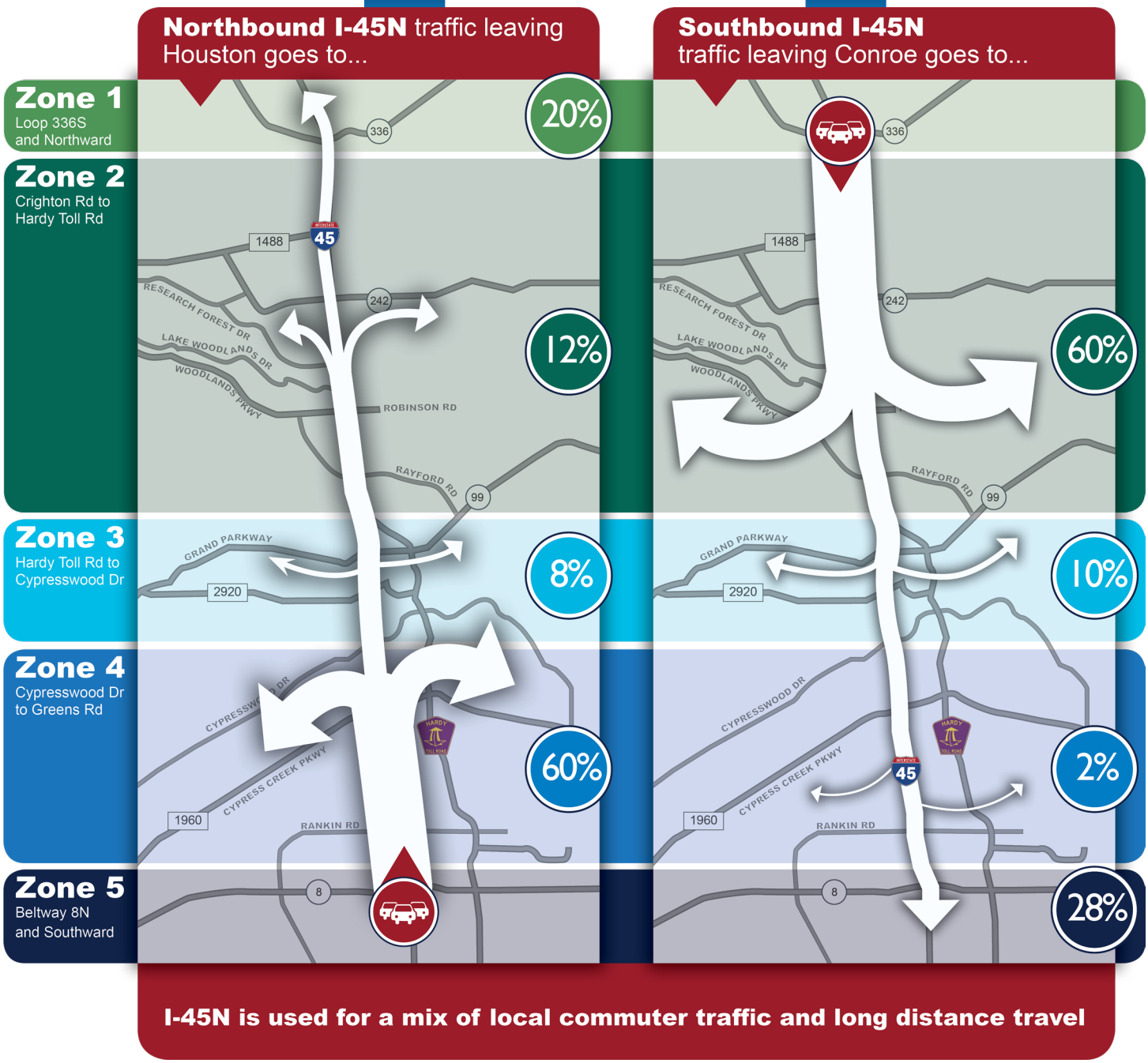
- **Inadequate Mobility:** Existing congestion along the I-45N mainlanes and frontage roads causes delays and unreliable travel times for users along the corridor. Traffic congestion and travel times are projected to further deteriorate in the future, resulting in longer daily commutes and increased transportation costs for freight companies.
- **Safety Issues:** During the five years from 2012 to 2016, the crash rates along the I-45N corridor were higher than the statewide average for similar interstate facilities.
- **Poor System Connectivity:** I-45N has limited accessibility and connections to the local roadway network, parallel facilities, and alternative modes of transportation. Many existing interchanges are inadequate to handle existing traffic effectively and safely, a situation that is expected to worsen in the future.

The following sections describe the existing and forecasted future conditions that function as the foundation for the project needs. The conditions of the corridor act as both a demonstration of the need for transportation improvements, and as a baseline against which alternatives can be evaluated in future project phases.

4.1 *Inadequate Mobility*

As both a primary roadway connecting Houston and Dallas and as a major north-south commuter route in the Houston area, I-45N is heavily traveled by both short- and long-distance travelers. Figure 9 illustrates the typical travel patterns in the corridor, demonstrating that I-45N provides important access and connects cities along the corridor and beyond. The volume of traffic in the corridor, congestion of the roadways, and travel time reliability all help to paint a picture of how the roadways within the corridor function today, and where improvements can be made in the future.

Figure 9: I-45N Daily Travel Patterns

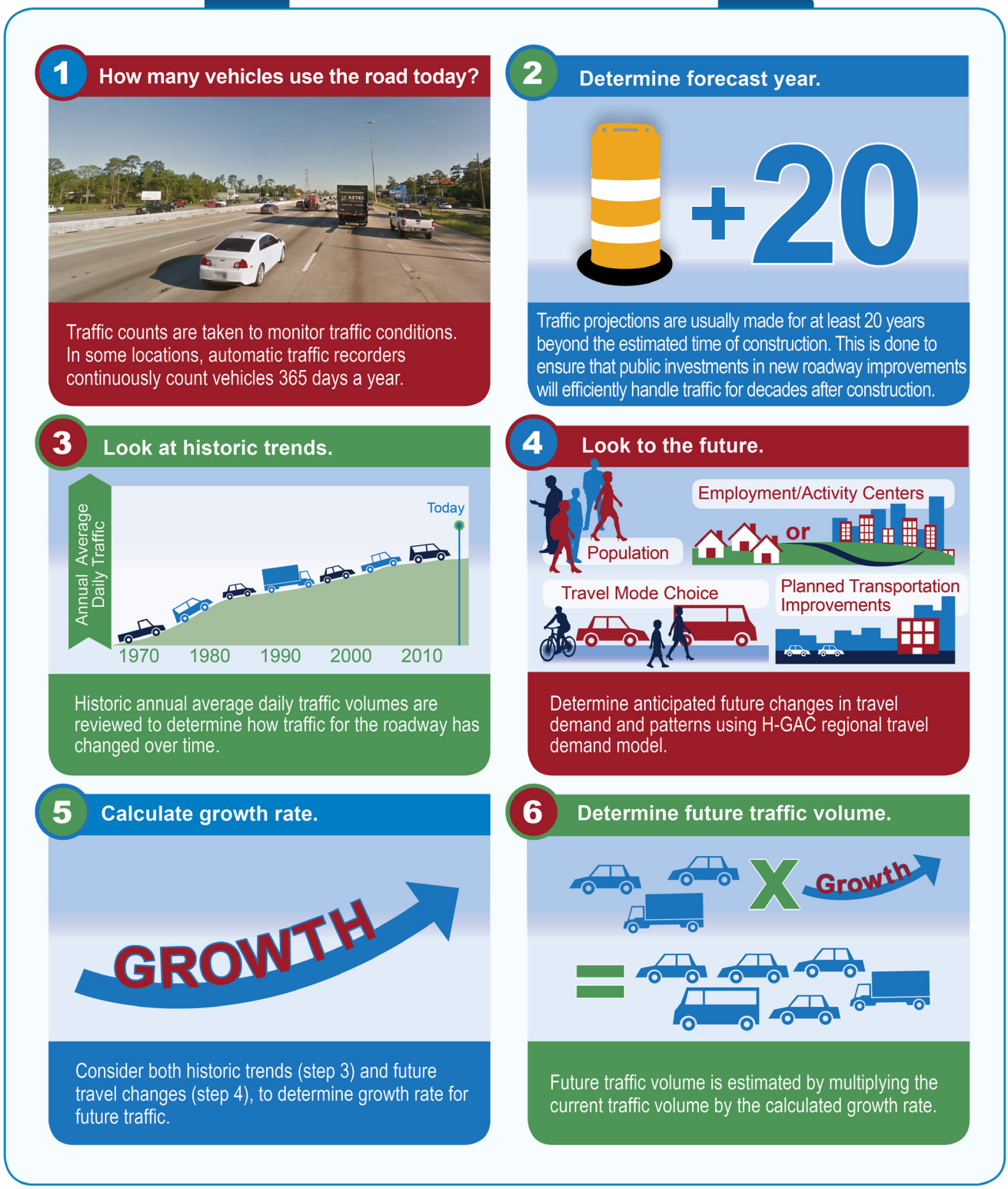


Source: O-D data collected via bluetooth in 2017

4.1.1 Traffic Volume Trends

Traffic volume is an important measure of a roadway's usage as a whole and for specific segments along a roadway. Traffic volumes are based on traffic count data collected in 2017.[4] Future traffic volumes were developed based on historic growth trends and anticipated changes in travel patterns using H-GAC's conformity regional travel demand model. Figure 10 provides an overview of the traffic forecast process.

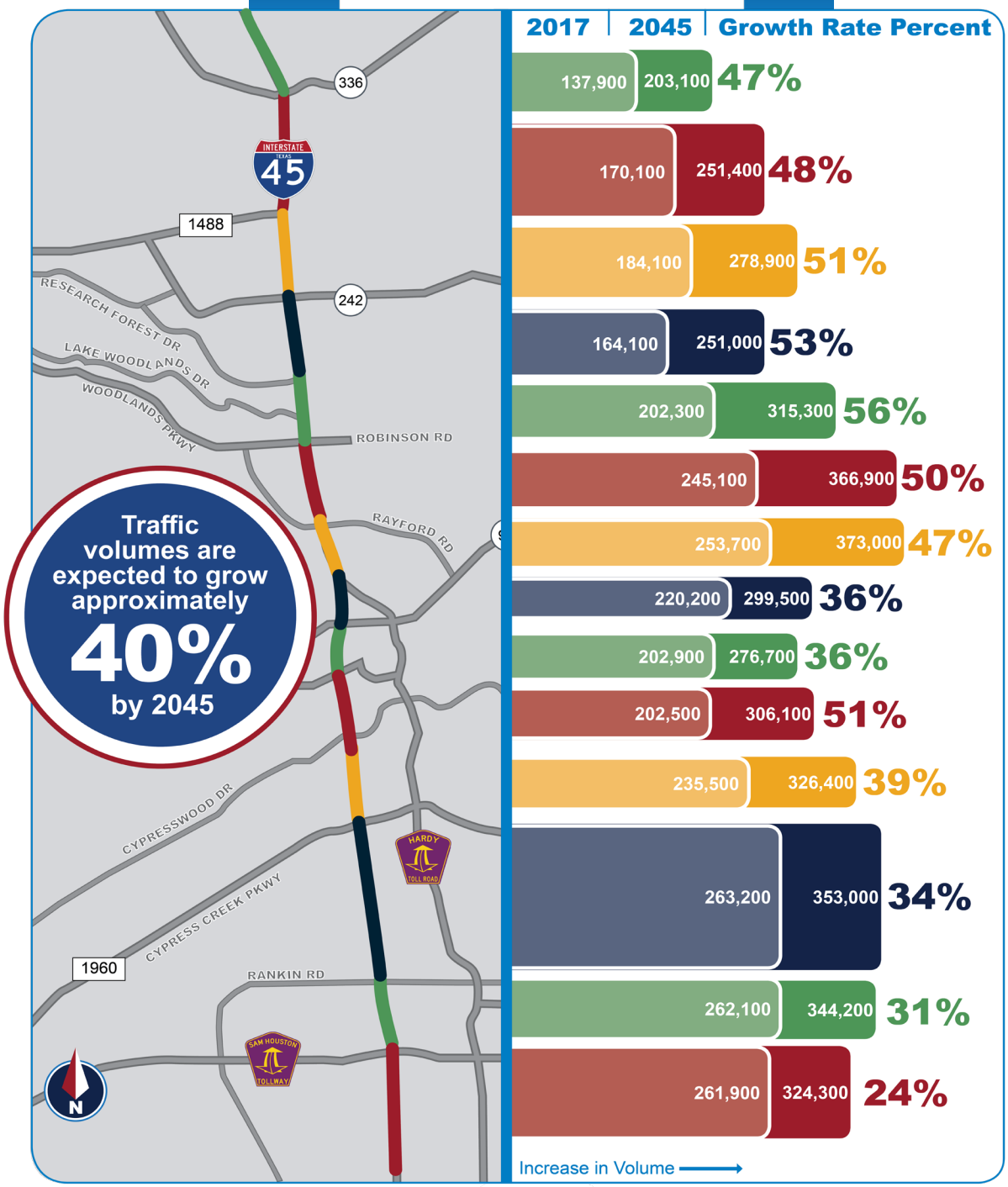
Figure 10: Traffic Projection Methodology



[4] Detailed explanations of traffic volume data collection and methodology are available in the Data Collection Memorandum (February 2018) and the Existing and Future No-Build Traffic Analysis Report (September 2019).

Mainlane daily traffic volumes along the corridor generally increase from north to south (Figure 11), due to the higher population and employment densities in the southern section of the study corridor. Traffic volumes are generally higher at interchanges with major highways such as State Highway 99 (SH 99) and the Hardy Toll Road. The growth rates that were applied to the mainlanes range from 0.8 percent to 1.6 percent per year, with lower growth occurring in the existing highly-developed areas in the southern part of the corridor. The highest cumulative growth rate from 2017 to 2045, at 56 percent, is expected within the segment of I-45N between Woodlands Parkway and Research Forest Drive.

Figure 11: 2017 Daily Traffic Volumes

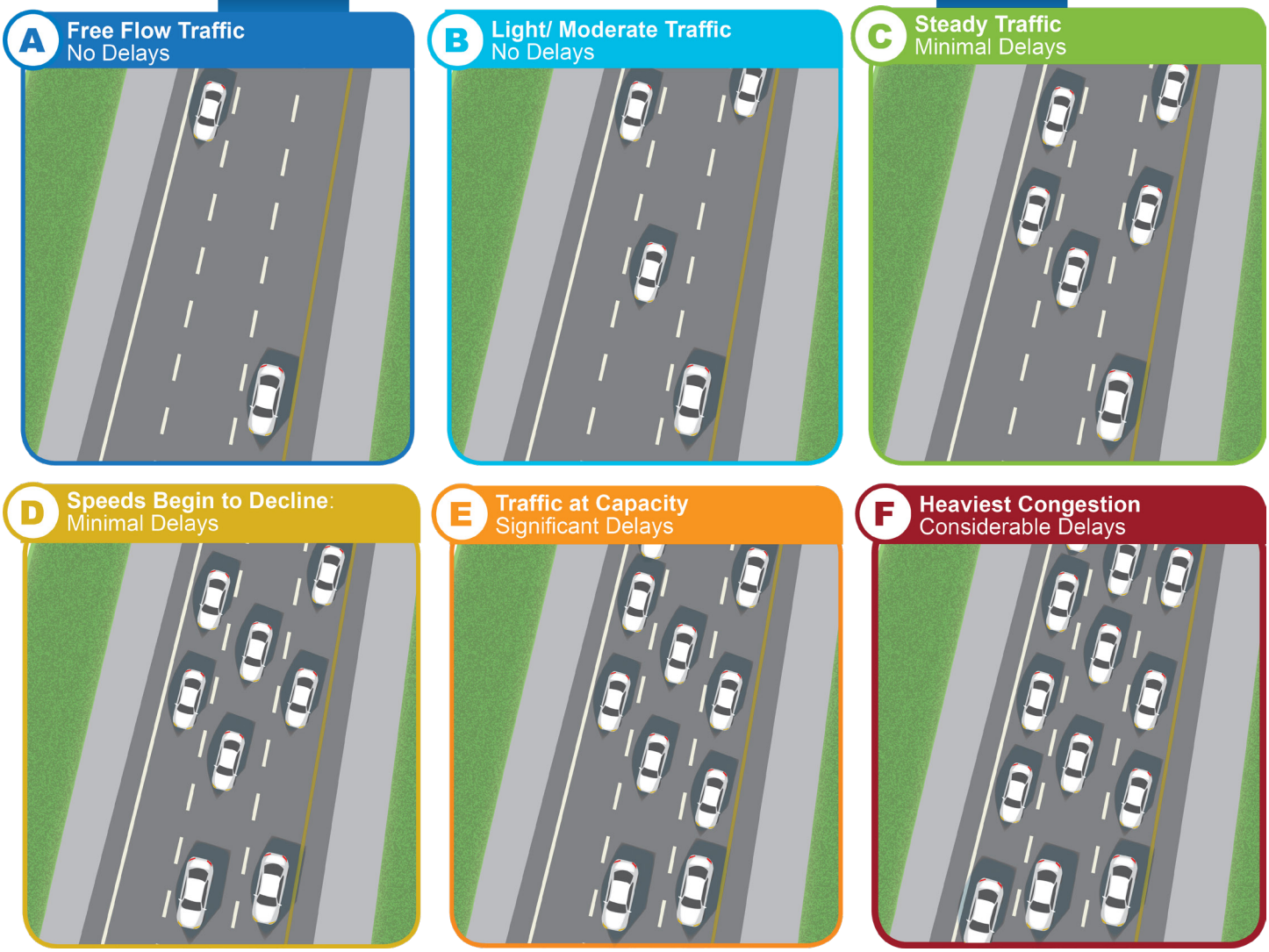


Traffic volume data was also collected for frontage roads. Frontage road intersection traffic volumes are based on turning movement counts collected in May and September 2017 at each of the signalized intersections along the I-45N frontage roads. These traffic volumes were used to complete the intersection operational analysis, summarized in the following section.

4.1.2 Traffic Congestion

The mainlanes and frontage road intersections were analyzed for 2017 and 2045 traffic operations. The traffic operations of a roadway are typically represented by its Level of Service (LOS). The LOS provides a qualitative indication of the traffic conditions on a roadway or at an intersection, ranging from A (no congestion) to F (most congestion), as illustrated in Figure 12.

Figure 12: Level of Service Characteristics



The 2017 and 2045 traffic operations were calculated for both the mainlanes and frontage road intersections. The 2017 mainlane traffic conditions are generally poor in both travel directions during both the AM and PM peak periods. Many of the segments of I-45N currently operate at LOS D or worse in both the AM and PM peak periods. Increases in traffic volumes over time are anticipated to exacerbate congestion, as shown in Figure 13 and Figure 14. By 2045, the majority of I-45N is expected to operate at LOS F in both the AM and PM peak periods. Similar to the 2017 conditions, congestion on I-45N is expected to be worse during the 2045 PM peak period compared to the AM peak period.

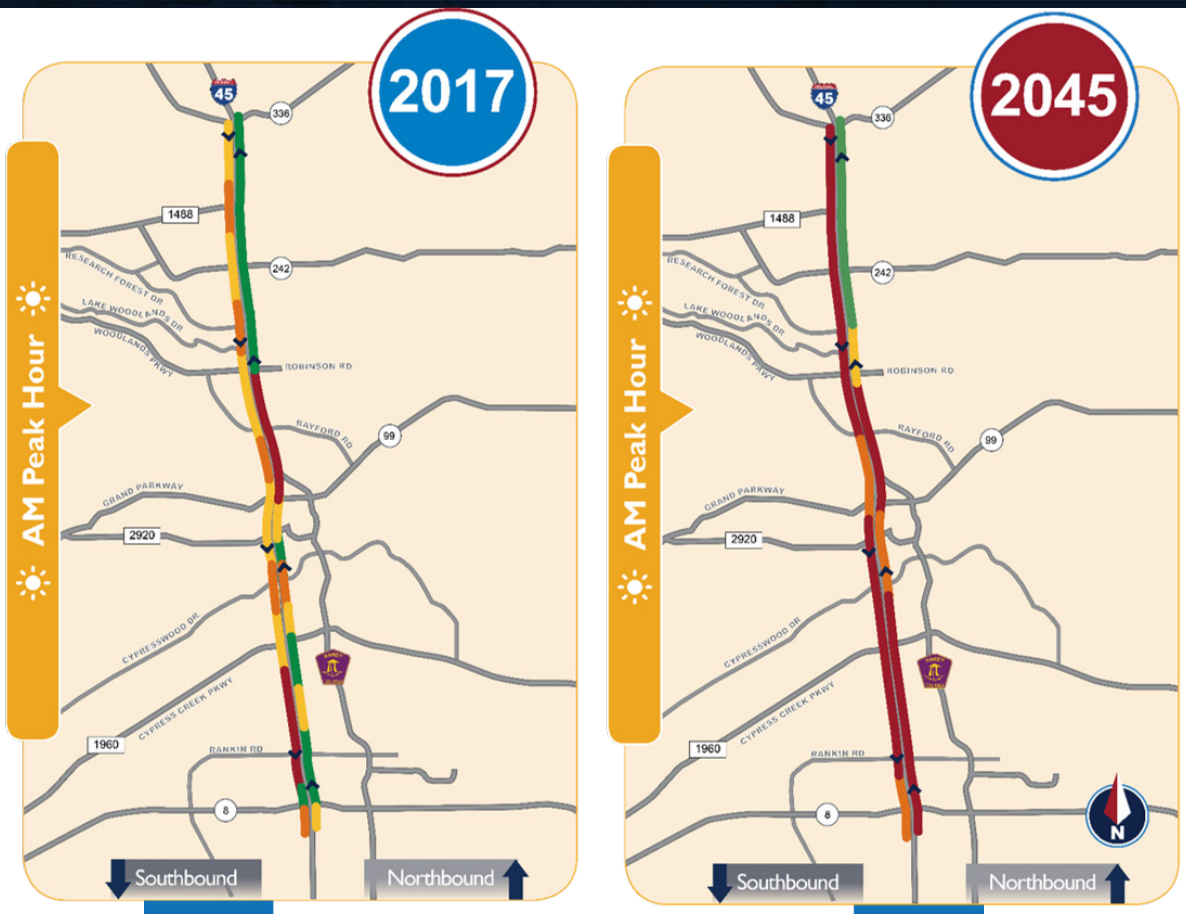


Figure 13: AM Peak Mainlane Level of Service

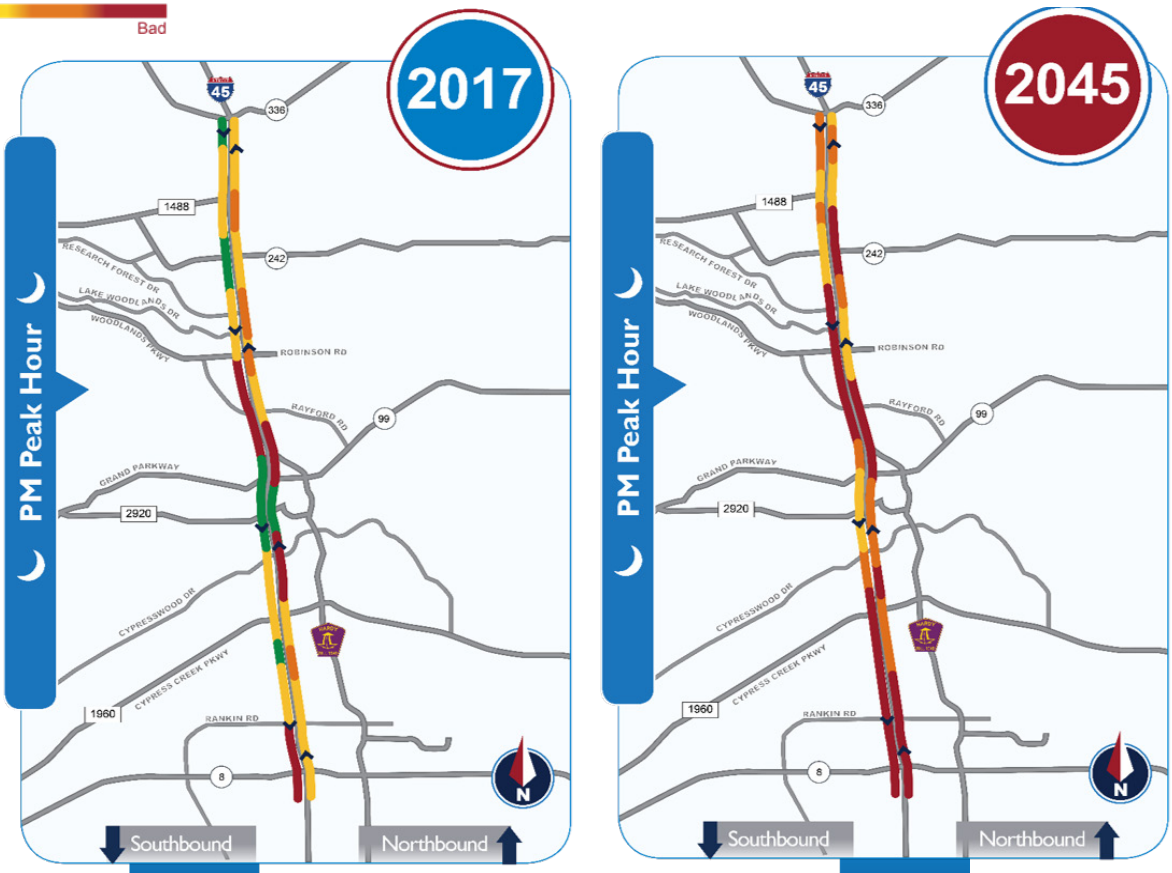


Figure 14: PM Peak Mainlane Level of Service

Frontage road signalized and unsignalized intersections are also operating poorly today, especially in the PM peak period. Figure 15 shows that the number of intersections experiencing high traffic congestion in the AM peak period will significantly increase by 2045. It is estimated that 14 signalized intersections will operate at LOS E or LOS F in the AM peak period compared to six signalized intersections already operating at LOS E or LOS F today. In the 2017 PM peak period, nearly half of the signalized intersections and all of the unsignalized intersections in the study corridor experienced high traffic congestion. The traffic operations for both signalized and unsignalized intersections in the PM peak period are anticipated to worsen under 2045 traffic volumes, as shown in Figure 16. In 2045, all signalized intersections in the corridor will operate at LOS F in the PM peak period, and all unsignalized intersections will continue to experience high traffic congestion.

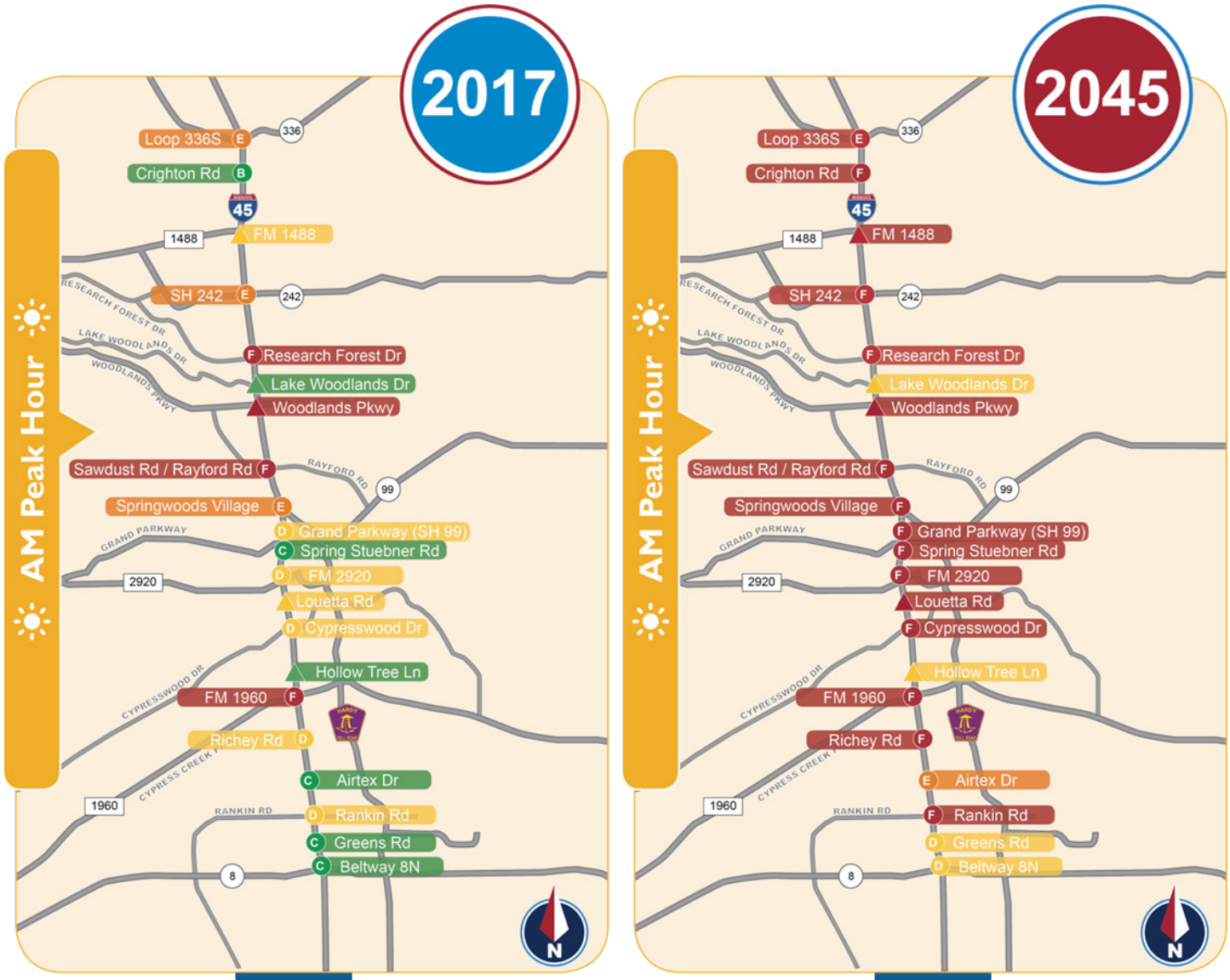


Figure 15: AM Peak Intersection Level of Service

Grading Scale

A/B/C D E F

Good Bad

Legend

Low Congestion

Moderate Congestion

High Congestion

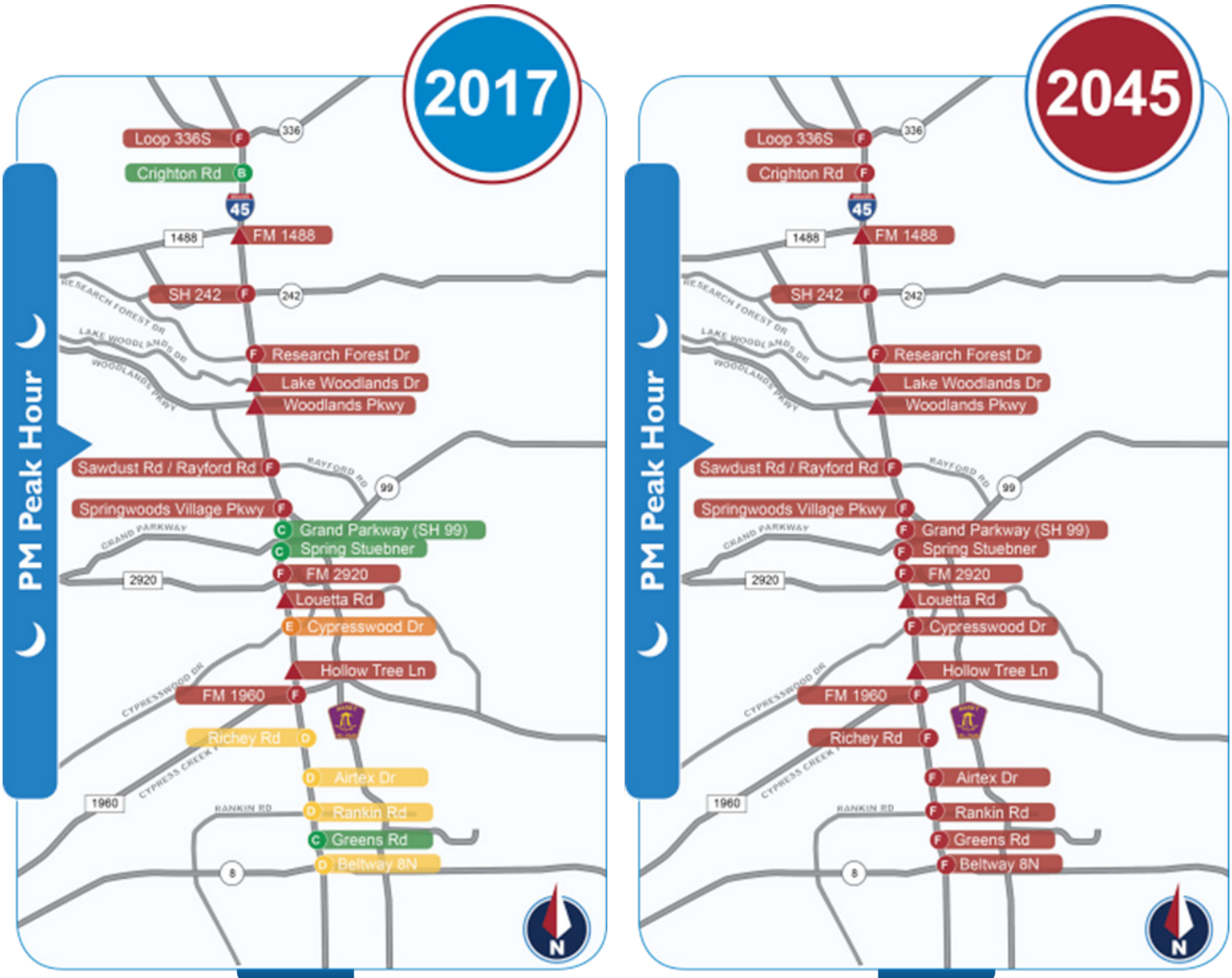


Figure 16: PM Peak Intersection Level of Service

Grading Scale

A/B/C D E F

Good Bad

Legend

Low Congestion

Moderate Congestion

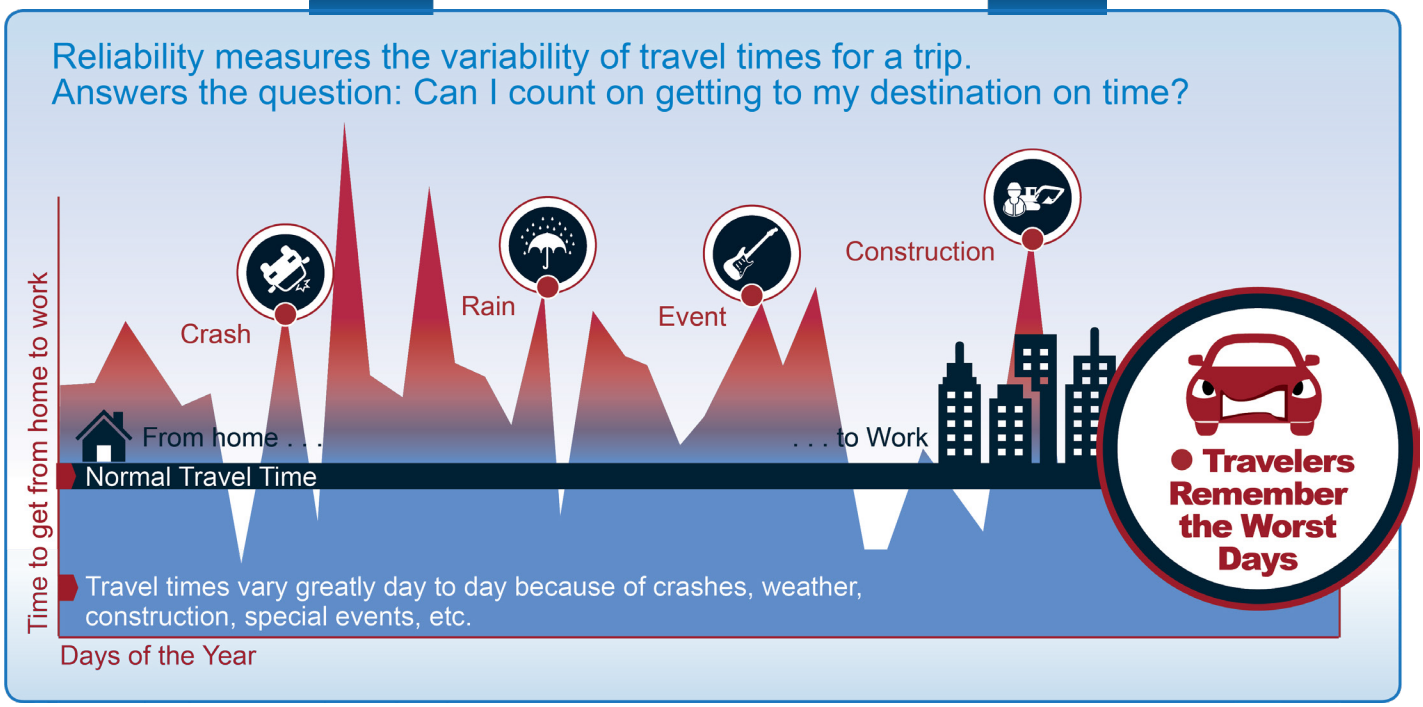
High Congestion

Ultimately, existing traffic throughout the corridor is prone to slow speeds, congestion, queuing, difficult lane changing, and limited or no spare capacity to absorb the effects of incidents or inclement weather. Traffic operations are expected to worsen in the future based on the expected increase in population and jobs, and the related strain on the regional transportation network.

4.1.3 Travel Time Reliability

Reliability describes the variability of travel time drivers experience from day-to-day. For example, a typical home-to-work commute time of 20 minutes with little day-to-day variance would be considered a reliable travel time; however, when the commute time of this trip frequently takes twice as long, or more, the travel time would be unreliable. Crashes, weather, work zones, traffic, special events, bottlenecks, and traffic control are all factors that can negatively affect the reliability of a trip (Figure 17).

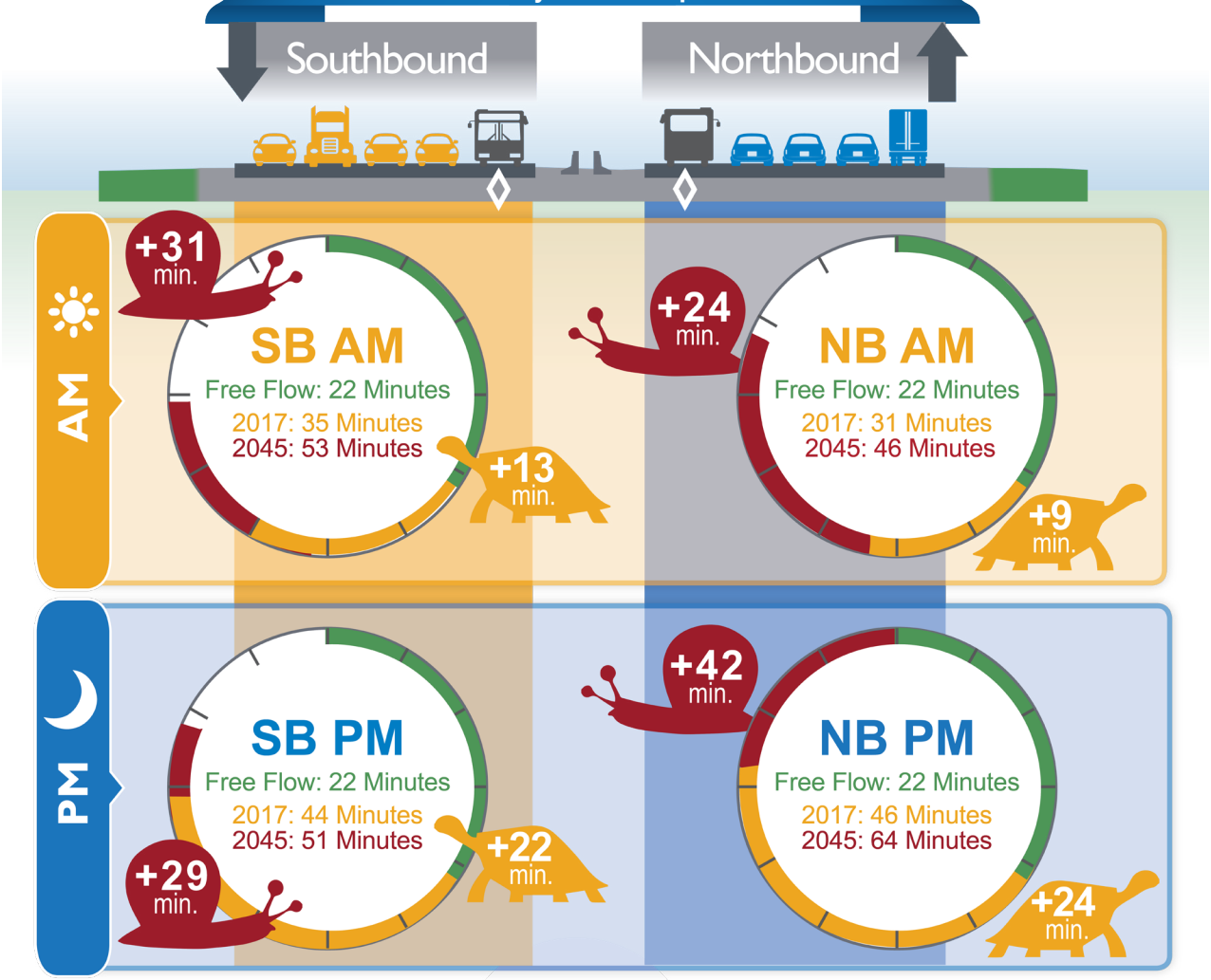
Figure 17: What is Travel Time Reliability?



I-45N generally has unreliable travel times throughout the corridor during both the AM and PM peak periods in both directions. The travel time on I-45N from Beltway 8N to Loop 336S, when driving the speed limit (free flow conditions), is approximately 22 minutes. In 2017, traffic congestion in the AM peak caused 2 to 13 minutes of delay. This delay is anticipated to increase to 13 to 31 minutes in the year 2045 AM peak. For the PM peak, traffic congestion in 2017 caused 7 to 24 minutes of delay. This delay is anticipated to increase to 15 to 42 minutes in the year 2045 PM peak.

Travel time reliability looks at both the typical delay experienced on a daily basis and the delay on the worst days. Figure 18 shows the travel times drivers on I-45N should anticipate today and in the future. Travel times on most days should be better than what is shown in Figure 18, but travel times are expected to be even worse on some days. In 2017, drivers experienced more than 24 minutes of delay about one day each month. In 2045, travel time delays could exceed 42 minutes about one day each month. While travelers can use the HOV and reversible high occupancy toll (HOT) lanes to improve travel time reliability, there is still a need to regularly plan for extra commute time to account for possible traffic, crashes, weather, and other sources of congestion.

Figure 18: Anticipated I-45N Travel Times – Beltway 8N to Loop 336S

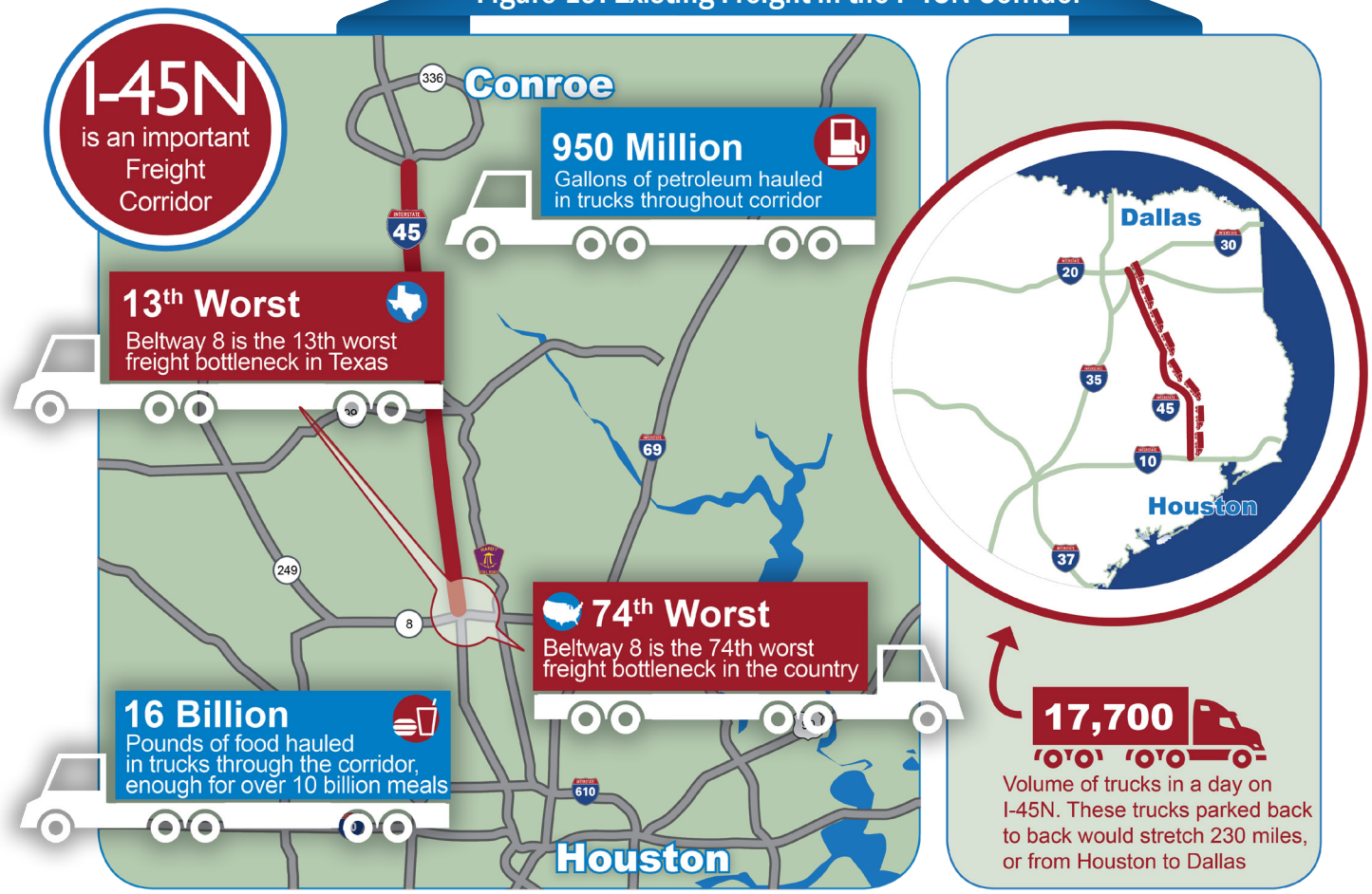


4.1.4 Freight Mobility

As part of the FHWA-designated Primary Highway Freight System and the Texas Highway Freight Network, the I-45N corridor serves as the primary freight link between the two largest metropolitan areas in the state, Houston and Dallas. Accordingly, there is a high level of freight capacity required to connect these growing areas. Freight mobility is an issue for the I-45N corridor, as Beltway 8 is the 13th worst freight bottleneck in Texas, and the 74th worst in the country.

Approximately 18,000 trucks use I-45N each day, accounting for up to nine percent of the total traffic traveling this interstate facility. Figure 19 shows the selected existing freight statistics for the study corridor. Traffic congestion on I-45N can cause major delays for such a high volume of freight traffic, which comes at a price for freight companies and consumers. The estimated cost of congestion to the freight industry in the Houston area exceeded $1.1 billion in 2015.[5] Reliable and predictable travel times are important to reduce costs. Delays encountered at signalized intersections or by waiting at a railroad crossing can impact delivery times and costs. Reducing the number of potential delays along a freight route would improve the consistency of travel times.

Figure 19: Existing Freight in the I-45N Corridor



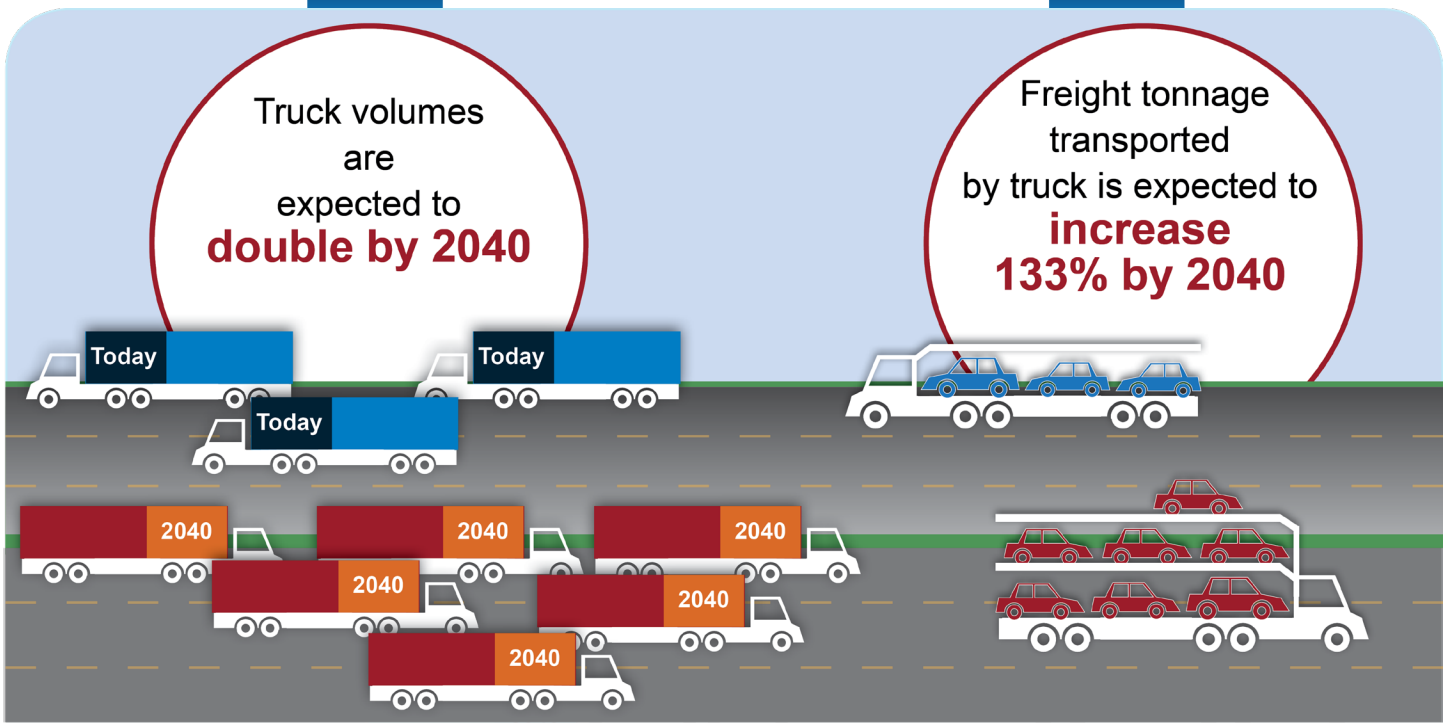
[5] Texas Freight Mobility Plan 2017, page 7-14; http://ftp.dot.state.tx.us/pub/txdot/move-texas-freight/studies/freight-mobility/2017/plan.pdf

The high volume of freight traffic on I-45N can be attributed to a number of freight generators in the region, including those listed below.

- **George Bush Intercontinental Airport:** Ranks 19th in the United States airports for landed cargo weight as of 2016.
- **Union Pacific railroad corridor parallel to I-45N:** Westfield Yard and Lloyd Yard are located in the study area. Westfield Yard is adjacent to Toyota's Gulf States Vehicle Processing Center.
- **Port of Houston:** I-45 connects to the Port of Houston, which is approximately 22 miles from the study area. I-45 is a major north-south artery for transporting imported goods from the port throughout the region, state, and country.
- **Numerous warehouses and distribution centers throughout the corridor:** 10 major warehouses and distribution centers are located in proximity to the I-45N corridor, ranging in size from approximately 155,000 square feet to nearly five million square feet.

Freight is important to the existing and future economy of Houston area and the state of Texas. The amount of freight and dependence on trucks for transportation will increase in the future. As a primary truck route, the increase in freight is expected to double the truck volumes along I-45N by the year 2040 (Figure 20).

Figure 20: Future Freight in the I-45N Corridor



Bridges also play an important role in freight mobility, requiring a vertical clearance that is high enough for freight travel. TxDOT standards were recently updated to increase the required design vertical clearance from 16 feet 6 inches to 18 feet 6 inches along primary freight corridors like I-45N. The purpose is to accommodate oversize or overweight vehicles, military transportation needs, and facilitate efficient movement people and goods. Based on this criterion, 23 bridges over the study corridor have a vertical clearance that is less than the minimum requirement, as shown in Figure 21.

Figure 21: Vertical Clearance Requirements for Freight

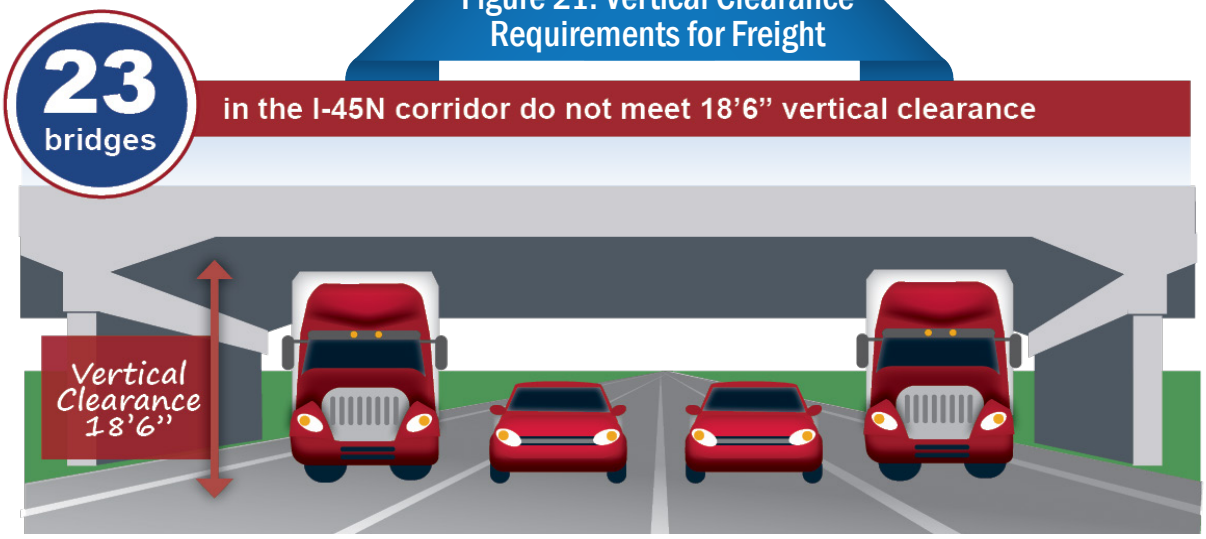
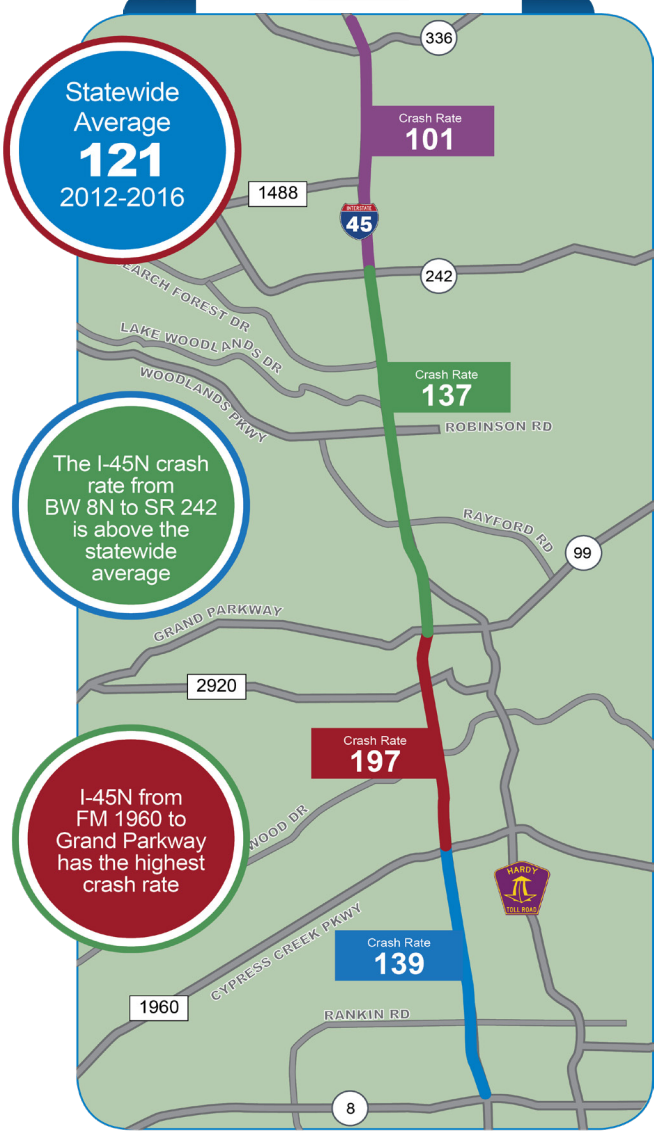


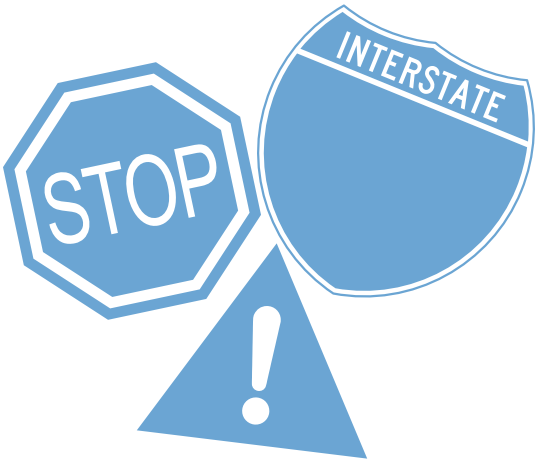
Figure 22: I-45N Overall Corridor Crash Rate



***Crash rates are the number of crashes per hundred million vehicle miles traveled**

4.2 *Safety Issues*

One of TxDOT's key goals is to promote safety, which involves reducing crashes and improving safety guidelines and education. Safety was evaluated for the study corridor using five year crash rates, derived from the 2012 to 2016 crash history obtained through TxDOT.[6] The overall I-45N corridor crash rate of 143, consisting of combined mainlane and frontage road crashes, is significantly higher than the state average of 121 for urban interstates.[7] Figure 22 breaks down the crash rate by segment, with the highest crash rate occurring between Farm-to-Market Road 1960 (FM 1960) and SH 99.

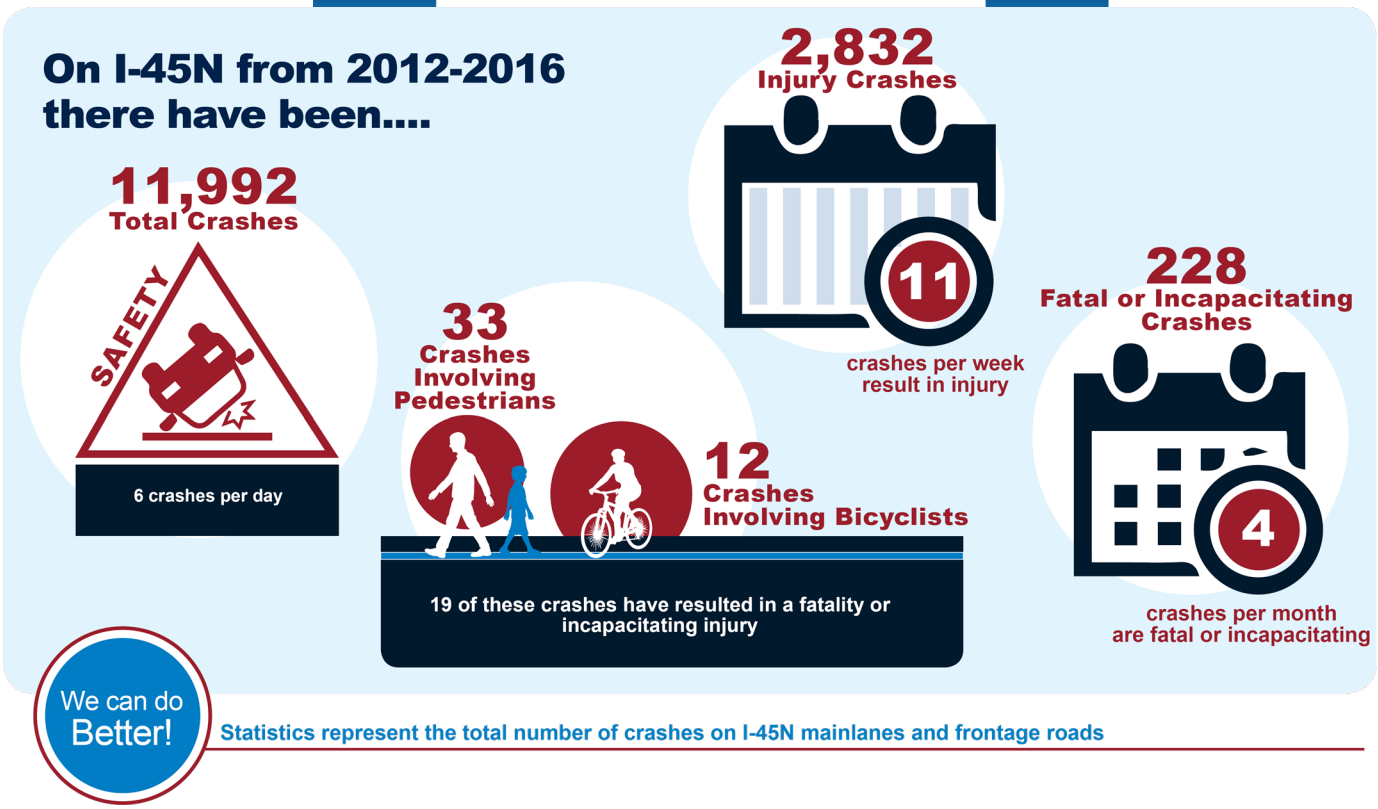


6 Detailed explanations of crash analysis data collection and methodology are available in the Existing Conditions Report (June 2018).

7 Crash rates are expressed as crashes per hundred million vehicle miles traveled

Figure 23 provides a summary of the safety statistics for the I-45N corridor. Within the five year time frame, there were nearly 12,000 total crashes in the corridor, of which 24 percent resulted in injuries and two percent resulted in fatal or incapacitating injuries. Furthermore, 45 crashes involved bicyclists or pedestrians on the mainlanes or frontage roads, signaling a critical need for safety improvements across numerous modes of transportation. These rates are higher than similar urban interstates in Texas, signifying that there is a distinct need for safety improvements within the overall I-45N corridor.

Figure 23: How Safe is the I-45N Corridor?



4.2.1 Mainlane Crash Analysis

Most mainlane locations with the highest crash rates are concentrated in the southern portion of the study corridor with eight of the top 10 located south of Spring Cypress Road, as shown in Figure 24. This finding suggests that more crashes occur in areas with dense development, many conflict points, and high traffic volumes. Congestion, geometry, merging, weaving, and sight distance are considered the most common causes of crashes on the I-45N mainlanes, based on an evaluation of the potential causes of high crash rates. Crashes on the mainlanes were also analyzed by injury severity and crash type, as summarized in Figure 25. Rear end crashes were the most common type of crash, followed by side swipe crashes. The majority of mainlane crashes resulted in property damage and a total of 26 crashes resulted in fatality. The type and severity of mainlane crashes are likely a product of the majority of traffic traveling in the same direction at high speeds.

Figure 24: Top Ten I-45N Mainlane Crash Locations

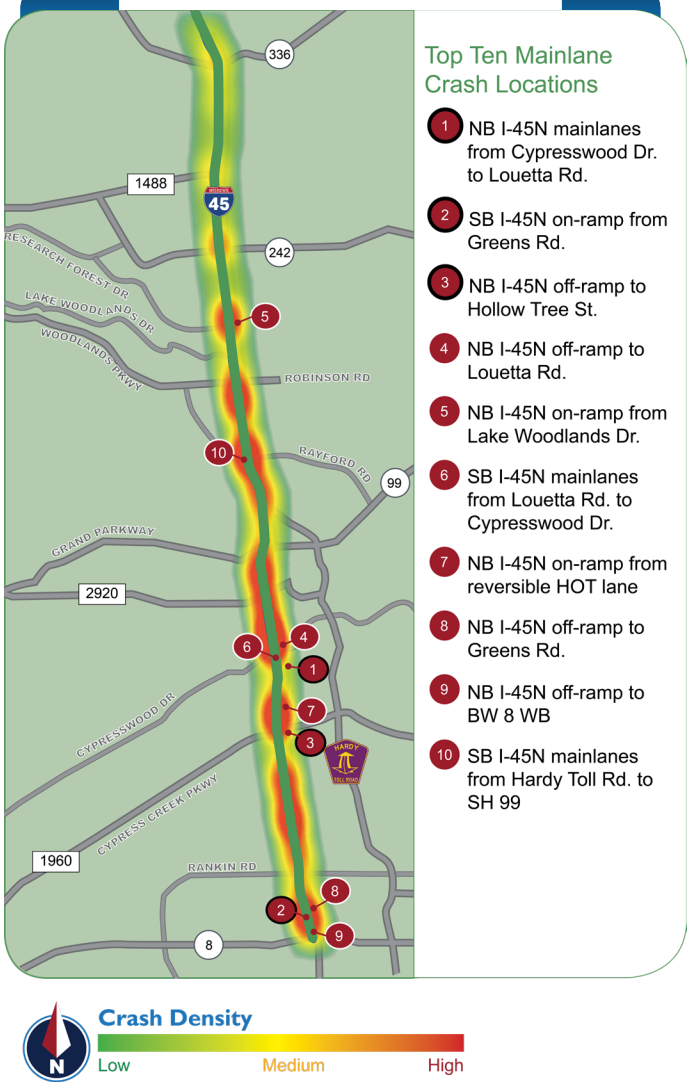
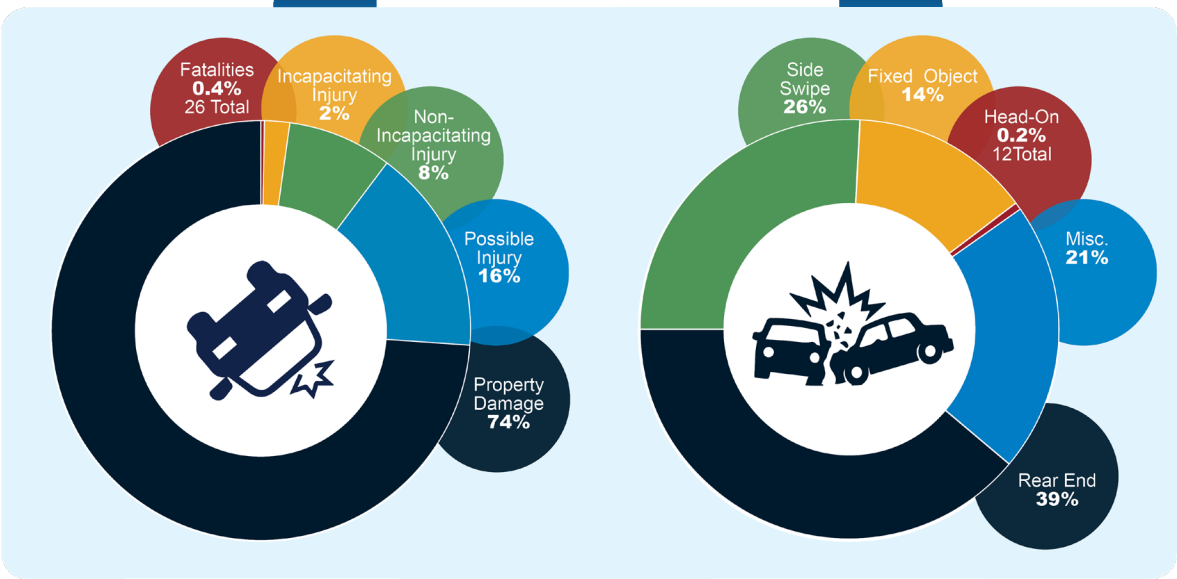


Figure 25: I-45N Mainlane Injury Severity and Crash Type



4.2.2 Frontage Road Intersection Crash Analysis

Top crash locations at frontage road intersections are scattered along the I-45N study area. High crash rates among frontage road intersections are typically concentrated within major commercial areas with high traffic volumes. Based on an evaluation of possible causes for high crash rates at frontage road intersections, the most common cause is poor geometry, right turn merges, and driveway spacing. Figure 26 provides an overview of the top ten crash locations at frontage road intersections within the I-45N study area based on crash rate. Fixed object crashes are the most common type of frontage road intersection crash, followed by angle crashes, as summarized in Figure 27. The majority of frontage road intersection crashes resulted in property damage, and 11 of these crashes resulted in fatality.

Figure 26: Top Ten I-45N Frontage Road Intersection Crash Locations

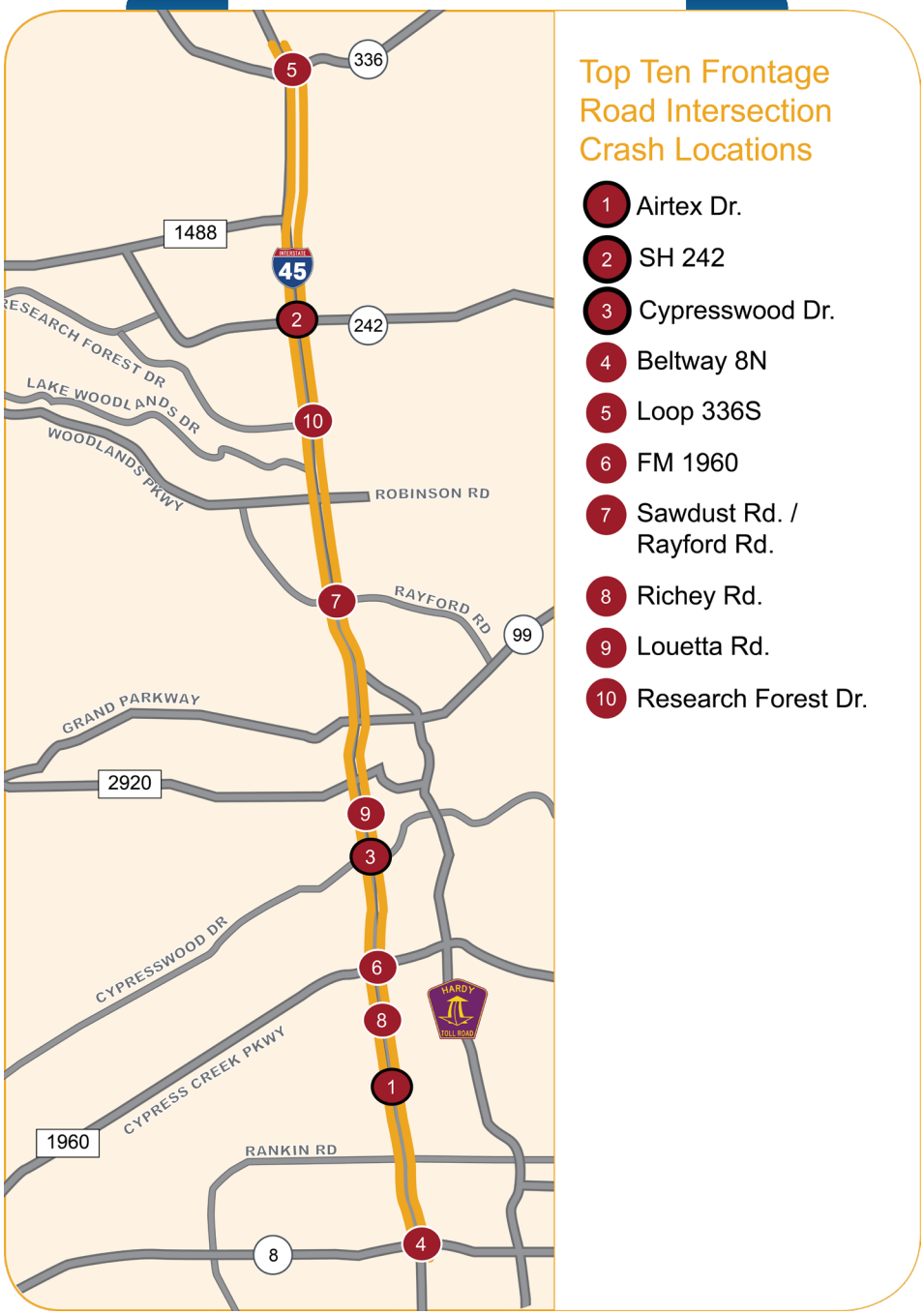
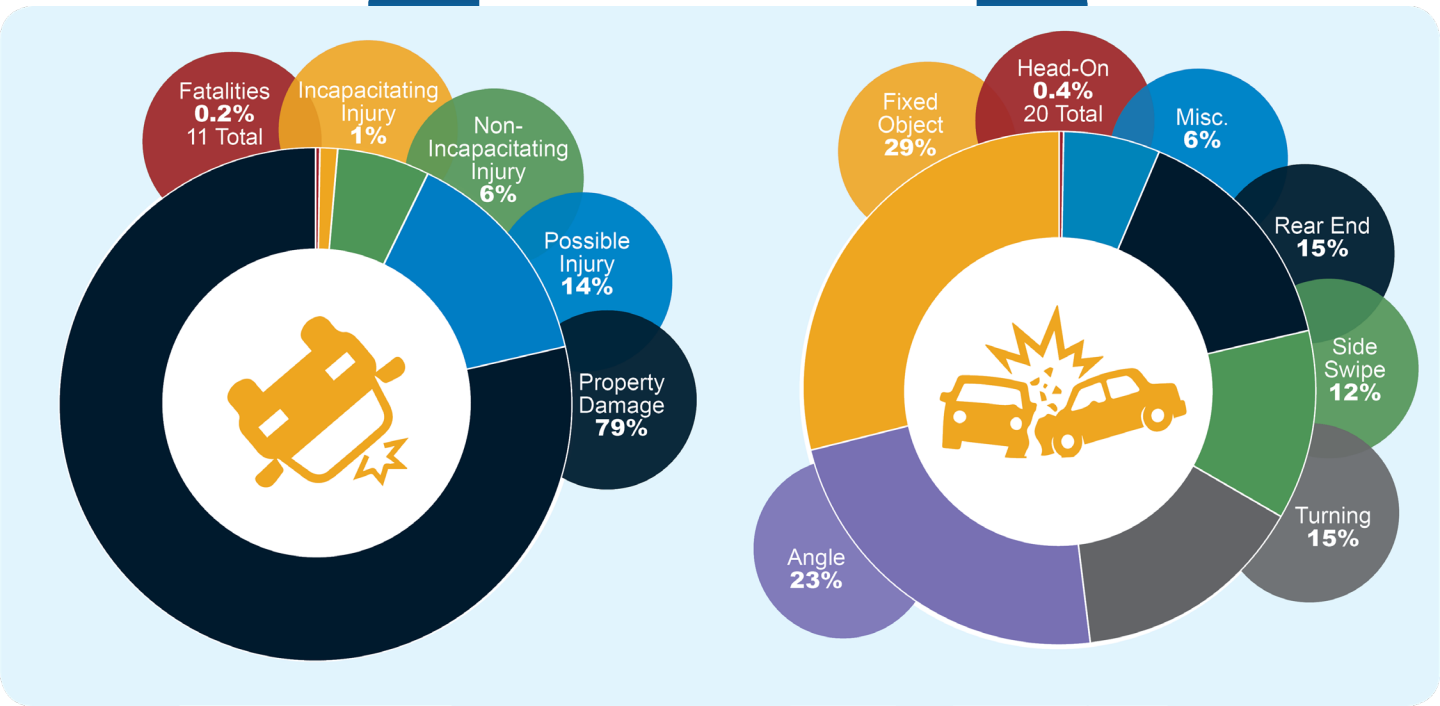


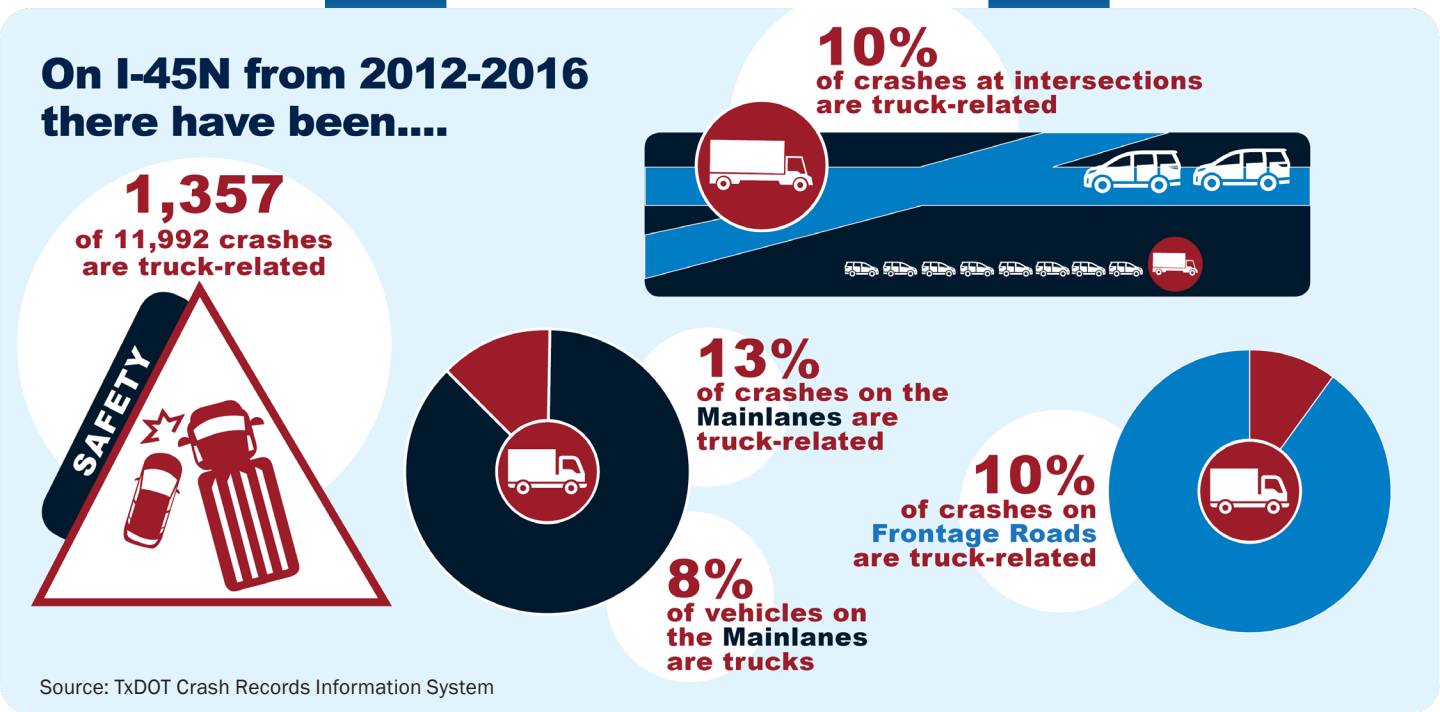
Figure 27: Frontage Road Intersection Injury Severity and Crash Type



4.2.3 Truck-Related Crashes

Because I-45N is a key freight corridor, a high volume of trucks use the I-45N mainlanes and frontage roads. Truck-related crash information was extracted from the crash analysis data to provide insight on the extent of crashes in the corridor that involve trucks, as summarized in Figure 28.

Figure 28: Truck-Related Crash Statistics



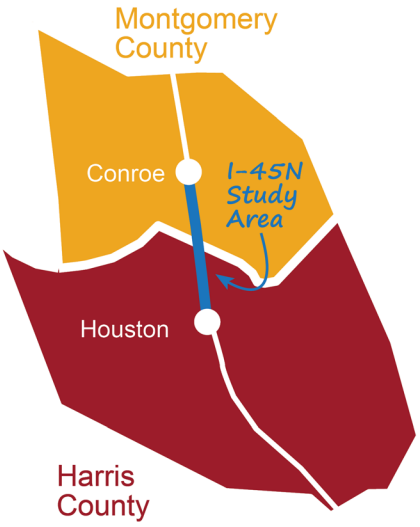
Source: TxDOT Crash Records Information System

Truck-related crashes are an important indicator of the I-45N corridor's safety issues. Although trucks comprise only eight percent of the vehicles on the I-45N mainlanes, they are involved in 13 percent of the mainlane crashes. While a five percent difference may not seem significant, the proportion of truck-related crashes exceeds the share of trucks driving on the I-45N mainlanes, which signifies a safety issue. Truck- related crashes are also prevalent on frontage roads and at intersections. Trucks are generally much larger than the other vehicles traveling throughout the I-45N corridor, suggesting that any truck-related crash could become more serious than a crash involving passenger cars.

4.3 *Poor System Connectivity*

The I-45N corridor is part of a regional transportation system that should aim to provide good accessibility to all municipalities and connections for all transportation modes. Connectivity in the I-45N corridor in some developed locations has become inadequate due to rapid development, which has led to congestion and safety issues. East-west connectivity, interchange connectivity, transit connectivity, and bicycle and pedestrian connectivity were evaluated for the I-45N corridor. Figure 29 provides a high-level summary of connectivity by county.

Figure 29: Connectivity Summary by County



Measure of Connectivity	Harris County	Montgomery County
Linear Miles of I-45N within the Study Area	12	12
Number of I-45N Grade Separated Crossings	14	11
Number of I-45N Interchanges	12	7
Number of I-45N Crossings with Bus Routes	5	4
Number of I-45N Crossings with Bicycle Accommodations	1	1
Number of I-45N Crossings with Pedestrian Accommodations	7	5

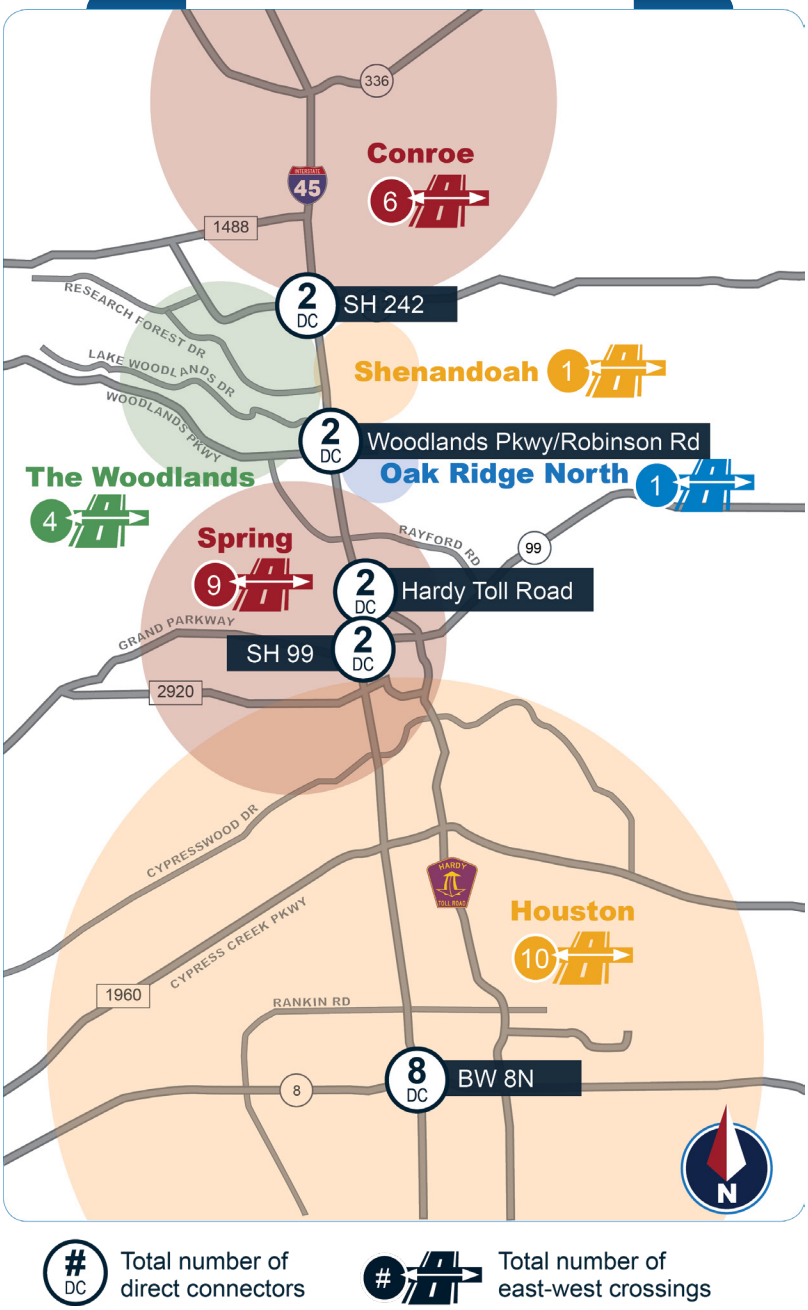
4.3.1 East-West Grade Separation and Interchange Connectivity

As a major north-south oriented roadway facility, I-45N acts as a barrier to east-west movement. Along the I-45N study area, a total of 25 grade separated crossings provide east-west connectivity to the surrounding municipalities. The east-west crossings are not evenly spaced throughout the I-45N study area. Figure 30 illustrates the number of crossings that provide access to each of the municipalities along the study corridor. Some crossings provide access to multiple municipalities. Therefore, the total number of municipality connections presented in Figure 30 exceeds the number of grade separated crossings. For example, Woodlands Parkway/ Robinson Road provides access to both The Woodlands and Oak Ridge North.

South of the Hardy Toll Road, the spacing between east-west crossings is approximately one mile. North of the Hardy Toll Road, there are about two miles between east-west crossings. Limited accessibility can worsen congestion in some municipalities more than others, as limited crossings or long distances between crossings can place strain on the east-west connections that are located within a municipality.

Interchanges are a vital component of roadway connectivity, providing access to and from freeways, major roadways, and local roads. The interchanges provide access to the cross roads via ramps that connect to the frontage roads. Interchange geometry plays a significant role in the way an interchange functions. In the I-45N corridor, cloverleaf intersections such as FM 1488, Woodlands Parkway, Louetta Road, and Hollow Tree Lane, all experience significant traffic congestion due to the design and configuration of these interchanges.

Figure 30: East-West Connectivity by Municipality



Direct connectors are another component of connectivity, providing convenient uninterrupted access between the I-45N mainlanes and the crossing road. As seen in Figure 30, direct connectors are not evenly spread throughout the I-45N corridor, and sometimes only exist for certain directions of an interchange. The SH 99, Hardy Toll Road, Woodlands Parkway/Robinson Road, and SH 242 interchanges each have direct connectors for only two movements. The absence of direct connectors for the other directions limits accessibility and increases traffic volumes along the frontage roads.

4.3.2 Transit

The existing transit service in the I-45N corridor includes local bus, express bus, Park-n-Ride, trolley, and shuttle services. METRO provides transit service throughout Harris County, and the Brazos Transit District operates trolley and Park-n-Ride service in Montgomery County. While there are 14 transit routes that currently operate in the I-45N study area, half of the routes are specific to the Park-n-Rides, providing service during peak hours only. The majority of all-day transit service exists in Harris County, with only one route, The Woodlands Trolley, operating all day in Montgomery County. Additional local bus service is planned in Conroe, and additional trolley service is planned in The Woodlands. Figure 31 shows select statistics about transit connectivity in the I-45N corridor.

Three Park-n-Ride lots are located in the I-45N study area, and two more Park-n-Ride lots are located just west of the study area. In order for Park-n-Rides to remain a reasonable option for travelers, there must be exceptional connectivity between I-45N, Park-n-Rides, and transit service. The longer the transition time between driving, parking, and riding transit, the less likely that travelers will use Park-n-Rides. For this reason, a Park-n-Ride's location is especially important, along with a convenient connection to I-45N and transit.

Figure 31: Transit Connectivity

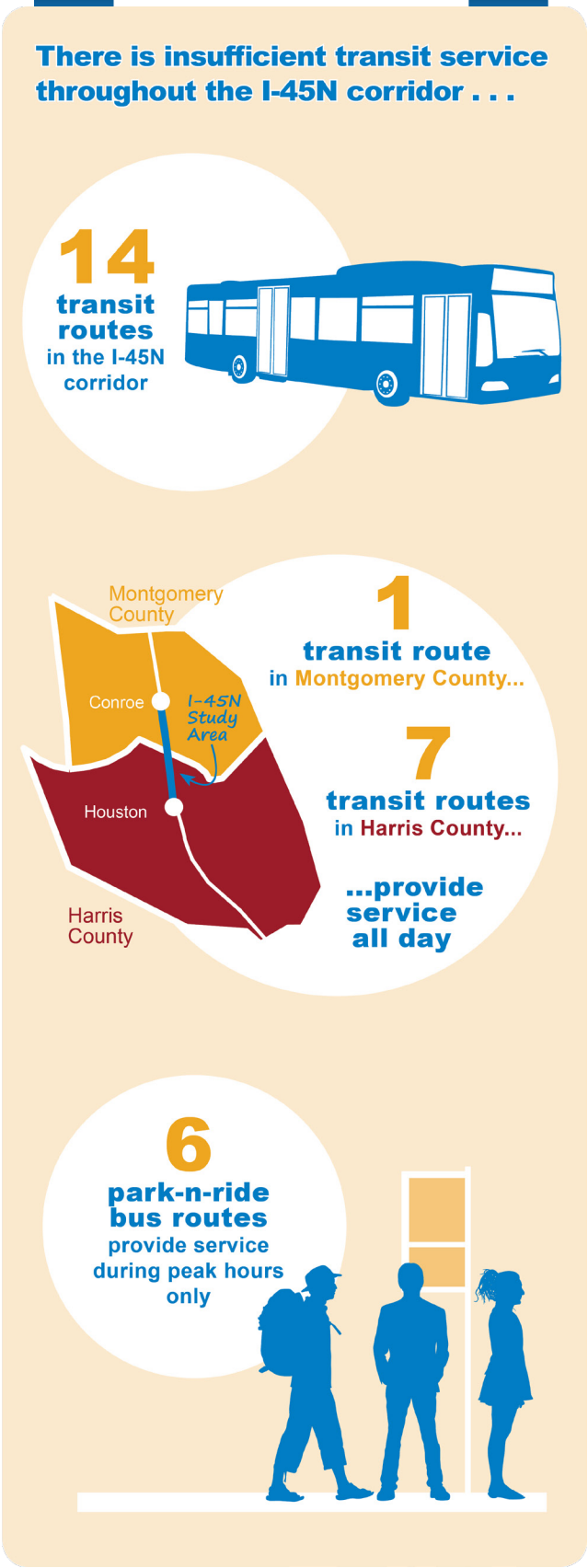
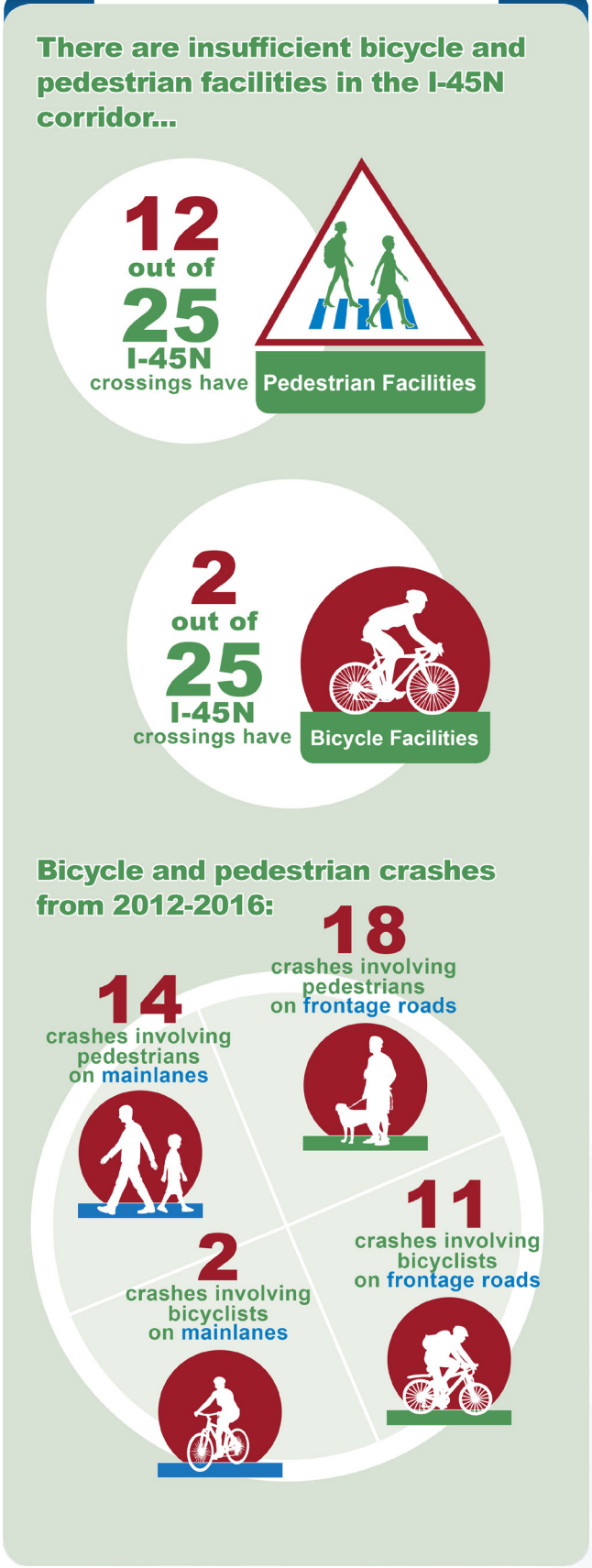


Figure 32: Bicycle and Pedestrian Connectivity

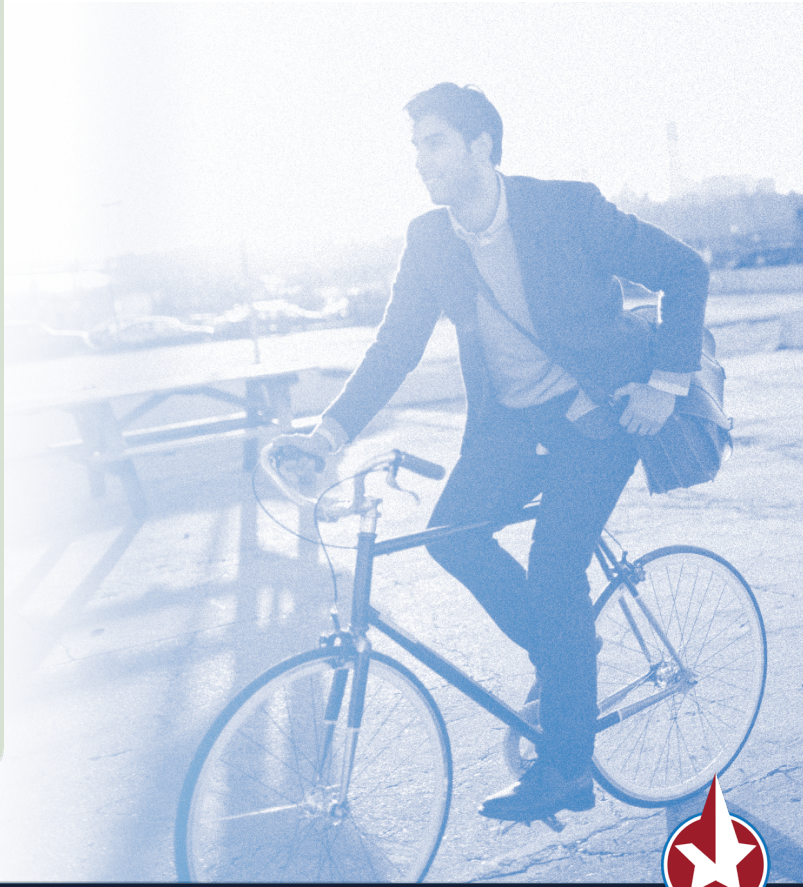


Crash Data Source: TxDOT Crash Records Information System

4.3.3 Bicycle and Pedestrian Facilities

While there are several existing bicycle and pedestrian facilities in the I-45N study area, many are disconnected and fail to provide an integrated network for bicycle and pedestrian travel. Bicycle and pedestrian facilities tend to be located parallel to I-45N with limited east-west connections. As a major interstate facility, I-45N acts as a barrier for bicyclists and pedestrians to cross I-45N. Pedestrian facilities such as sidewalks, crosswalks, and curb ramps exist at 12 of the 25 grade separated crossings. Pedestrian infrastructure at several of these locations provides limited accessibility to the surrounding area due to a disconnected sidewalk network. There are very few bicycle facilities in the I-45N study area, with only two located along crossing roads, west of I-45N. Neither bicycle facility crosses I-45N. Figure 32 displays bicycle and pedestrian connectivity statistics for the I-45N corridor.

The lack of pedestrian and bicycle facilities has led to crashes as people have tried to cross the I-45N mainlanes and frontage roads. Pedestrian and bicycle crashes tend to be severe, and 19 of the 45 crashes on I-45N resulted in a fatality or incapacitating injury. Improving connectivity between bicycle and pedestrian facilities to create an integrated network would improve safety and reduce barriers to those considering walking or bicycling as a viable mode of transportation.



5 STUDY GOALS AND OBJECTIVES

The purpose of the I-45N PEL Study is to identify solutions to address the existing and future transportation needs of the I-45N corridor by improving mobility for all users and goods, reducing crashes, and enhancing local and regional accessibility and connections between transportation modes.

Goals and objectives have been established to guide the I-45N PEL Study and to expand the transportation improvements developed during future project phases to provide viable solutions beyond the project needs. Figure 33 lists the goals established for this study.

Figure 33: Study Goals and Objectives

Improve mobility and travel time reliability	Reduce frequency and severity of crashes
Improve system connectivity and accessibility: • Enhance east-west connections • Improve interchanges and access to/from the I-45N mainlanes • Improve connections to parallel facilities	Improve transit accessibility and connections to I-45N
Improve bicycle and pedestrian facilities	Improve accommodation of freight traffic
Enhance economic development and strong regional economic competitiveness	Minimize impacts to natural and built environments
Maximize use of existing right-of-way	Accommodate future technology to promote sustainability
Reduce roadway flooding	Improve functionality and resiliency of I-45N as a hurricane and emergency evacuation route
Maintain and preserve existing I-45N infrastructure	Identify and prioritize short-term solutions for quicker implementation of improvements
Incorporate cost-effective solutions	Achieve active stakeholder and public participation throughout study

6 INPUT FROM PUBLIC AND STAKEHOLDER GROUPS

Stakeholder groups and the public have provided essential input on the issues and goals to consider for the I-45N PEL Study. TxDOT has engaged stakeholder groups and the public beginning early in the study process, and will continue to seek feedback and involvement from these groups throughout the development of the study to make informed planning decisions for the study corridor. Between December 2017 and June 2018, TxDOT held multiple stakeholder, Project Ambassadors Committee (PAC), and public meetings to gather input on the corridor's challenges and opportunities, and the goals for the PEL study.[8] Figure 34 illustrates some of the groups who are providing input throughout the I-45N PEL Study process.

[8] Detailed information on the input gathered during the first round of public meetings is available in the Documentation of Public Meeting report (May 2018).

Figure 34: Who Provides Input on the I-45N PEL Study?

Overall, I-45N experiences high levels of congestion and travel delays that impact businesses, residents, freight traffic, and the economy. Traffic in the corridor results in an increased potential for crashes and safety, as well as degradation of air quality and the surrounding environment. There is a general consensus that the corridor could improve connectivity across the study area and region and provide more options to travel using alternative transportation modes.

7 SUMMARY

There are several identified transportation deficiencies throughout the I-45N corridor. A review of previous studies, public input, and an evaluation of the existing and future conditions of the corridor indicate that the I-45N corridor suffers from the following:

- Inadequate mobility
- High levels of traffic congestion
- Unreliable travel times
- Poor freight mobility
- High crash rates
- Poor local and regional accessibility
- Incomplete connections between transportation modes

The I-45N PEL Study is intended to address these transportation deficiencies by identifying potential solutions that improve mobility for all users, reduce crashes, and enhance local and regional accessibility. While the alternatives developed as part of this study should primarily meet the specified needs of the I-45N corridor, there may be opportunities to incorporate solutions that provide supplementary benefits to the region. The project goals identified in this document should guide the solutions developed for the corridor in order to address the project needs. Ultimately, the needs, purpose, and goals identified in this document should serve as the foundation for the planning decisions made throughout the course of the I-45N PEL Study and influence future transportation planning decisions.