ES.4.19 Vegetative Community Impacts

The Preferred Alternative, 10R, would directly impact approximately 1,025.27 ac of agricultural vegetation, 635 ac of forest, 24 ac of riparian zone, and 15 ac of non-forested wetland, for a total vegetative community impact of 1699 ac. The No-Build Alternative would not impact vegetative communities.

ES.4.20 Wildlife

The primary significant impacts to wildlife species inhabiting the project area are loss of habitat and habitat fragmentation. The Preferred Alternative would impact approximately 690 acres of wildlife habitat. The wildlife habitat is comprised of bottomland hardwood forests, upland pine/hardwood forests, Gulf Coast prairie rangelands, and cultivated cropland habitats. The No-Build Alternative would not impact wildlife.

ES.4.21 Floodplains

Avoidance of floodways and floodplains during the development of the Preferred Alternative was carefully balanced with avoidance of other sensitive resources in the project areas. The Preferred Alternative would encroach on the following streams and their associated regulatory floodways and floodplains: Peach Creek, Caney Creek, East Fork San Jacinto, Luce Bayou, East Fork Cedar Bayou, and Cedar Bayou.

The Preferred Alternative would potentially impact approximately 43 ac of floodway and 158 ac of 100-year floodplain. The proposed project would have little to no impact to regulatory floodways as these would be bridged. Further avoidance and minimization of floodplain encroachments would be considered during preliminary and final design of the selected Preferred Alternative. Under the Preferred Alternative, rainfall runoff rates would be expected to increase slightly due to an increase in impervious pavement surface area; however, the increased runoff would be mitigated and not alter or affect the natural and beneficial floodplain functions, values, or characteristics. The proposed project would not increase the water surface elevation of the base flood more than 1-ft at any point. The No-Build Alternative would not impact floodways or floodplains.

ES.4.22 Non-Archeological Historic Resources

There is one site with two National Register of Historic Places (NRHP) recommended eligible resources within the project Area of Potential Effect (APE). Resources 030a and 030b are located on the south side of FM 1485, outside the proposed project ROW but within the APE. There would be no direct effect to Resources 030a and 030b as a result of this project. They would be separated from the proposed project location by existing FM 1485, which would become a frontage road. There would be no direct effect to this

resource due to the construction of the project. In addition, there would be no indirect effect to the resource. The resource's original orientation towards the FM 1485 would not change and therefore, its original setting and association would not change. The No-Build Alternative would not impact non-archeological historic resources.

ES.4.23 Section 4(f)

A *de minimis* Section 4(f) evaluation was prepared to address the potential impacts from the proposed project, as well as efforts to avoid, minimize, and mitigate impacts to the Lake Houston Wilderness Park. The proposed construction of the Preferred Alternative would potentially impact 10.84 ac of the park; however, it would not adversely affect the features, attributes, or activities that qualify the Lake Houston Wilderness Park as a recreation area, and subsequently a Section 4(f) resource. The Preferred Alternative would improve access to the Lake Houston Wilderness Park by enhancing the existing access points, which complies with the City of Houston's Lake Houston Park Master Plan dated March 24, 2009. The improved park entrance design would be determined at a later date during the design phase of the project, with coordination with TxDOT, TPWD, and the City of Houston. No other parks or recreation areas publicly owned parklands, wildlife or waterfowl refuges, recreational areas, or known historic sites would be directly impacted by the Preferred Alternative. The No-Build Alternative would not impact publicly owned parklands, wildlife or waterfowl refuges, recreational areas, or known historic sites. The No-Build Alternative, however, would not provide the opportunity to enhance access to the Lake Houston Wilderness Park.

ES.4.24 Hazardous Material Impacts

The No-Build Alternative would not result in hazardous materials impacts associated with the construction or operation of the proposed project. The Preferred Alternative would have minimal risks for hazardous materials impacts. Impacts would most likely occur on or near existing hazardous materials sites. There were 18 total sites identified within or near the Preferred Alternative. However, only nine of the 18 sites fall within the proposed ROW of the Preferred Alternative. These sites create a higher potential for encountering hazardous contamination during construction. All nine of the sites may affect the Preferred Alternative, and should be further reviewed prior to ROW acquisition.

The Railroad Commission of Texas (RRC) records (2012) indicate that there are 24 well sites located within or adjacent to the ROW for the Preferred Alternative. The Preferred Alternative, 10R, would have 10 impacted wells.

Asbestos and lead-based paint investigations for all structures impacted by the Preferred Alternative would be addressed during the ROW acquisition process prior to construction.

The Build Alternatives cross/impact approximately 64 petroleum pipeline segments. During further project development, owners and/or operators of these pipelines would be contacted. During ROW negotiation, determinations would be required to make necessary adjustments and/or relocations of these pipelines. If proper precautions are taken, impacts related to petroleum lines within the project area should be minimal.

There would be no anticipated impacts from hazardous materials or pipelines with the No-Build Alternative.

ES.4.25 Railroads

The Preferred Alternative would cross four rail lines in the project corridor owned by UPRR. In each case, the individual track would not be impacted by the proposed project, due to an elevated roadway structure anticipated at the crossing locations. TxDOT would coordinate with UPRR for access, design, and construction phasing during the design/build phase of the project. Therefore, no long term adverse impact to any railroad line or operation is anticipated from the Preferred Alternative or the No-Build Alternative.

ES.4.26 Energy

The Preferred Alternative would have greater energy consumption as compared to the No-Build Alternative. Approximately 4.7 percent more British thermal Units (Btu) per day are predicted to be consumed under the reasonable alternatives than under the No-Build Alternative. Approximately 14,000 more gallons of fuel would be consumed under the Preferred Alternative due to the increase in VMT/day.

The No-Build Alternative would not result in energy impacts associated with the construction or operation of the proposed project. The No-Build Alternative would not have the short-term energy impacts from construction, but it also would not benefit from operation energy efficiencies gained through an improved transportation facility over many decades.

ES.4.27 Construction Impacts

Construction impacts may include temporary degradation of air and water quality, increase in the noise levels, impedance to mainstream traffic operation, safety concerns resulting from changes in traffic flow patterns, aesthetic issues due to stockpiling and disposal of construction materials, as well as mitigation in project specific locations. Construction activities would temporarily affect residents and businesses along

the project corridor as well as travelers in the vicinity.

Air Quality: Construction activities associated with the facility could have a short-term impact on local air quality during periods of site preparation. Particulate matter, also known as fugitive dust, has the greatest impact during construction activities. Any effects of fugitive dust would be temporary and would vary in scale depending on local weather conditions, the degree of construction activity, and the nature of the construction activity. During construction, the contractor would be required to adhere strictly to dust control measures to minimize this effect.

Noise: Heavy equipment operations and certain construction activities, such as pile driving and the vibratory compaction of embankments, would result in temporary noise increases within the area.

Water Quality: Effects to water quality resulting from erosion and sedimentation, as well as from pollutants such as chemicals, fuels, lubricants, raw sewage, and other harmful waste, would be strictly controlled.

Maintenance and Control of Traffic: Maintenance of the current flow of traffic on the existing roadway network would be planned and scheduled to minimize adverse impacts to the traveling public.

Health and Safety: All reasonable safety considerations and safeguards necessary would be taken to protect the life and health of employees on the job, the safety of the public, and the protection of property in connection with roadway construction.

There are no construction impacts with the No-Build Alternative.

ES.4.28 Relationship of Local Short-Term Uses Versus Long-Term Productivity

Construction of the proposed Segments H and I-1 Preferred Alternative would cause limited short-term adverse effects on the environment. The short-term uses of the environment associated with the Preferred Alternative include construction-related noise, air quality impacts, water quality impacts, and visual impacts. In comparison to these short-term impacts, the most evident long-term benefit of the Preferred Alternative is the improved local and regional system linkage, decreased congestion, safety, and improved emergency evacuation. In addition, several long-term economic benefits would result from the construction of the proposed project. There are no impacts with the No-Build Alternative.

ES.4.29 Irreversible and Irretrievable Commitments of Resources

Construction of the proposed Segments H and I-1 Preferred Alternative 10R would involve an irreversible and irretrievable commitment of resources. These include a range of physical, human, natural, and economic resources. The commitment of land for the proposed ROW would be 1,933 acres. This land includes residential and business properties, farmland, natural and forested landscapes. Land occupied by the proposed Segments H and I-1 would be considered an irreversible commitment during the period that the land is used for a highway facility. However, if a greater need arises for use of the land, or if the highway facility is no longer needed, the land could be converted to another use.

The natural resources required for construction includes aggregate, cement, asphalt, sand, and iron ore for steel products. Once used for construction, these resources cannot be replaced as natural resources. They are not in short supply, and their use would not have an adverse effect upon the continued availability of these resources. Construction would also require an expenditure of fossil fuel. Although this is an irretrievable resource, the amount expended toward construction could be offset by the benefits to improved mobility in the region that could improve fuel efficiency. The commitment of these resources is based on the concept that residents in the immediate area, state, and region would benefit by the improved quality of the transportation system. These benefits would consist of improved mobility and safety, system linkage resulting in savings in time, and providing infrastructure to support population growth that are anticipated to outweigh the commitment of these resources. There would be no impact with the No-Build Alternative.

ES.4.30 Indirect and Cumulative Impacts

The induced growth was mapped through information gathered from meetings with local elected officials, participating agencies and an expert panel survey. The potential indirect effects due to the proposed Segments H and I-1 may include the following:

- Development and land use changes due to improved access;
- Impacts due to tolling;
- Runoff increases due to changes in land use and increased development on land surrounding the proposed facility;
- Increased sedimentation of wetlands and streams and decreased water quality due to future development of land adjacent to the new facility;
- Increased use of parks and recreational areas due to more convenient access provided by the new facility; and

- Stimulation of the local economy from the circulation of construction spending; improved access to employment opportunities, markets, goods, or services such as health and education; an increased work force related to construction; and development stemming from the new facility.

For the Preferred Alternative, four major resources/issues were identified that warranted a detailed discussion that includes: land use; air quality (Mobile Source Air Toxics); surface water; and environmental justice due to tolling. There would be no impacts with the No-Build Alternative.

ES.4.31 Mitigation

When impacts are unavoidable, steps would be taken to minimize impacts and mitigate for impacts, as required under the National Environmental Policy Act (NEPA), FHWA, and TxDOT guidelines. Every effort has been made in the selection of alternatives and the identification of the Preferred Alternative to avoid or minimize adverse effects to the human and natural environments. Where impacts to resources require coordination and permitting, required processes would be followed with the appropriate agency with resource jurisdiction.

ES.4.32 Summary of Environmental Consequences

Impacts to the social, economic, natural, and cultural environment would result from construction of the Preferred Alternative and are evaluated in detail in this document. **Table ES-2** summarizes the potential impacts of the Preferred Alternative. The Preferred Alternative was developed within the Segments H and I-1 study area through avoidance and minimization of impacts to a number of resources, while addressing the project's purpose and need and providing feasible engineering alternatives. The Preferred Alternative 10R best satisfies the purpose and need while balancing the project's benefits and overall impacts. The No-Build Alternative would have fewer impacts as compared to the Preferred Alternative, 10R; however, the No-Build Alternative would not meet the purpose and need of the proposed project.

ES.5 AGENCY AND PUBLIC COORDINATION

FHWA, TxDOT, and GPA have engaged governmental agencies, resource agencies, and the public in an extensive coordination effort to inform others of progress in the planning process and solicit input from them. The Segments H and I-1 project has been open to comments by any person and to all views on the proposed project, alternatives development, environmental impacts, and any other matter concerning the proposed project. FHWA, TxDOT, and the GPA have considered all comments to date and would continue to consider all comments through the project development process.

A Project Coordination Plan (The Plan) was prepared to facilitate and document the lead agencies' structured interaction with the public and other agencies and to inform the public and other agencies of how the coordination would be accomplished. The Plan outlines how the lead agencies have divided the responsibilities for compliance with the various aspects of the environmental review process, such as the issuance of invitations to participating agencies, and how the lead agencies would provide opportunities for input from the public and other agencies, in accordance with applicable laws, regulations, and policies. The Plan identifies which participating/cooperating agencies were included for the proposed project and their roles and responsibilities.

Elected officials and agency coordination meetings were held throughout the development of the EIS process at important milestones of the process that included the corridor study, development and analysis of the preliminary and reasonable alternatives, and prior to and following public scoping meetings. A public hearing was held in August 2011, prior to the FEIS development. A meeting with affected property owners in the vicinity of FM 1960 was held to discuss a minor alignment shift. Alignment changes to the Recommended Alternative (10) were made as a result of input received at the public hearing and affected property owners meeting to create the Preferred Alignment (10R).

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CHAPTER 1
PURPOSE AND NEED

The Grand Parkway, as a concept, was first proposed in 1961 by Harris County and the City of Houston Planning Commission following traffic studies that identified regional transportation deficiencies. The Grand Parkway corridor was placed on city maps in 1968, but funds were not readily available to advance the project. With the development of the greater Houston metropolitan area, the need for additional transportation facilities became more evident. County officials mapped a proposed corridor for State Highway (SH) 99 (the Grand Parkway) and submitted the plan to the Texas Highway Commission in 1983.

In 1984, the Texas Legislature authorized the creation and organization of nonprofit transportation corporations to act on behalf of the State Department of Highways and Public Transportation (the predecessor name for the Texas Department of Transportation [TxDOT]) in the promotion and development of public transportation facilities and systems within the state. The Grand Parkway Association (GPA), the first of these corporations created, was charged with obtaining land and funding to meet the planning, legal, engineering, and right-of-way (ROW) requirements of the Grand Parkway. Since its inception, the GPA has worked directly with landowners, city, county, state, and federal governmental agencies and elected officials in an effort to complete the Grand Parkway.

The Grand Parkway Segments H and I-1 (Control-Section-Job Numbers [CSJ]s: 3510-07-003, 3510-08-001, 3510-09-001, 3510-09-002, and 3510-10-001) are part of a planned 180+ mile (mi) circumferential loop around the greater Houston metropolitan area as shown in **Exhibit 1-1**. The Grand Parkway is divided into 11 segments, each of which has logical termini and independent utility to facilitate planning, design, and construction. Due to limited state and federal funding, there is no assurance that all of the Grand Parkway segments will be constructed. Each segment connects at least two existing major transportation corridors to ensure independent utility as well as independent significance as required by the Federal Highway Administration (FHWA) regulations (23 Code of Federal Regulations [CFR] 771.111(f)). The United States Congress confirmed this segment-by-segment development approach to be in compliance with federal law in the "Department of Transportation and Related Agencies Appropriations Bill of 1993." The April 2003 Texas Transportation Commission Minute Order 109226 states, "The completion of the Grand Parkway is essential and urgent, as construction of the projects would alleviate congestion and improve traffic flow in the greater Houston metropolitan area and the surrounding region," and "The commission has determined that constructing and operating the Grand Parkway as a toll facility is the most

efficient and expeditious means of ensuring its development, and encourages the development of partnerships and the employment of innovative methods for its financing and construction."

TxDOT prepared a Grand Parkway overview document in 1992, which was revised in June 1993. This document provides an overall assessment of the entire Grand Parkway outer loop facility and a general description of the area where the facility is proposed. **Table 1-1** summarizes the current status of each of the 11 segments of the Grand Parkway using information obtained from the GPA website (www.grandpky.com).

Table 1-1: Status of Segments

Segment	Limits	Status
Segment A	SH 146 to I-45 (S)	Corridor Feasibility Study completed.
Segment B	I-45 (S) to SH 288	Environmental review ongoing for final environmental impact statement (FEIS). Draft environmental impact statement (DEIS) approved June 2011.
Segment C	SH 288 to US 59 (S)/I-69	Record of Decision (ROD) issued March 29, 2013.
Segment D	US 59 (S)/I-69 to I-10 (W)	Interim facility constructed consisting of frontage roads and at-grade intersections, opened in 1994. Grade separations under construction in 2013.
Segment E	I-10 (W) to US 290	ROD received on June 9, 2009; in construction phase.
Segment F-1	US 290 to SH 249	ROD received on June 12, 2009; in design-build phase.
Segment F-2	SH 249 to I-45 (N)	ROD received on December 31, 2009; in design-build phase.
Segment G	I-45 (N) to US 59 (N)/I-69	ROD received on December 29, 2010; in design-build phase.
Segments H and I-1	US 59 (N)/I-69 to I-10 (E)	Environmental review ongoing. DEIS approved May 2011. FEIS in progress.
Segment I-2	I-10 (E) to SH 146	Phase I (I-10 to FM 1405) opened to traffic on March 25, 2008. FEIS reevaluation approved on October 9, 2012.

Source: Grand Parkway Association, 2013

Due to the similarities between Segment H and Segment I-1, it was agreed upon by FHWA and TxDOT that these segments could be studied jointly. These similarities include a rural setting, low projected traffic volumes and a slower anticipated growth. Each segment satisfies independent utility for the purposes of evaluating environmental impacts. The logical termini for each segment was determined in 1993 by FHWA and the segment would connect at least two major transportation corridors or freeways to provide assurance that each segment would have independent utility. Segments H and I-1 collectively constitute the proposed project evaluated in this final environmental impact statement (FEIS). Segments H and I-1 are located on the northeast side of the greater Houston metropolitan area. The study area was originally defined in the approved 1993 Environmental Overview document that discussed all of the segments of the

Grand Parkway. The circumferential facility was set at approximately 25 to 30 miles from the downtown Houston area to accommodate the expected growth in the region. The following boundaries met the criteria for the study area established in the Environmental Overview. The study area for the environmental analysis extends approximately one half mile beyond United States Highway (US) 59 North (N)/Interstate Highway (I) 69 and I-10 East (E) to fully evaluate environmental impacts at the perimeter of the study area. The study area spans Montgomery, Harris, Liberty, and Chambers counties and is generally bound by Farm-to-Market Road (FM) 2090 on the north, I-10 (E) on the south, US 59 (N)/I-69 and FM 2100 on the west, and SH 146 and SH 321 on the east (**Exhibit 1-1**).

Refer to **Exhibit 1-2** for a map showing the preliminary study area for Segments H and I-1. Segment H begins at US 59 (N)/I-69 near New Caney and continues south/southeast to US 90. Segment I-1 begins where Segment H ends at US 90 and continues south to I-10 East (E) near Mont Belvieu. Both segments are proposed as 4-mainlane, at-grade controlled-access toll facilities with proposed grade separations at major intersections within 400-feet (ft) of ROW. The study area for the environmental analysis extends approximately one half mile beyond US 59 (N)/I-69 and I-10 (E) to fully evaluate environmental impacts at the perimeter of the study area.

TxDOT and FHWA filed a Notice of Intent (NOI) for Segments H and I-1 in January of 2006 (**Appendix A**). The formal public scoping meetings required by these notices were held February 28 and March 1, 2006, and May 8 and 9, 2007. Additional guidance from TxDOT and FHWA was obtained following the first series of public scoping meetings in 2006 as a result of the Safe, Accountable, Flexible, Efficient, Transportation Equity Act: A Legacy for Users (SAFETEA-LU) that required the development of a Project Coordination Plan (**Appendix B**). The purpose of the Project Coordination Plan is to facilitate and document the lead agencies' (TxDOT, FHWA, and GPA) structured interaction with the public and other agencies and to inform the public and other agencies of how the coordination would be accomplished. The original Project Coordination Plan was developed and shown as a draft during the first series of public scoping meetings. It was revised per SAFETEA-LU guidance and approved in April 2007 and provided to the public for review and comment at the second series of public scoping meetings in May 2007. Subsequent to the public scoping meetings, environmental studies and analyses were conducted and incorporated into the draft environmental impact statement (DEIS). The DEIS was approved by FHWA on May 10, 2011. A series of two public hearings were held in August 2011 to present the DEIS and the Recommended Alternative. A Meeting with Affected Property Owners was held in May 2013 to present a

slight shift in the alignment at FM 1960, primarily due to comments received at the public hearings and the opportunity for a reduction of the number of residential displacements.

All segments of the Grand Parkway, including Segments H and I-1, would be built using alternative funding sources and are proposed as tolled facilities. It is anticipated that the proposed project would be constructed in phases. The first phase is anticipated to be a two-lane tolled facility that would be open to traffic by 2019. The second phase would be to complete the ultimate project as proposed in this document and would be open to traffic by 2025.

During the 2011 legislative session (82nd Legislature, Regular Session), Section 228.013 was added to the Texas Transportation Code through Senate Bill (SB) 1420. The Texas Administrative Code (TAC) was also updated (Title 43, Part 1, Sections 27.90-27.92) and requires that the distribution of a toll project's financial risk, the method of financing for the project, and the tolling structure and methodology be determined by the SB 1420 committee when a private entity has a financial interest in the project's performance. A SB 1420 committee would be formed for the purpose of making certain statutory determinations with respect to the Grand Parkway Segments H and I-1 Project. Members of the SB 1420 committee have not yet been identified but will include representatives of local jurisdictions associated with Segments H and I-1 of the Grand Parkway. Meetings held by the SB 1420 committee will be advertised in the Texas Register, and a report will be released that documents the committee's decisions.

1.1 PURPOSE AND NEED

As explained in the American Association of State Highway and Transportation Officials (AASHTO) Practioner's Handbook: *Defining the Purpose and Need and Determining the Range of Alternatives for Transportation Projects*, federal regulations require every environmental impact statement (EIS) to "briefly specify the underlying purpose and need to which the agency is responding in proposing the alternatives including the proposed action." The purpose and need is the fundamental building block of any EIS and is a key factor in determining the range of alternatives considered in an EIS and, ultimately, the selection of the preferred alternative. This section was prepared in accordance with FHWA Technical Advisory T 6640.8A, Guidance for Preparing and Processing Environmental and Section 4(f) Documents; FHWA's memorandum entitled Purpose and Need in Environmental Documents; FHWA and Federal Transit Administration (FTA) joint memorandum entitled Integration of Planning and National Environmental Policy Act (NEPA) Processes; and TxDOT memorandum entitled Guidance on Need and Purpose. Studies

conducted for the proposed Grand Parkway Segments H and I-1 included substantial interaction with project stakeholders including the general public, local businesses, landowners, local officials, community leaders, regulatory agencies, FHWA, and TxDOT. FHWA approved the purpose and need of the proposed project on April 11, 2007.

1.2 PURPOSE OF THE PROPOSED PROJECT

The purposes of the proposed transportation improvements in the Segments H and I-1 study area are to provide system linkage, improve mobility, enhance safety, and provide infrastructure to support population growth.

1.2.1 Provide System Linkage

The proposed project would produce benefits locally and regionally by improving connectivity within the existing transportation network by providing a circumferential link between US 59 (N)/I-69 and I-10 (E). This would accommodate circumferential travel movement within the Segments H and I-1 study area to two of Houston's major radial roadways that border the study area, thus improving connectivity to suburban communities, industrial complexes, and local ports, and providing better connectivity for hurricane evacuation.

1.2.2 Improve Mobility

The proposed project would improve the Level of Mobility/Level of Service (LOM/LOS), alleviate transportation demand, reduce congestion, and provide more travel options for the traveling public. The LOM is a concept developed by the Houston-Galveston Area Council (H-GAC), the Metropolitan Planning Organization (MPO) for the area, to illustrate the degree of congestion on roadways within the region. Level of Service is a qualitative measure of operating conditions based on control delay. Level of Service is given a letter designation from A to F, where LOS A represents free-flow conditions and LOS F represents heavy congestion. Further, the proposed Segments H and I-1 would provide another emergency evacuation option for the traveling public that would help reduce the strain on the major radial roadways through the Houston area. This would help reduce congestion during hurricane evacuations and flood events leading to safer and more efficient evacuation conditions. During a hurricane evacuation, the tolls for the proposed Segments H and I-1 would be waived to provide a free evacuation route to the traveling public.

1.2.3 Enhance Safety

The proposed project would improve safety within the Segments H and I-1 study area for the traveling public by helping to reduce stop-and-go conditions, lower crash rates, and provide an alternate evacuation route to help relieve congestion during emergency evacuations and peak travel times. The proposed project would help reduce traffic on local roadways with high crash rates, such as FM 1314 and FM 3360, which would likely lead to reduced crash rates. In addition, the proposed project would enhance safety on local roads by providing an alternate route for truck traffic currently utilizing local roads to transport freight.

1.2.4 Provide Infrastructure to Support Population Growth

The proposed project would accommodate the forecasted population growth of the Segments H and I-1 study area by providing a facility that would improve the movement of people and goods to businesses, places of employment, and residential areas within and near the study area.

1.3 NEED FOR THE PROPOSED PROJECT

The needs to be addressed for the purposes of the project are discontinuous system linkage, decreased mobility, compromised safety, and the lack of infrastructure to support population growth. Transportation improvements are needed in the Segments H and I-1 study area because of a lack of efficient connections to major radial roadways, suburban communities, local ports, and industries. Improvements are also needed because the existing and future transportation demand of the study area exceeds the capacity of the local roadways, and many of the study area's roadways have high crash rates. Projected population growth within the study area is expected to place an even greater strain on the existing transportation infrastructure. The needs of the Segments H and I-1 study area are further detailed in the following sections.

1.3.1 Discontinuous System Linkage

The existing transportation system does not provide efficient circumferential connections to the major radial roadways in the area, such as US 59 (N)/I-69, US 90 (E), and I-10 (E) which results in a lack of connectivity for suburban communities and industries located within and near the Grand Parkway Segments H and I-1 study area.

I-10 (E), US 90 (E), and US 59 (N)/I-69 are three radial facilities linking Houston to the study area and beyond. No major circumferential facilities currently exist within the Segments H and I-1 study area to

connect these facilities. Currently, travelers utilize minor arterial and collector roadways, such as FM 1485, FM 1960, FM 2100, SH 146, FM 3360, FM 1942, FM 1413, and FM 1314 to make such connections as depicted in **Exhibit 1-1**. The central portion of the study area is especially deficient in transportation infrastructure that supports circumferential and north-south mobility.

With a stronger emphasis on multimodal transportation facilities, TxDOT is committed to proactively plan, design, and construct facilities to safely accommodate bicyclists and pedestrians on appropriate facilities. The restriction of bicycle and pedestrian use on a controlled-access facility, such as a high-speed tollway, is permitted under Texas Transportation Code 545.0651. However, the proposed project would consider sidewalks on the non-tolled portions of the facility, and the facility would accommodate existing and future crossings for both pedestrians and bicyclists at intersections, bridges, and over/underpasses affecting or providing direct access to designated pedestrian or bicycle facilities.

1.3.1.1 Function and Role of Highways and Roadways within Houston's Northeast Quadrant

There are limited routes that connect US 59 (N)/I-69 to I-10 (E) through the northeast greater Houston metropolitan area. East-west roadways that traverse the area include FM 1960, FM 1485, US 90, FM 1942, and I-10. North-south roadways that traverse this area include SH 321, US 59 (N)/I-69, FM 2100, and SH 146. The Sam Houston Parkway (Beltway 8), although outside of the study area (**Exhibit 1-1**), is the nearest continuous roadway connecting I-10 (E) to US 59 (N)/I-69. Beltway 8 exists as a six-lane, all-electronic toll facility with frontage roads from US 59 (N)/I-69 to US 90 and as a four- to eight-lane facility with frontage roads from US 90 to I-10 (E). Beltway 8 connects to I-10 (E) near Channelview and to US 59 (N)/I-69 south of Humble. Roadway characteristics such as number of lanes and posted speed limits for the study area roadways are summarized in **Exhibit 1-3**. I-10 (E) provides the most direct route to and through downtown Houston for communities located to the east, northeast, and southeast of downtown Houston. US 59 (N)/I-69 provides the most direct route to and through downtown Houston for communities located to the north and northeast of downtown Houston. TxDOT traffic studies from 2000 to 2010 indicate that FM 1960, US 90, FM 526, FM 2100, and SH 146, as well as other city and county roadways within northeast Houston, accommodate local travel. Traffic volumes on these roadways carried an estimated 340 to 29,000 vehicles per day (vpd) in 2010.

Those traveling from the northeast Houston metropolitan area to all areas beyond this have three general route options available. These options are as follows:

- Follow US 59 (N)/I-69 or I-10 (E) to the downtown area before continuing on route;
- Access Beltway 8 via US 59 (N)/I-69 or I-10 (E) and circumvent the downtown area before continuing along the planned route; or
- Follow disconnected city and county roadways that meander through the area before continuing along the planned route.

1.3.1.2 Transportation System Demands and Trends

As discussed above, the interstate and regional highways are predominantly oriented in either an east-west or a north-south direction. No interstate or state highway alternative connecting major radial facilities exists in the Segments H and I-1 study area. The existing transportation system within the study area does not provide efficient connections to the suburban communities of Kingwood, New Caney, Huffman, Dayton, and Mont Belvieu as indicated in **Exhibit 1-2**.

Major industrial complexes within the Segments H and I-1 study area include a Chevron refinery plant located along I-10 (E), the Dow Industrial Chemical Plant, an Exxon refinery plant, a Wal-Mart Distribution Center north of Dayton, and numerous gas storage facilities associated with the salt dome formation in Mont Belvieu. The study area lacks an efficient circumferential connection for these industrial complexes to US 59 (N)/I-69 and I-10 (E). In addition, freight traffic is transported via trucks through the study area to the Port of Houston.

Based on the H-GAC's 2012 Travel Demand Model (TDM), an estimated 77 percent of the traffic that originates within the study area has destinations in the northeast area of Houston, from north of I-610 (N) between I-45 (N) and I-10 (E). Of the projected trips generated from the study area, 29 percent have destinations within the Segments H and I-1 study area (**Exhibit 1-4**). The projected trend for 2039 (**Exhibit 1-5**) is similar. Of all the trips generated from the study area, 12 percent are destined for Montgomery County and a portion of Harris County, 14 percent are destined for Liberty County and portions of Harris and Montgomery Counties, 20 percent are destined for Liberty County and portions of Chambers and Harris counties, and 28 percent of trips begin and end within the study area, for a total of 74 percent of traffic that originates within the study area.

1.3.2 Decreased Mobility

The transportation demand exceeds the current and future capacity of the study area's existing transportation facilities. Further, the City of Houston and its surrounding areas are an important conduit to

receive traffic from the Texas Gulf Coast during emergency evacuations and distribute it to points beyond. The collector roadways that are used to accomplish partial circumferential travel in the study area such as FM 1485, FM 2100, FM 1413, and FM 3360 are not continuous and would not be able to meet the future traffic demand. The following sections contain data to support the need for improved mobility.

A traffic needs analysis of the existing roadway network in the study area for Segments H and I-1 of the Grand Parkway was conducted to evaluate the need for improvements in mobility and access for vehicular traffic. The base year for analysis was 2011. After meeting with FHWA, TxDOT, and H-GAC to obtain consensus, 2039 was selected as the horizon year (design year), with 2019 as the interim year (Phase I construction completion date). The travel demand model utilized for analysis is based on the 2035 Regional Transportation Plan (RTP) Update which was adopted in October 2010 and approved in January 2011. The H-GAC has demographic forecasts through 2050 and, therefore, provided a year 2039 dataset which comprises 2039 travel demand on the 2035 RTP Update roadway network. The 2035 RTP Update roadway network includes all segments of the Grand Parkway; however, in evaluating the No-Build Alternative, Segments H and I-1 were removed from the roadway network.

1.3.2.1 Traffic Volumes and Congestion

The H-GAC regional travel demand model was used for base year (2011) traffic volumes and future (2039) traffic volume projections. Base year and future traffic were compared to determine the change in traffic volumes over time. The H-GAC model determines traffic volumes on roadway facilities based on current and projected population and employment data as well as the transportation network available to travelers.

In addition to traffic volumes, LOM calculations were used to assess roadway operating conditions. Level of mobility is the primary mobility measure used in the H-GAC's 2035 RTP Update to assess the effectiveness of the Houston area roadway system. The LOM is used to illustrate the degree of congestion on roadways within the region. Tolerable LOM represents acceptable traffic operating conditions. A moderate LOM is the point at which the volume of vehicles is approaching the capacity of the facility and the traffic flow is breaking down. Serious and severe LOMs relate to considerable delays and roadway system failure. Level of mobility is comparable to the Transportation Research Board (TRB) Highway Capacity Manual's LOS methodology (TRB, 2000). LOS is a qualitative measure of operating conditions based on control delay. Level of service is given a letter designation from A to F, where LOS A represents free-flow conditions and LOS F represents heavy congestion. Level of service D is considered an

acceptable LOS, especially for urban areas such as Houston. The LOS categories are summarized in **Table 1-2**. **Table 1-3** summarizes the LOS and LOM vehicle to capacity (V/C) ratios criteria and also provides a comparison of LOS and LOM. This comparison is also illustrated in **Figure 1-1**.

Table 1-2: LOS Descriptions

LOS	DESCRIPTION
A	Very low vehicle delays, free traffic flow, signal progression extremely favorable, most vehicles arrive during given signal phase.
B	Good traffic flow, good signal progression, more vehicles stop and experience higher delays than for LOS A.
C	Stable traffic flow, fair signal progression, significant number of vehicles stop at signals.
D	Noticeable traffic congestion, longer delays and unfavorable signal progression, many vehicles stop at signals.
E	Unstable traffic flow, poor signal progression, significant congestion, traffic near roadway capacity, frequent traffic signal cycle failures.
F	Unacceptable delay, extremely unstable flow, heavy congestion, traffic exceeds roadway capacity, stop-and-go conditions.

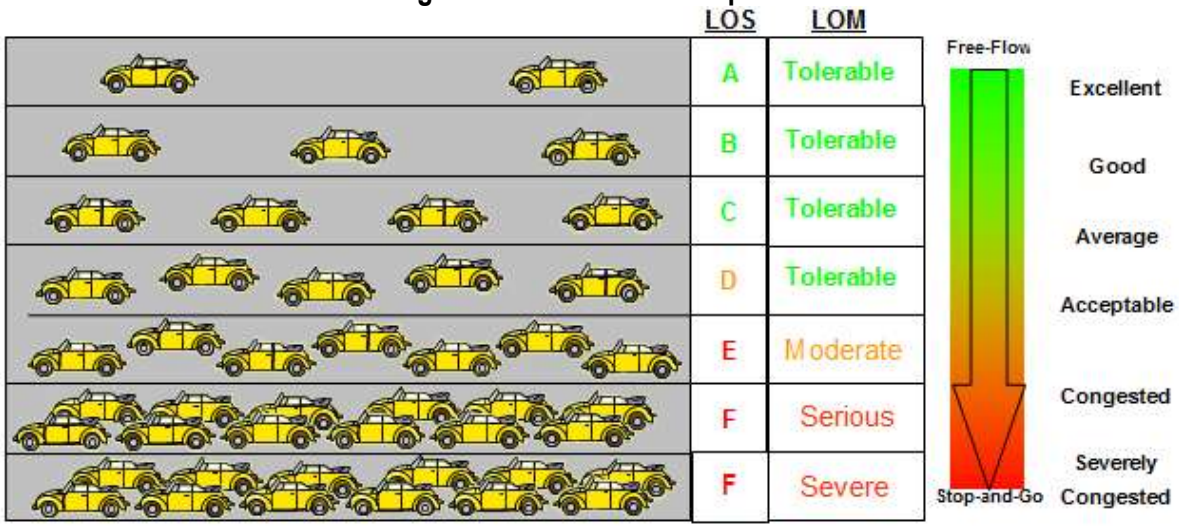
Source: TRB, 2000

Table 1-3: LOS/LOM Criteria

Highway Capacity Manual		H-GAC	
V/C	LOS	V/C	LOM
0.27	A	N/A	Tolerable
0.44	B	N/A	Tolerable
0.64	C	N/A	Tolerable
0.85	D	0.85	Tolerable
1.00	E	1	Moderate
>1.00	F	1.24	Serious
N/A	F	>1.24	Severe

V/C - Vehicle to Capacity, N/A - Not Applicable
Source: TRB, 2000

Figure 1-1: LOS/LOM Comparison



Source: CDM Smith, based on TRB (2000)

Existing LOS for study-area roadways is illustrated in **Exhibit 1-6**. Most of the rural minor collector roadways such as FM 686, FM 1413, and FM 3360 operate at LOS A-C. US 59 (N)/I-69 also operates at LOS A-C in the study area. I-10 (E) operates at LOS A-C west of SH 146 and at LOS D for a portion of I-10 west of SH 146 and east of SH 146. Traffic operating conditions vary along SH 146 from LOS A-C north of Dayton to LOS F near I-10. US 90 and FM 1960 operate at LOS E/F in the study area. Traffic analyses were conducted for the following facility types defined by FHWA: freeways, principal arterials, minor arterials, and collector roads.

Freeway facilities, including interstate highways, freeways, and expressways, are divided roadways that provide for the rapid and efficient movement of large volumes of traffic between regions and across the urban area. Direct access to abutting property is not an intended function of these facilities. Design characteristics support the function of traffic movement by providing multiple travel lanes, a high degree of access control, and few or no at-grade intersections. The freeways in the Segments H and I-1 study area are I-10 (E) and US 59 (N)/I-69.

Principal arterials primarily provide for traffic movement with a secondary function being the provision of direct access to abutting property. Principal arterials typically serve as connections between major traffic generators and land use concentrations and facilitate large volumes of through traffic traveling across the community. The principal arterials in the Segments H and I-1 study area include US 90, FM 1960, and SH 146.

Minor arterials typically serve as connections between local/collector roads and principal arterials, and facilitate the movement of large traffic volumes over shorter distances within the community. Because direct access to abutting property is a secondary function of arterial streets, access should be carefully managed to avoid adverse impacts on the movement function intended for these facilities. The minor arterials in the Segments H and I-1 study area include SH 321, FM 2100, and FM 1942.

Collector roads provide a balance of traffic movement and property access. Traffic movement is often internal to local areas and connects residential neighborhoods, parks, churches, etc. with the arterial street system. Compared to arterial streets, collector roads accommodate smaller traffic volumes over shorter distances. The existing collector roadways in the Segments H and I-1 study area are FM 1413, FM 1485, FM 3360, FM 686, Ford/Mills Branch Road, Roman Forest Boulevard, FM 163, and FM 1008.

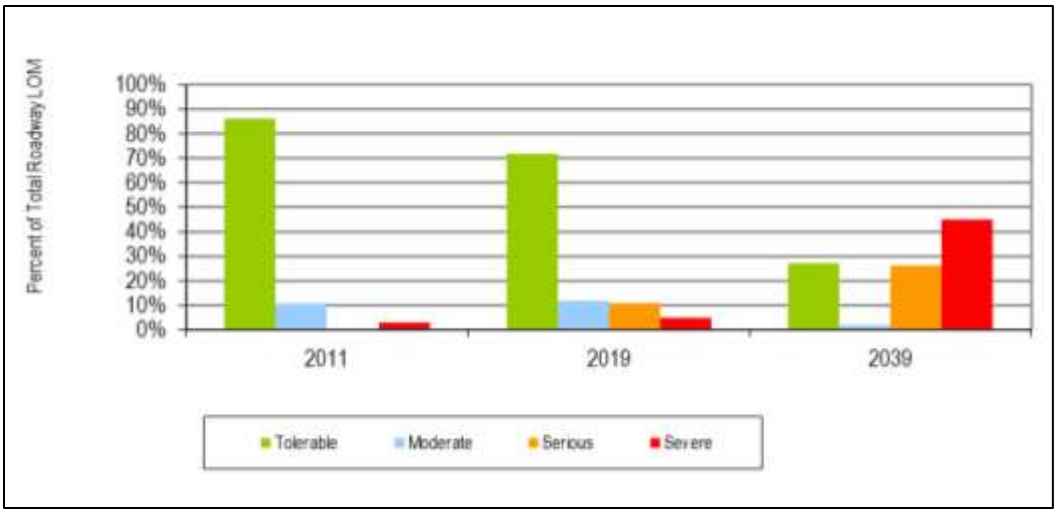
Level of Service for the Year 2039 No-Build scenario roadways, which excludes Segments H and I-1, is summarized in **Exhibit 1-7**. Base year and future No-Build LOM for years 2019 and 2039 are summarized in **Table 1-4** and **Figure 1-2** for the study area. The data shows that even with planned and programmed transportation improvements (excluding Segments H and I-1), congestion is expected to worsen through 2019 and 2039. For example, in 2011, 3 percent of all roadway miles operated with a serious or severe LOM. This is projected to increase to 11 percent for a LOM of serious and to 5 percent for a LOM of severe for a total of 16 percent in 2019, and to 26 percent for a LOM of serious and to 45 percent for a LOM of severe for a total of 71 percent in 2039. Alternatively, the portion of roadway miles with tolerable conditions is projected to reduce from 86 percent in 2011 to 27 percent in 2039. This shows that without additional area improvements, the level of congestion in the study area would increase dramatically through 2039.

Table 1-4: Traffic Study Area Base Year and Future No-Build LOM by Functional Class

LOM	2011 Base Year (%)	2019 No-Build (%)	2039 No-Build (%)
Freeways			
Tolerable	100%	100%	0%
Moderate	0%	0%	13%
Serious	0%	0%	87%
Severe	0%	0%	0%
Principal Arterials			
Tolerable	75%	57%	33%
Moderate	16%	24%	0%
Serious	0%	19%	16%
Severe	9%	0%	51%
Minor Arterials			
Tolerable	85%	66%	21%
Moderate	15%	9%	0%
Serious	0%	10%	11%
Severe	0%	15%	68%
Collector Roadways			
Tolerable	100%	100%	58%
Moderate	0%	0%	0%
Serious	0%	0%	20%
Severe	0%	0%	22%
Total Roadway Miles			
Tolerable	86%	72%	27%
Moderate	11%	12%	2%
Serious	0%	11%	26%
Severe	3%	5%	45%

Note: Data is for Segments H and I-1 Traffic study area limits
Source: H-GAC, 2012

Figure 1-2: Segments H and I-1 Traffic Study Area Base Year and Future No-Build LOM



Note: Data for Segments H and I-1 traffic study area limits
Source: H-GAC, 2012

Another trend illustrated in **Table 1-4** is the deterioration in traffic conditions along freeways and arterial roads. The percent of freeway miles operating at a tolerable LOM is projected to decrease from 100 percent in 2011 to zero in 2039. The percent of principal arterial miles operating at tolerable LOM is projected to reduce from 75 percent in 2011 to 33 percent by 2039. The percent of collector miles operating at tolerable LOM is projected to reduce from 100 percent in 2011 to 58 percent in 2039. Arterial and collector roads currently provide most of the connectivity in the study area; therefore, a new circumferential controlled-access facility, if constructed, would reduce the traffic load on those facilities and, subsequently, improve the LOM for the study area. FM 1008, a collector road outside of the study area, provides a major north-south connection from Dayton to northern parts of Liberty County. FM 3360, another collector road inside of the study area, provides the connection between SH 146 and I-10. Both of these minor arterials provide connectivity affecting the study area, and the addition of the proposed Segments H and I-1 would improve the LOM on these and other area roads.

This FEIS documents travel demand for the No-Build Alternative and the Preferred Alternative for the Grand Parkway Segments H and I-1. The only difference in the two model sets is the presence of Segments H and I-1. All other roadway improvements including other segments of the Grand Parkway were held constant between the two scenarios. Therefore, any change in traffic volume is attributable to Segments H and I-1 of the Grand Parkway. Depending on their proximity, connectivity, and area served, different roads would be impacted differently by Segments H and I-1.

Table 1-5 summarizes base year 2011 and future No-Build average daily traffic (ADT) and LOM for years 2019 and 2039 for major roadways in the study area. Frontage roads and low-volume lower-category streets, such as neighborhood streets, were not included in the sampling for **Table 1-5** because they would be too numerous to list individually within the table. These frontage roads and low volume lower category streets primarily account for the moderate LOM category listed in **Table 1-4**.

As mentioned previously, the No-Build Alternative represents a condition in which all planned improvements in the 2035 RTP Update are in place except Grand Parkway Segments H and I-1. Overall, traffic volumes within the Segments H and I-1 study area are projected to increase by an average of 167 percent from 2011 to 2039. Traffic volumes on some arterials such as FM 3360 and FM 3180 are projected to increase more than 400 percent. This growth in traffic is consistent with the projected future population and employment growth for the study area.

Table 1-5: Traffic Study Area Base Year and Future No-Build ADT and LOM by Roadway Segment

Facility	From	To	2011 Base Year		2019			2039		
			ADT (vpd)	LOM	No-Build ADT (vpd)	No-Build LOM	Traffic Growth (%)	No-Build ADT (vpd)	No-Build LOM	Traffic Growth (%)
US Highways and Interstates										
US 59 (N)/I-69	SH 105	Community Dr.	54,805	Tolerable	71,466	Tolerable	30	122,890	Serious	124
US 59 (N)/I-69	Community Dr.	BW 8	136,406	Tolerable	163,971	Tolerable	20	270,392	Serious	98
I-10 (E)	BW 8	FM 2100	103,510	Tolerable	124,974	Tolerable	21	199,291	Serious	93
I-10 (E)	FM 2100	SH 146	67,327	Tolerable	78,035	Tolerable	16	117,302	Serious	74
I-10 (E)	SH 146	FM 1410	64,131	Tolerable	73,048	Tolerable	14	102,778	Serious	60
BW 8	US 59 (N)/I-69	West Lake Houston Pkwy	42,865	Tolerable	60,716	Tolerable	42	125,175	Serious	192
BW 8	West Lake Houston Pkwy	US 90	41,669	Tolerable	56,802	Tolerable	36	112,746	Moderate	171
BW 8	US 90	I-10	49,674	Tolerable	65,660	Tolerable	32	141,367	Moderate	185
Grand Parkway	I-45 (N)	US 59 (N)/I-69	N/A	N/A	37,513	Tolerable	N/A	74,714	Moderate	N/A
Grand Parkway	US 59 (N)/I-69	US 90	N/A	N/A	0	N/A	N/A	N/A	N/A	N/A
Grand Parkway	US 90	I-10	N/A	N/A	0	N/A	N/A	N/A	N/A	N/A
Grand Parkway	I-10	SH 146	N/A	N/A	2,908	Tolerable	N/A	25,016	Tolerable	N/A
Highways and Interstate Average Traffic Growth							26			125
Principal Arterials										
US 90	BW 8	FM 2100	33,185	Tolerable	49,547	Tolerable	49	106,319	Severe	220
US 90	FM 2100	SH 321	21,712	Moderate	24,531	Serious	13	30,304	Severe	40
US 90	SH 321	SH 61	15,441	Moderate	17,397	Moderate	13	21,418	Serious	39
FM 1960	BW 8	FM 2100	20,364	Severe	33,132	Serious	63	51,504	Severe	153
FM 1960	FM 2100	SH 321	3,864	Tolerable	12,249	Serious	217	16,469	Severe	326
Kingwood Drive/ Treaschwig Road	US 59 (N)/I-69	FM 2100	17,642	Tolerable	24,612	Tolerable	40	24,073	Tolerable	36

Table 1-5: Traffic Study Area Base Year and Future No-Build ADT and LOM by Roadway Segment

Facility	From	To	2011 Base Year		2019			2039		
			ADT (vpd)	LOM	No-Build ADT (vpd)	No-Build LOM	Traffic Growth (%)	No-Build ADT (vpd)	No-Build LOM	Traffic Growth (%)
Kingwood Drive	FM 2100	FM 686	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
SH 105	SH 321	FM 2518	7,482	Tolerable	9,292	Moderate	24	13,832	Severe	85
SH 105	FM 2518	SH 146	6,056	Tolerable	7,751	Tolerable	28	12,482	Serious	106
West Lake Houston Pkwy.	FM 1485	Kingwood Drive	13,629	Tolerable	14,459	Tolerable	6	13,026	Tolerable	-4
West Lake Houston Pkwy.	Kingwood Dr.	BW 8	25,401	Moderate	32,505	Serious	28	49,939	Severe	97
SH 146	FM 787	US 90	5,471	Tolerable	6,050	Tolerable	11	7,981	Tolerable	46
SH 146	US 90	I-10	8,983	Tolerable	12,323	Tolerable	37	29,174	Severe	225
SH 146	I-10	SH 99	27,883	Tolerable	36,921	Tolerable	32	63,821	Tolerable	129
SH 321	US 59 (N)/I-69	US 90	8,210	Tolerable	10,047	Moderate	22	16,268	Severe	98
Spur 330	I-10	SH 146	32,537	Tolerable	39,563	Tolerable	22	50,088	Tolerable	54
Principal Arterials Average Traffic Growth							40			110
Minor Arterials										
FM 787	SH 321	SH 146	7,189	Tolerable	8,587	Tolerable	19	14,471	Severe	101
FM 1008	SH 321	US 90	3,499	Tolerable	4,226	Tolerable	21	6,786	Tolerable	94
FM 1010	SH 321	FM 1485	3,598	Tolerable	4,592	Tolerable	28	11,206	Serious	211
FM 1405	SH 146	FM 2354	1,579	Tolerable	2,071	Tolerable	31	2,936	Tolerable	86
FM 1409	US 90	FM 565	4,486	Tolerable	4,820	Tolerable	7	16,172	Severe	260
FM 1485	US 59 (N)/I-69	West Lake Houston Pkwy.	9,113	Tolerable	12,045	Serious	32	14,253	Severe	56
FM 1485	West Lake Houston Pkwy.	FM 2100	7,057	Tolerable	10,812	Serious	53	15,101	Severe	114
FM 1942	Crosby Lynchburg	SH 146	8,246	Tolerable	10,235	Serious	24	19,551	Severe	137
FM 2100	FM 1485	US 90	14,706	Moderate	20,099	Severe	37	39,407	Severe	168
FM 2354	FM 565	FM 1405	814	Tolerable	1,240	Tolerable	52	3,254	Tolerable	300

Table 1-5: Traffic Study Area Base Year and Future No-Build ADT and LOM by Roadway Segment

Facility	From	To	2011 Base Year		2019			2039		
			ADT (vpd)	LOM	No-Build ADT (vpd)	No-Build LOM	Traffic Growth (%)	No-Build ADT (vpd)	No-Build LOM	Traffic Growth (%)
FM 3180	I-10	FM 2354	2,004	Tolerable	2,997	Tolerable	50	14,612	Severe	629
FM 3360	SH 146	I-10	2,026	Tolerable	3,497	Tolerable	73	11,167	Serious	451
FM 563	US 90	I-10	4,014	Tolerable	4,994	Tolerable	24	13,539	Severe	237
FM 565	Loop 207	SH 146	7,999	Tolerable	8,921	Moderate	12	13,961	Severe	75
Minor Arterials Average Traffic Growth							33			209
Collector Roads										
FM 1410	SH 61	I-10	1,937	Tolerable	2,327	Tolerable	20	7,613	Serious	293
FM 1413	US 90	SH 146	2,680	Tolerable	4,954	Tolerable	85	12,757	Severe	376
FM 2090	US 59 (N)/I-69	FM 1010	3,864	Tolerable	5,826	Tolerable	51	14,352	Severe	271
FM 686	FM 1960	SH 321	1,195	Tolerable	1,486	Tolerable	24	3,500	Tolerable	193
FM 770	SH 105	FM 563	2,564	Tolerable	3,405	Tolerable	33	8,411	Tolerable	228
Roman Forest Boulevard	US 59 (N)/I-69	Tram (Galaxy)	10,170	Tolerable	13,904	Tolerable	37	28,213	Severe	177
Tram (Galaxy)	FM 2090	Roman Forest Blvd	2,157	Tolerable	3,388	Tolerable	57	7,299	Tolerable	238
Collectors Average Traffic Growth							44			254
Study Area Roadways Average Traffic Growth							36			167

ADT = Average Daily Traffic
Source: H-GAC, 2012

1.3.2.2 Emergency Evacuation

Major hurricane evacuation routes for the greater Houston metropolitan area per the *Task Force on Evacuation*, *Transportation and Logistics Final Report to the Governor* dated February 14, 2006 are identified as:

- US 69, north out of Beaumont to Lufkin
- US 59/I-69, northeast from Beltway 8
- I-10, west out of Houston to San Antonio
- I-45, north out of Galveston Island
- I-45, north out of Houston to Dallas
- US 290, northwest out of Houston to Austin

Of these, only one designated route would currently serve as a preferred option for residents in Houston's northeast quadrant, I-45 north out of Houston to Dallas. This route would be difficult for study area residents to reach due to the lack of roadways connecting I-45 to US 59 (N)/I-69 within the study area. In addition, a contraflow plan is in place for US 59 (N)/I-69 from Houston to Nacogdoches. This contraflow plan, where US 59/I-69 southbound lanes would be reversed to carry two lanes of northbound traffic, would begin south of Kingwood Drive and continue northward to Nacogdoches. This would allow for additional capacity during an evacuation.

During the 2005 Atlantic hurricane season, Hurricane Rita was the tenth hurricane and second Category 5 hurricane. According to the *Houston Chronicle*, Hurricane Rita was attributed to the death of 6 people directly and over 100 indirectly, mostly due to evacuation struggles; such as lengthy evacuation times in the heat, lack of proper provisions and water, and accidents. The threat of Hurricane Rita prompted the largest peacetime evacuation in U.S. history and tested the existing roadway system and local emergency management plans. An estimated 2.5 to 3.5 million people evacuated between Wednesday, September 21, 2005 and Friday, September 23, 2005. The total estimated average evacuation time was estimated to be approximately 31 hours.

Mandatory evacuations of storm surge zones, flood prone areas, persons with special needs, and mobile home residents, were put into effect three days prior to landfall of Hurricane Rita. According to the Harris County Office of Emergency Management, evacuation of the various surge zones was to be staggered over an 18 hour period. Officials hoped that the staggering of the evacuation times of established surge zones

would prevent bottlenecks leaving the area; however, with the recent Hurricane Katrina disaster, which hit Louisiana three weeks earlier, numerous residents outside the mandatory evacuation zones chose to voluntarily evacuate at the same time. The combination of the voluntary and mandatory evacuations occurring at the same time caused gridlock on all the major arterial roadways in and out of Houston and increased the travel evacuation times for those in the mandatory zones. Travel times to evacuation destinations such as Austin, San Antonio, Dallas, Lufkin, and Huntsville took approximately 24 hours or more.

During Hurricane Rita, evacuation was impeded by the lack of circumferential highways in the Houston region. Traffic trying to evacuate to the north had limited choices on available facilities. SH 146 is identified as a hurricane evacuation route on **Exhibit 1-7: Hurricane Evacuation Route for Houston Region**. The *Task Force on Evacuation*, *Transportation and Logistics Final Report to the Governor (*February 14, 2006) indicated that during the 2005 evacuation, traffic on SH 146 was backed up from Dayton south to Mont Belvieu, a distance of 15 miles, due to limited capacity, traffic signals, and lack of connectivity to US 59 (N)/I-69.

During the 2008 Atlantic hurricane season, Hurricane Ike made U.S. landfall near Galveston, Texas as a Category 2 hurricane with winds of 110 miles per hour. Hurricane Ike is blamed for over 100 deaths in the U.S. and was the third most destructive storm to make landfall in the U.S. The evacuation during Hurricane Ike had much less congestion than the Hurricane Rita evacuation, largely attributed to the late evacuation of many people in mandatory evacuation zones, and the decreased evacuation numbers of those in non-essential evacuation zones.

In order to reach either US 59 (N)/I-69 or I-45 (N), persons residing within or near the Segments H and I-1 study area would need to access I-10, Beltway 8, or traverse through city/county (rural) roadways. There are relatively few connections to I-45 (N) from US 59 (N)/I-69 north of Beltway 8. Roadways within the study area are primarily rural that connect scattered, small communities and towns. These rural roadways consist of many narrow two-lane roadways with little or no shoulders. Upon reaching US 59 (N)/I-69, there are more options for direct routes to I-45, if desired. Within the study area and for areas north and east of Beltway 8, a direct route to US 59 (N)/I-69 with the capacity to accommodate a portion of the evacuating public is needed.

The Grand Parkway and its northeastern Segments (I-1, H and G) would play a potentially substantial role in the evacuation of residents and tourists from the surge vulnerable areas of Harris, Chambers, Liberty, Jefferson, and Orange Counties in Texas. It would also serve southwest Louisiana evacuees for various inland Texas destinations. The location of the proposed corridor would provide an additional means for evacuees to reach intended destinations.

Evacuees who are candidates to use the Grand Parkway from those coastal surge areas will travel along (heading north) Segments I-1 and H where a portion of the vehicles will exit northbound US 59/I-69 and the remaining vehicles will continue to travel along Segment G to exit northbound I-45. The potential volume on Segment G is lower due to the bleed-off of some traffic using northbound US 59/I-69. The distribution of traffic between US 59/I-69 and I-45 is described in detail in the section "Potential Grand Parkway Evacuation Traffic."

The magnitude of the role that the Grand Parkway may play is a function of how many evacuees would logically use the route given their location and intended destination and the relief that the Grand Parkway provides to expected evacuation corridors and bottlenecks in the area. Given the location of the greater Houston metropolitan area and surrounding counties along the northwest Gulf Coast and the intense recent hurricane activity, hurricane evacuation is a critical public safety issue.

Modeled Hurricane Evacuation Data

An independent study was conducted to analyze the improvements in evacuation time for Chambers, Liberty, Harris and Montgomery Counties with Segments H and I-1 as well as Segment G constructed. This independent study was conducted to evaluate all segments of SH 99 and thus grouped some of the segments together to evaluate SH 99 as a whole. Therefore, while Segments H and I-1 do have independent utility to access US 59/I-69, a designated hurricane evacuation route, Segment G was included in the modeling in order to provide additional evacuation opportunities by connecting with I-45. The discussion, which follows next, explains that analysis in detail.

Evacuation Trip Generation

For each county and southwest Louisiana, a number of evacuation models were developed relevant to the analysis for the current year (2008) and year 2035. The evacuation model developed for the Galveston region study area (from the recent U.S. Army of Corps of Engineers/FEMA hurricane evacuation study) was

used as a starting point and major modifications were made based on new zip code-based evacuation zones delineated by the counties. In addition, Chambers, Jefferson, Liberty, and Orange Counties were added into the modeling because these counties had not been included in a USACE/FEMA hurricane evacuation study. Evacuation models for southwest Louisiana had already been developed in the federal study done for the 12 counties in that study area. Numbers of evacuation vehicles were generated and projected into the future using growth factors developed for each county. Evacuation zones form the basis of areas contributing evacuation traffic to the existing and future evacuation routes.

Using census data for the year 2000, a state population center estimate for 2008, and an H-GAC projection for 2035, the growth factors developed for each county are as follows in **Table 1-6:**

Table 1-6: County Growth Rates

	2000 Census Population	2008 Population Estimate	2008 Growth Factor	2035 Population Projection	2035 Growth Factor
Galveston County	250,158	286,987	1.15	412,000	1.65
Brazoria County	241,767	296,691	1.23	496,000	2.05
Harris County	3,400,578	3,922,115	1.15	5,840,000	1.72
Chambers County	26,031	33,225	1.28	53,000	2.04
Liberty County	70,154	77,451	1.10	131,000	1.87
Jefferson County	252,051	245,904	0.98	280,000	1.11
Orange County	84,966	84,286	0.99	95,000	1.12

Source: US Census, 2000, H-GAC, 2008

Estimates for the number of evacuation vehicles leaving the area were then generated by applying the growth factors to the Year 2000 baseline exhibits developed from the zip code modified USACE/FEMA hurricane evacuation study (HES) traffic model and are listed below in **Table 1-7**:

Table 1-7: Vehicle Evacuation by County

Contributing Areas	Est. Total Evacuation Vehicles Year 2000 generated from Zip Code Zones	Est Total Evacuation Vehicles Year 2008 generated from Zip Code Zones	Est Total Evacuation Vehicles Year 2035 generated from Zip Code Zones
Galveston Zones	117,235 vehicles	134,494 vehicles	193,081 vehicles
Brazoria Zones	72,077 vehicles	88,451 vehicles	147,870 vehicles
Harris Eastern Zones	17,882 vehicles	20,624 vehicles	30,709 vehicles
Chambers County area	10,747 vehicles	13,717 vehicles	21,882 vehicles
Liberty southern county area	4,447 vehicles	4,909 vehicles	8,304 vehicles
Jefferson County area	13,291 vehicles	12,966 vehicles	14,764 vehicles
Orange County area	4,955 vehicles	4,915 vehicles	5,540 vehicles
Louisiana southwest	8,500 vehicles	9,095 vehicles	11,823 vehicles
Totals	**249,134 vehicles**	**289,171 vehicles**	**433,973 vehicles**

Source: USACE/FEMA HES Study

Behavioral Data

Of critical importance to determining which evacuation zones might use each existing evacuation route and the proposed Grand Parkway Segments I-1, H and G (and to what degree), all available behavioral information was collected and reviewed. The American Red Cross was able to conduct approximately 4,000 telephone surveys in the early 1980's to learn what Texas residents did during Hurricane Allen. Texas A&M conducted a series of behavioral interviews in 1990 which were more hypothetical in nature but presumably allowed residents to reflect on Hurricane Alicia in 1983. More recently, Dr. Michael Lindell and Carla Prater of the Hazard Reduction and Recovery Center of Texas A&M published a report entitled "Behavioral Analysis Texas Hurricane Evacuation Study, February 2008" which provided a wealth of behavioral parameters for each coastal region of Texas. Various newspaper articles from the *Houston Chronicle* provided anecdotal behavioral information for the Hurricane Rita and Ike evacuations.

Data regarding direction of travel and intended destinations were of primary significance to this analysis. A composite of all available behavioral information led to these estimated percentages listed below in **Table 1-8**:

Table 1-8: Evacuation Traffic Direction and Destination

Direction of evac traffic	Avg	Destination Cities	Avg
North	60%	Austin	10%
Northeast	10%	Dallas/Ft. Worth	40%
West	20%	Houston	10%
East	10%	San Antonio	5%
		Other	35%
Total	**100%**	**Total**	**100%**

Source: Texas A&M, 2008

Potential Grand Parkway Evacuation Traffic

Using the generated evacuation model and behavioral data, it was concluded that a number of vehicles would potentially use Grand Parkway Segments I-1, H and G as evacuation routes. Segments G and H must be in place for Segment I-1 to function as a major evacuation route. **Exhibit 1-8** depicts evacuation zones for Segments H and I-1 and G for the year 2035. Assumptions regarding what portion of each evacuation zone's directional traffic is using each segment are as follows:

- Grand Parkway Segments I-1, H and G in place.
- Harris eastern zones – 40 percent of northbound traffic would use I-1 and H; 30 percent of northbound traffic would use G.
- Chambers zones – 90 percent of northbound traffic would use I-1 and H; 75 percent of northbound traffic would use G.
- Liberty southern zones - 40 percent of northbound traffic would use I-1, H and G.
- Jefferson zones – 60 percent of northbound traffic would use I-1 and H; 45 percent of northbound traffic would use G.
- Orange zones - 40 percent of northbound traffic would use I-1 and H; 30 percent of northbound traffic would use G.
- Galveston zones (including tourists) - would generally not use I-1, H, or G but a small portion would use Grand Parkway Segment I-2 to go eastbound on I-10.
- Brazoria zones - would not use I-1, H, or G.
- Southwest Louisiana – 50 percent of traffic entering Texas on I-10 westbound would use I-1, and G to get to I-45 northbound.

Using these key assumptions, the evacuation vehicle data (generated by zone), and the directional travel percentages (listed previously), the following maximum potential evacuation vehicle volumes (**Table 1-9**) were generated by segment for the year 2035:

Table 1-9: Evacuation Vehicle Volumes

Contributing Area	Grand Parkway Segments I-1, H	Grand Parkway Segment G
Harris east zones	7,370 evac vehicles	5,528 evac vehicles
Chambers	11,816	9,847
Liberty southern area	1,993	1,993
Jefferson	5,315	3,987
Orange	1,330	997
Brazoria	0	0
Galveston	0	0
Southwest Louisiana	5,912	5,912
Total by Segment	**33,736 evac vehicles**	**28,264 evac vehicles**

Source: USACE/FEMA HES Study

Evacuation Route Capacities

Data from post storm evacuation assessment work for FEMA and the USACE contain actual hour by hour traffic counts during major evacuations over the last twenty years and this data helped in developing appropriate service volumes for the proposed segments. The estimated average hourly rate volumes of evacuation vehicles are as follows in **Table 1-10**:

Table 1-10: Evacuation Vehicle Average Hourly Rate Volumes

Galveston Routes	Current Year 2008	Future Year 2035
Grand Parkway Segment I-1	not in place	3000
Grand Parkway Segment H	not in place	3000
Grand Parkway Segment G	not in place	3000

Source: USACE/FEMA HES Study

Evacuation Impacts With and Without the Project

Without the implementation of Segments I-1, H, and G, evacuation traffic from the coastal areas of Houston to Port Arthur would go to the Sam Houston Tollway thereby creating additional congestion on routes already heavily traversed by other Harris and Galveston County evacuees. With Southwest Louisiana traffic, up to 33,700 evacuation vehicles may use the Sam Houston Tollway during an evacuation that otherwise would not use it if Grand Parkway Segments I-1, H, and G were in place. This translates to roughly 7 hours of additional demand/segment clearance time on the Sam Houston Tollway. In addition, the Sam Houston Tollway's I-45 northbound on-ramp/merge lanes are a bottleneck for evacuations. Any reduction in evacuation traffic at this location would greatly help overall flow within the immediate Houston metro area.

With the implementation of Grand Parkway Segments I-1, H, and G, the new corridor would carry a substantial amount of evacuation traffic in a worst case hurricane threat and reduce congestion on Houston area existing routes. Specifically, Segments I-1 and H would carry approximately 33,700 and Segment G would carry approximately 28,200 evacuation vehicles. The potential volume on Segment G is lower due to the bleed-off of some traffic onto US 59/I-69 northbound before it gets to I-45 northbound.

The implementation of Grand Parkway Segments I-1, H, and G has several evacuation benefits:

1) Reduces evacuation congestion on existing northeast Houston freeways thereby easing travel for other evacuees from parts of Galveston and Harris Counties. A rough calculation yields a savings of approximately 7 hours of demand.

2) Although not reducing overall regional clearance times on I-45 northbound upstream (as the Grand Parkway Segments H and I-1 tie back into I-45), the new Segments would allow nominal travel time savings for certain evacuees traveling westbound on I-10 who desire to go north on I-45 and US 59/I-69.

3) The potential new segments provide an alternative route for many evacuees if a traffic incident closes down the Sam Houston Tollway or close in sections of I-45 for part of an evacuation.

4) Separation of Houston local evacuees from Trinity Bay to Lake Sabine evacuees allows emergency management officials to tailor variable message boards to giving group specific sheltering instructions and downstream information.

1.3.3 Compromised Safety

A crash analysis was conducted to determine how travel safety would be affected by a new circumferential roadway facility. National research has shown that controlled-access facilities have lower crash rates than those without full control of access (TRB, 1999). This is attributable to higher design standards for freeways, fewer access points, fewer driver distractions, and less stop-and-go conditions. Therefore, diverting traffic from collector roadways to a limited access facility such as the proposed Grand Parkway Segments H and I-1 would be expected to result in a reduction in study area roadway crash rates.

Crash data was provided by TxDOT from their Crash Records Information System (CRIS). Three-year crash data for the period 2010-2012 were analyzed for roadway segments within the Segments H and I-1 study area that are considered primary travel routes. Crashes were summarized by crash type including

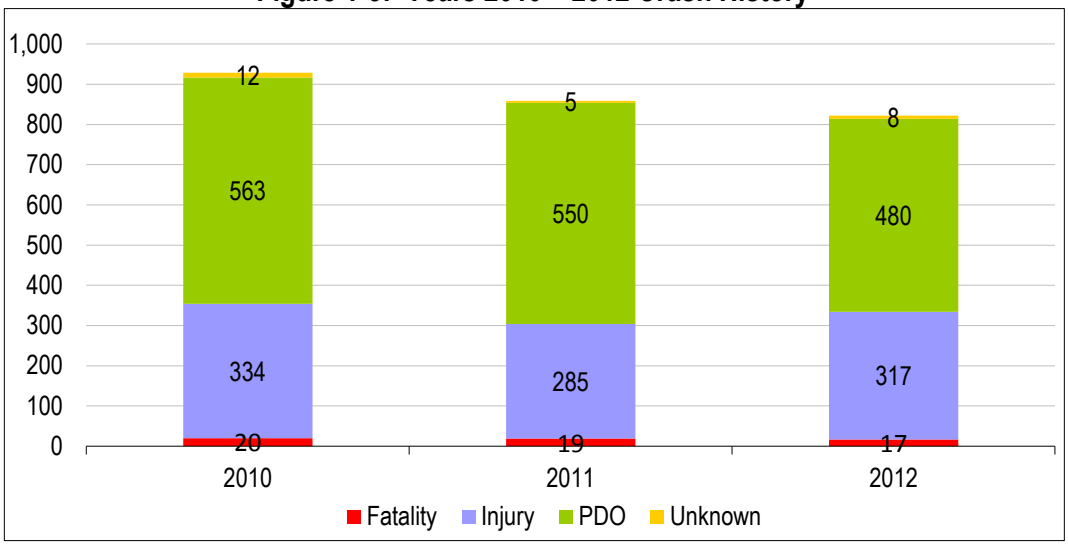
fatality, injury, or property damage only (PDO), as shown in **Table 1-11**. **Figure 1-3** illustrates crashes by type from 2010 to 2012 for the Segments H and I-1 study area. The total number of crashes over the three-year analysis period was 2,610 (**Table 1-11**), with the highest number of crashes, 929 (12 unknown, 20 fatality, 334 injury, and 560 PDO [**Figure 1-3**]) occurring in 2010.

Table 1-11: Study Area Crashes (2010 – 2012)

Road Segment	Location	Crash Type				
		Fatality	Injury	PDO	Unknown	Total
I-10	Garth Rd to Eagle Rd / FM 3180	3	110	184	4	**301**
US 90	Main St / Crosby Fwy-Lynchburg Rd to FM 321	8	98	131	1	**238**
US 59/I-69	Northpark Dr to Deerbrook Dr	4	119	211	3	**337**
SH 321	US 90 to FM 1008	2	64	116	2	**184**
SH 146	Old Needlepoint Rd to US 90	6	80	144	2	**232**
FM 1960	Fairlake Ln to Liberty County Line	0	24	34	0	**58**
FM 1485	Gene Campbell Blvd to FM 2100	9	122	162	6	**299**
FM 2100	FM 1485 to US 90	11	75	200	4	**290**
FM 1314	Loop 494 to Andrew Ln	3	123	239	1	**366**
FM 1942	Cedar Grove to SH 146	7	31	42	0	**80**
FM 3360	FM 565 to SH 146	0	4	22	0	**26**
FM 1413	SH 146 to US 90	1	4	15	0	**20**
FM 686	FM 321 to FM 1960	1	6	5	0	**12**
Loop 494	Northpark Dr to US 59/I-69	1	76	88	2	**167**
Totals		**56**	**936**	**1,593**	**25**	**2,610**

Source: TxDOT, 2013

Figure 1-3: Years 2010 – 2012 Crash History



Source: TxDOT, 2013

Crash rates were calculated for the major roadways which currently serve as the primary routes for travel to and within the study area and are based on the number of crashes per 100 million vehicle miles traveled (MVMT) as shown in **Table 1-12**. A review of the results indicates that FM 1314 had the highest average crash rate (733) while I-10 (E) has the lowest rate (53).

Table 1-12: Study Area Crashes

Roadway Segment	Facility Type	Functional Class	Location	Length (Mile)	Accident Rate (Accidents per 100 MVMT)			
					2010	2011	2012	Average
I-10	Interstate	Freeway	Garth Rd to Eagle Rd / FM 3180	8.30	65.6	69.1	24.0	52.9
US 90	US Highway	Arterial	Main St / Crosby - Lynchburg to FM 321	15.31	123.4	106.8	77.9	102.7
US 59/I-69	US Highway	Arterial	Northpark Dr to Deerbrook Dr	4.47	59.1	68.9	100.0	76.0
SH 321	State Highway	Arterial	US 90 to FM 1008	14.03	173.4	178.1	212.4	188.0
SH 146	State Highway	Arterial	Old Needlepoint Road to US 90	15.95	107.6	96.7	142.8	115.7
FM 1960	Farm to Market Road	Arterial	Fairlake Lane to Liberty County Line	4.18	116.7	83.3	78.7	92.9
FM 1485	Farm to Market Road	Collector	Gene Campbell Blvd to FM 2100	9.36	382.4	277.4	341.9	333.9
FM 2100	Farm to Market Road	Arterial	FM 1485 to US 90	14.19	222.0	104.4	49.7	125.4
FM 1314	Farm to Market Road	Arterial	Loop 494 to Andrew Lane	1.78	695.8	740.2	763.6	733.2
FM 1942	Farm to Market Road	Arterial	Cedar Grove to SH 146	9.95	104.2	126.8	114.1	115.0
FM 3360	Farm to Market Road	Collector	FM 565 to SH 146	2.25	126.2	504.8	462.7	364.5
FM 1413	Farm to Market Road	Collector	SH 146 to US 90	5.15	193.2	274.6	274.6	247.5
FM 686	Farm to Market Road	Collector	FM 321 to FM 1960	11.94	55.7	82.3	49.4	62.5
Loop 494	2 Lane 2 way	Collector	Northpark Dr to US 59/I-69	7.15	286.9	238.6	308.2	277.9

Source: TxDOT, 2013

The crash rate takes into account the length of roadway segments and traffic volume, and provides a very strong indication of traffic safety. Crash rates are influenced by roadway type, conditions, travel speed, and accessibility. **Table 1-13** summarizes statewide crash rates for various roadway types. Typically, roadways are considered to have a substantial crash problem when the crash rate is at least double the statewide average for that particular facility type.

Table 1-13: Statewide Crash Rates for Rural Area

Roadway Type	Accident Rate (Accidents per 100 MVMT)			
	2010	2011	2012	Average
Interstate	42.40	42.04	48.96	44.47
US Highway	60.88	55.53	62.09	59.50
State Highway	86.46	80.58	85.52	84.19
FM Roads	126.10	116.40	118.27	120.26
Two-Lane Two-Way Roads	101.47	94.09	97.88	97.81

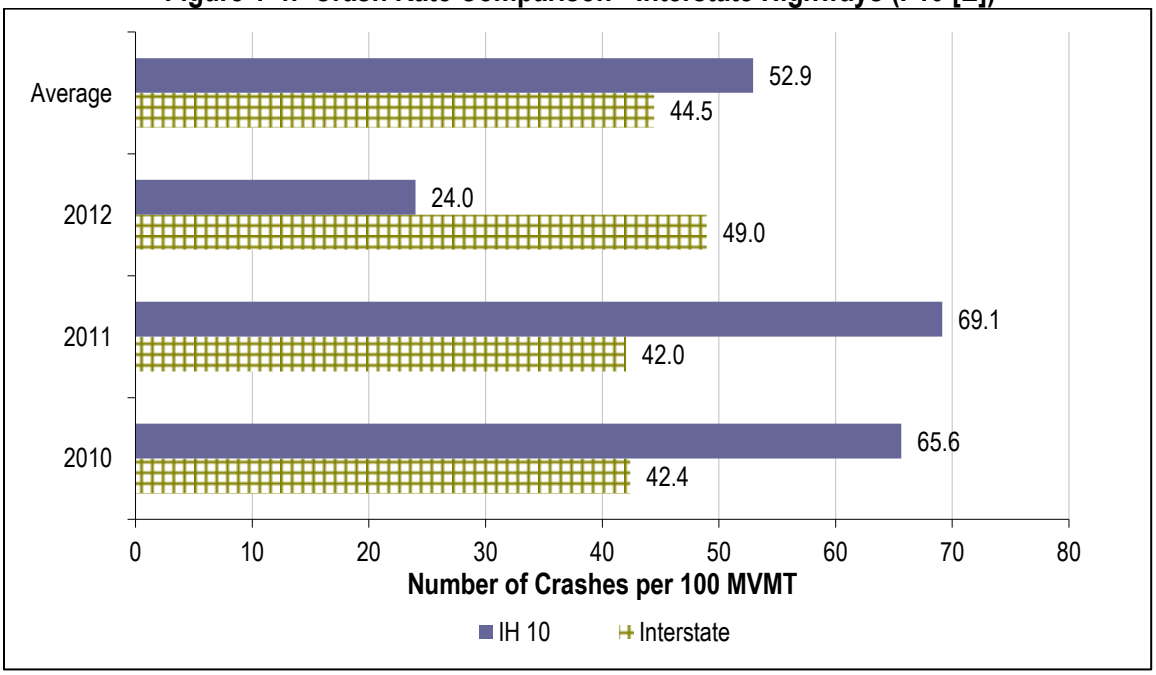
Source: TxDOT, 2013

Figures 1-4 through **1-7** illustrate the comparison of study area roadway crash rates to corresponding statewide averages. **Figure 1-4**, for example, shows that the crash rate for I-10 (E) in the study area is 52.9, which is higher than the statewide average of 44.5 for an interstate facility. **Figure 1-5** shows that the average three-year crash rate for US 90 and US 59 (N)/I-69 are both higher than the statewide average.

Similarly, **Figure 1-6** shows that the average crash rate for SH 321 and SH 146 are higher than the statewide average. On the other hand, **Figure 1-7** shows that FM 1314 has a crash rate more than five times the statewide average and FM 1485 and FM 3360 have crash rates more than double the statewide average, indicative of substantial safety issues.

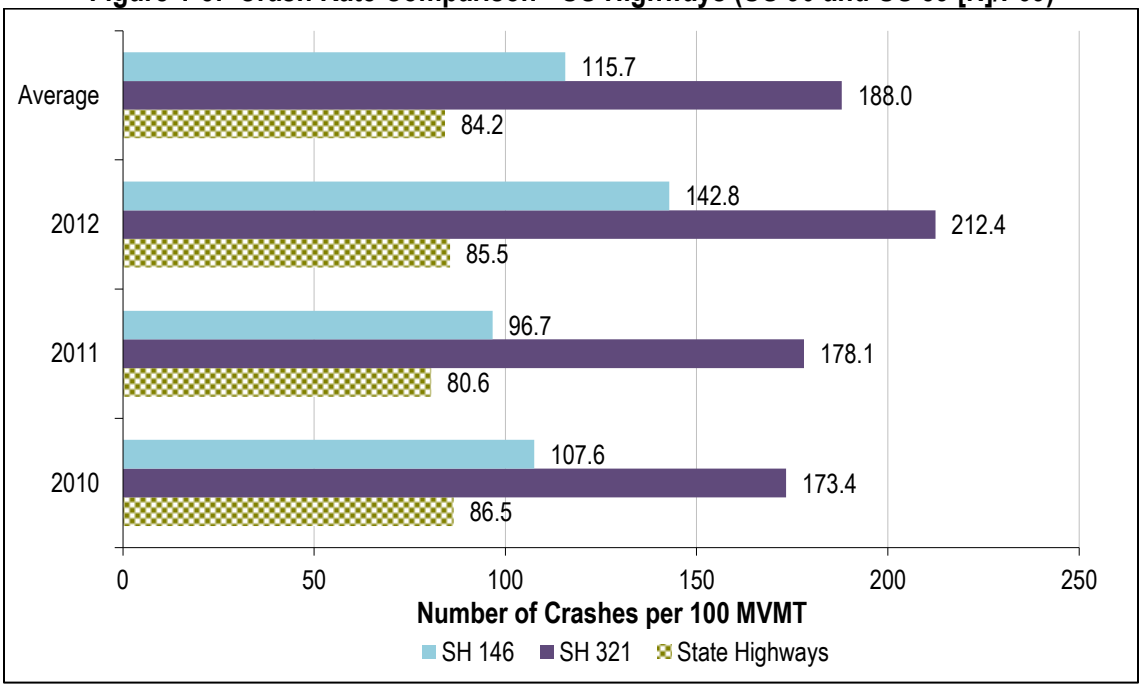
Local roads, collector facilities, and non-freeway principal arterials typically have much higher crash rates due to more frequent turns, stop-and-go conditions, roadway distractions, and lack of access control. Based on the data illustrated previously in **Table 1-5**, travel demand is projected to increase on FM 3360 by 451 percent and by 56 percent to 114 percent on FM 1485. Traffic on FM 1314 is projected to increase by approximately 80 percent by 2039. With many crash rates more than double the statewide crash rate for the period 2010-2012 on these roadways, further increase in traffic volumes would likely exacerbate the existing safety situation.

Figure 1-4: Crash Rate Comparison - Interstate Highways (I-10 [E])



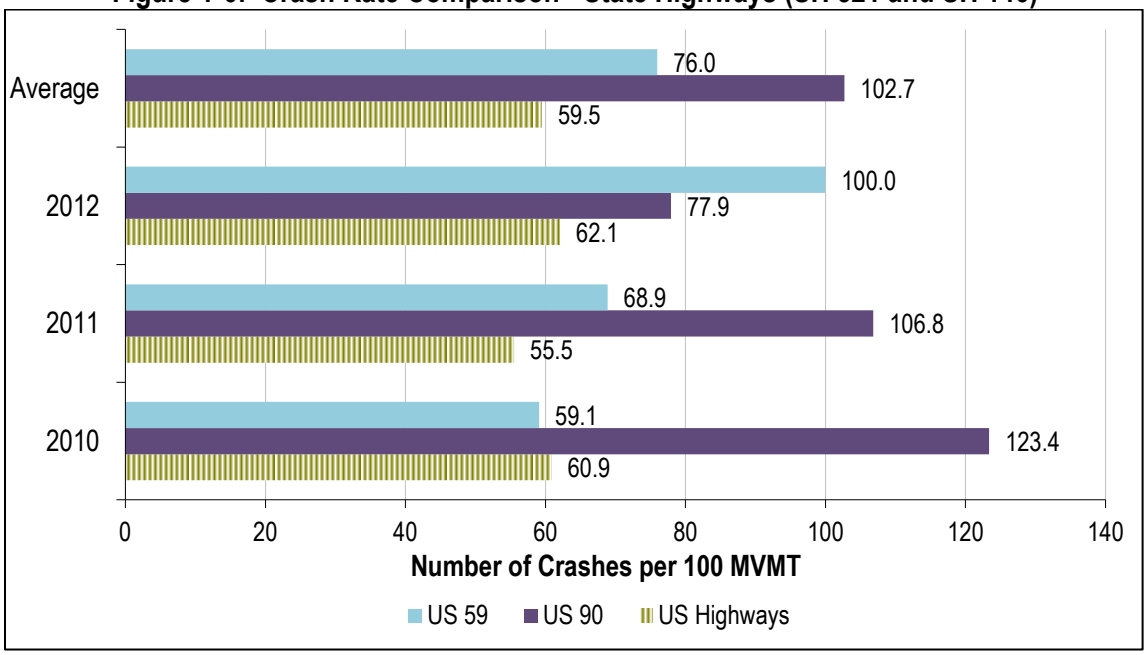
Source: CDM Smith and TxDOT, 2013

Figure 1-5: Crash Rate Comparison - US Highways (US 90 and US 59 [N]/I-69)



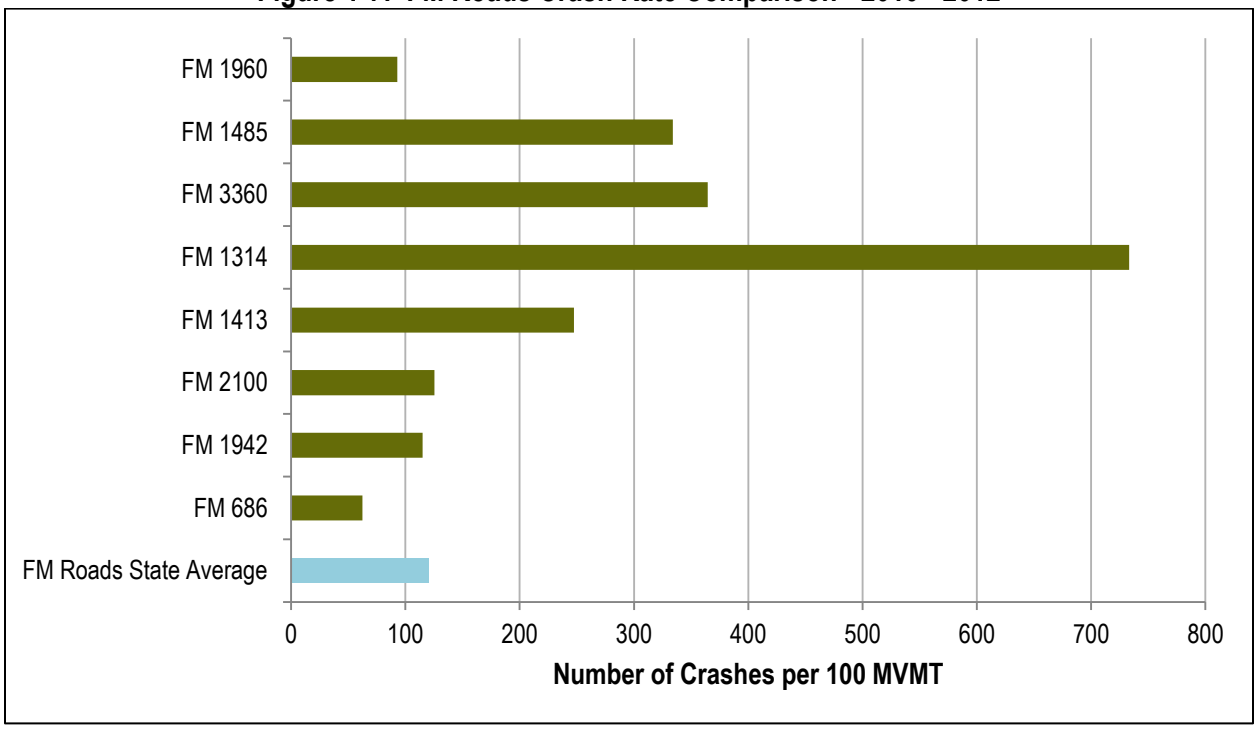
Source: CDM Smith and TxDOT, 2013

Figure 1-6: Crash Rate Comparison - State Highways (SH 321 and SH 146)



Source: CDM Smith and TxDOT, 2013

Figure 1-7: FM Roads Crash Rate Comparison - 2010 - 2012



Source: CDM Smith and TxDOT, 2013

1.3.4 Lack of Infrastructure to Support Population Growth

The existing transportation system does not provide the necessary infrastructure to support the potential for population growth through efficient circumferential connections and access (Refer to **Section 1.3.1**, Discontinuous System Linkage).

Based on the H-GAC 2035 forecasts (**Table 1-14**), population growth for the Segments H and I-1 study area is projected to increase through 2035. This predicted increase in population along with the predicted increases in traffic and congestion would lead to an even greater travel demand for the study area. Additional travel alternatives would be needed to support the efficient movement of people and goods through the study area to support the projected population growth.

1.3.4.1 Growth Projections

The H-GAC has projected population and employment growth through 2035 for the region. Based on the H-GAC's 2035 Forecast Data, the population in Montgomery, Harris, Liberty, and Chambers counties is expected to increase from 4.7 million in 2011 to 6.8 million by 2035. These projections represent projected growth within the region where the Segments H and I-1 study area is located. This represents a population

growth of approximately 46 percent. Employment growth within the same area is expected to increase from 2.5 million in 2011 to 3.4 million in 2035. This represents an employment growth rate of approximately 39 percent. **Table 1-14** illustrates the H-GAC 2035 Forecast Data for population and employment growth for the four counties within the Segments H and I-1 study area.

Table 1-14: H-GAC 2035 Population and Employment Growth by County

County	Total Population			Employment		
	2011	2035	% Increase	2011	2035	% Increase
Chambers	35,000	53,000	51	9,000	13,000	44
Harris	4,088,000	5,769,000	41	2,296,000	3,136,000	37
Liberty	83,000	120,000	45	24,000	36,000	50
Montgomery	455,000	858,000	89	133,000	239,000	80
Area Total	**4,661,000**	**6,800,000**	**46**	**2,462,000**	**3,424,000**	**39**

Source: H-GAC, 2035 Forecast Data, 2012

Table 1-15 illustrates the H-GAC 2035 Forecast Data for population and employment growth for the Regional Analysis Zones (RAZ) that are within the Segments H and I-1 study area. Refer to **Exhibit 1-9** for a map of the locations of the RAZs within the study area. The growth forecast by RAZs is more localized and more representative of what is predicted for the Segments H and I-1 study area than the growth forecast for the counties within the study area. The boundaries of the RAZs do extend slightly beyond the Segments H and I-1 study area. However, this is the best and most detailed forecast data available for the region. Based on the H-GAC 2035 Forecast Data, the population for the RAZs that includes the Segments H and I-1 study area is expected to increase from 225,163 in 2011 to 539,346 in 2035. This represents a population growth of approximately 140 percent. Employment growth within the same area is expected to increase from 52,626 in 2011 to 92,564 in 2035. This represents an employment growth rate of approximately 76 percent. The forecast growth for the Segments H and I-1 study area demonstrates the need for expanded infrastructure to support it.

Table 1-15: H-GAC 2035 Population and Employment Growth by Regional Analysis Zone (RAZ)

RAZ ID	Total Population			Employment		
	2011	2035	% Increase	2011	2035	% Increase
79	57,690	67,761	17	14,115	20,718	47
80	16,231	48,484	199	1,992	4,798	141
81	23,713	95,719	304	1,532	4,151	171
83	18,960	111,397	488	3,859	8,337	116
84	38,726	96,177	148	9,520	16,878	77
128	33,626	67,893	102	9,303	19,580	110
192	6,105	9,347	53	4,536	6,839	51
195	22,200	31,789	43	5,643	8,219	46
196	7,912	10,779	36	2,126	3,044	43
RAZ Area Total	**225,163**	**539,346**	**140**	**52,626**	**92,564**	**76**

Source: H-GAC, 2035 Forecast Data, 2012

CHAPTER 2: ALTERNATIVES ANALYSIS
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