VOLUME I: FINAL ENVIRONMENTAL IMPACT STATEMENT AND EXHIBITS

THE GRAND PARKWAY SEGMENTS H AND I-1

SH 99: US 59 (N)/I-69 to I-10 (E)

MONTGOMERY, HARRIS, LIBERTY, AND CHAMBERS COUNTIES, TEXAS

CSJs: 3510-07-003, 3510-08-001, 3510-09-001, 3510-09-002, 3510-10-001

APRIL 2014

The Grand Parkway Association

Department of Transportation United States of America

Texas Department of Transportation

US Army Corps of Engineers®

THE GRAND PARKWAY

CSJ (control-section-job) Nos. 3510-07-003, 3510-08-001, 3510-09-001, 3510-09-002, and 3510-10-001

GRAND PARKWAY (STATE HIGHWAY 99)
SEGMENTS H and I-1
FROM UNITED STATES HIGHWAY (US) 59 (N)/Interstate Highway (I) 69 TO I-10 (E)

Montgomery, Harris, Liberty, and Chambers Counties

FINAL ENVIRONMENTAL IMPACT STATEMENT (FEIS)

SUBMITTED PURSUANT TO 42 USC 4332(2)(c)

BY THE

U.S. DEPARTMENT OF TRANSPORTATION (USDOT)
FEDERAL HIGHWAY ADMINISTRATION (FHWA)
AND THE
TEXAS DEPARTMENT OF TRANSPORTATION (TxDOT)
AND THE
GRAND PARKWAY ASSOCIATION

COOPERATING AGENCY
U.S. ARMY CORPS OF ENGINEERS (USACE)

4/8/2014
Date of Approval

Federal Highway Administration

2/25/14
Date of Approval

Texas Department of Transportation
Environmental Affairs Division

Comments on this FEIS must be submitted no later than Monday, June 9, 2014 and will be published in the Federal Register and should be sent to the Grand Parkway Association, Attention: Mr. David Gornet, 4544 Post Oak Place, Suite 222, Houston, TX 77027 or to the Texas Department of Transportation, Attention: Director of Project Development, P.O. Box 1386, Houston, TX 77251-1386.

Price per copy: Actual Cost of Reproduction

FEBRUARY 2014

The following persons may be contacted for additional information concerning this document:

Mr. Carlos Swonke, PG
Director of Environmental Affairs
Texas Department of Transportation
150 E. Riverside Drive, Bldg. 118
Austin, Texas 78704

Mr. Gregory Punske, PE
District Engineer, District B (South)
Federal Highway Administration
Federal Office Building, Room 826
300 East 8th Street
Austin, Texas 78701

ABSTRACT

The proposed action is the construction of a new location highway toll facility, approximately 37.4 miles long, from United States Highway (US) 59 North (N)/Interstate Highway (I) 69 to I-10 East (E), and would be located in the northeast section of the planned 180+ mile State Highway (SH) 99 (Grand Parkway), the third loop around the City of Houston, Texas. The proposed action is the portion of the Grand Parkway known as Segments H and I-1, and is included in the Houston-Galveston Area Council's 2035 Regional Transportation Plan Update as revised, and the area's financially constrained 2013-2016 Transportation Improvement Plan. The study area for Segments H and I-1 is located on the northeast side of the greater Houston metropolitan area and spans the area from US 59 (N)/I-69 to I-10 (E), generally between US 59 (N)/I-69, Farm-to-Market Road (FM) 2100 on the west, and SH 146 on the east, in Montgomery, Harris, Liberty, and Chambers counties. Segments H and I-1 would provide a connection to Grand Parkway Segments G and I-2. The Preferred Alternative begins at US 59 (N)/I-69 and proceeds east along Community Drive, turning north to follow east along FM 1485. Past the Lake Houston Wilderness Park, the Preferred Alternative proceeds southeast, crossing FM 1960, and staying southwest of Dayton to cross US 90. From US 90, the Preferred Alternative proceeds south through the west side of the City of Mont Belvieu to connect to I-10 (E), near the I-2 segment of Grand Parkway. Cities within the study area include Mont Belvieu, Dayton, Plum Grove, Patton Village, Roman Forest, and Woodbranch. The conceptual design for this facility consists of a four-lane at-grade controlled-access tollway with grade separations at major intersections within a 400-foot right-of-way (ROW) width. Transportation improvements are needed in the study area because of a lack of north-south connections to major radial roadways, suburban communities, local ports, and industries. The purpose and need of the proposed transportation improvements in the Segments H and I-1 study area is to provide system linkage, improve mobility, enhance safety, and provide infrastructure to support population growth. The Preferred Alternative was selected based on its ability to best meet the purpose and need of the project while minimizing impacts to the natural, physical, and social environment. The recommended alternative transportation mode and the Preferred Alternative are proposed in this Final Environmental Impact Statement (FEIS) after evaluation of the potential environmental impacts and consideration of public and agency input. The Preferred Alternative, 10R, is a modified version of Alternative 10; one of the 11 reasonable alternatives, including the No-Build Alternative, evaluated and studied in detail in the FEIS. The Preferred Alternative included slight alignment adjustments recommended as a result of the public hearing and comment period held in 2011, as well as a meeting with affected property owners held in May 2013. The Preferred Alternative for Segments H and I-1 would require acquisition of 1,933 acres of new ROW, filling of aquatic resources, including jurisdictional waters/wetlands, impacts to vegetation, farmland, wildlife, park impacts, utility adjustments, and other areas of impact. A Section 404 individual permit would be required from the United States Army Corps of Engineers for proposed impacts to Waters of the United States, including wetlands. A *de minimis* Section 4(f) Evaluation for 10.84 acres of impacts to the Lake Houston Wilderness Park has also been prepared with the support of the City of Houston and the Texas Parks and Wildlife Department. The Preferred Alternative would provide improved access to the park, in keeping with the park's master plan. Within the proposed ROW, no known endangered species, historic resources, or archeological resources would be impacted. Wildlife and cultural resource surveys would be conducted prior to construction to the extent required under federal laws. The final decision on the Preferred Alternative would not occur until the FEIS receives a Record of Decision. The estimated proposed construction cost is approximately $1.2 billion. It Is anticipated to construct the entire project in two phases. Phase I construction is estimated to begin in 2016, with a projected opening year of 2019. Phase II construction has a projected opening year of 2025.

Comments on this FEIS should be sent to:

The Grand Parkway Association
4544 Post Oak Place, Suite 222
Houston, Texas 77027
Fax: 713-993-0106
E-mail: segmenthandi1comments@grandpky.com
Attn.: Mr. David W. Gornet

LIST OF ACRONYMS

%	percent
AASHTO	American Association of State Highway and Transportation Officials
Ab	Albany fine sand
ac	acres
ACHP	Advisory Council on Historic Preservation
ACS	American Community Survey
ACT	Antiquities Code of Texas
ADT	average daily traffic
Ad	Addicks loam
Ae	Aldine-Aris complex
Ak	Addicks-Urban land complex
Am	Aldine very fine sandy loam
An	Angie fine sand/Aldine-Uban land complex/Anahuac-Aris Complex
AOI	Area of Influence
APCA	Air Pollution Control Act
APE	area of potential effects
Ar	Aris Silt Loam
AST	above ground storage tank
ASTM	American Society for Testing and Materials
AtB	Atasco fine sandy loam
ATL	Average trip length
Ba	Beaumont Clay
Bb	Bibb soils
Bc	Beaumont-Utah land complex
Bd	Bernard Clay loam
Be	Bernard-Edna Complex
BFE	base flood elevation
Bg	Bernard-Urban land complex
BG	block group
BIC	Blanton fine sand
BMPs	best management practices
BnB	Bienville loamy fine sand
BNSF	Burlington Northern Santa Fe
Bo	Boy fine sand
Br	Bruno loamy fine sand
Btu	British thermal unit
BvB	Bienville-Kenefick complex
CAA	Clean Air Act
CAAA	Clean Air Act Amendments
CADD	computer aided design and drafting
CAT	corridor analysis tool
CB	census block
Cd	Clodine loam
CDR	Career Development Resources
Ce	Clodine-Urban land complex
CEQ	Council on Environmental Quality
CERCLIS	Comprehensive Environmental Response, Compensation, and Liability Information System
cfs	cubic feet per second
CLI	Closed Landfill Inventory
CMA	congestion mitigation analysis
CMAQ	Congestion Management Air Quality
CMS	Congestion Management System
CMZ	Coastal Management Zone
CO	carbon monoxide
CO_2	carbon dioxide
CORRACT	Corrective Action Database for Resource Conservation and Recovery Information System
CPA	Conservation Planning Assistance
CR	County Road
CRIS	Crash Records Information System
CRM	Cultural Resource Management
CRT	Commuter Rail Transit
CWA	Clean Water Act
CZMA	Coastal Zone Management Act
dB	decibel
dBA	A-weighted decibel level
DHV	Design Hourly Volume
DPM	diesel particulate matter
DEIS	draft environmental impact statement
DyC	Dylan Clay
E	Endangered
Ed	Edna fine sandy loam
EFH	Essential Fish Habitat
EIS	environmental impact statement
EJ	environmental justice
EJ TAZ	environmental justice traffic analysis zone
ENV	TxDOT Environmental Affairs Division
EO	Executive Order
EOID	Element of occurrence identification

EPA	U.S. Environmental Protection Agency
ERNS	Emergency Response Notification System
Es	Estes Clay
ESA	Environmental Site Assessment/Endangered Species Act
ETC	Estimated time of completion
Eu	Eustics loamy fine sand
FAST	Fast-Track Advisory and Streamlining Team
FEIS	final environmental impact statement
FEMA	Federal Emergency Management Agency
FHWA	Federal Highway Administration
FINDS	Facility Index Systems
FIRM	flood insurance rate maps
FM	Farm-to-Market Road
Fo	Frost silt loam
FPPA	Farmland Protection Policy Act
fps	feet per second
FrB	Frost-Anahuac complex
Fs	Fuquay loamy fine sand/Frost-Morey complex
ft	feet / foot
Ft	Fuquay loamy fine sand, terrace
FTA	Federal Transit Administration
FIFRA	Toxic Substances Control Act
FY	Fiscal Year
Ga	Garner Clay
Ge	Gessner loam
GIS	geographic information system
GLO	General Land Office
GPA	Grand Parkway Association
GPS	Global positioning system
GCD	Groundwater Conservation District
Gy	Guyton-Aldine Complex
Ha	Hatliff clay loam
HBW	Home based work trip
HBNW	Home based non-work trip
HCFCD	Harris County Flood Control District
HCTRA	Harris County Toll Road Authority
HDDV	Heavy-Duty Diesel Vehicle
HEI	Health Effects Institute
H-GAC	Houston-Galveston Area Council
HGB	Houston-Galveston-Brazoria
HGSD	Harris-Galveston Subsidence District
HHS	Department of Health and Human Services
HMIRS	Hazardous Material Incident Report System
HoB	Hockley fine sandy loam
HOT	high-occupancy toll
HOV	high-occupancy vehicle
HPA	high probability area
HRS	hazard ranking system
HRSR	Historic-age Resources Survey Report
HVAC	Heating, ventilation, and air conditioning
ICI	Indirect and cumulative impacts
I	Interstate Highway
ISD	Independent School District
IRIS	Integrated Risk Information System
Kf	Kaman Clay
Kh	Kemah silt loam
Km	Kemah-Aris complex
LEP	limited English proficiency
Leq	equivalent sound level
LOM	level of mobility
LOS	level of service
LPST	leaking underground storage tank
LRT	Light rail transit
Lu	Lake Charles-Urban land complex
Lu	Lucy loamy fine sand
Ma	Mantachie loam
MAPO	Meeting with Affected Property Owners
MBTA	Migratory Bird Treaty Act
MCAD	Montgomery County Appraisal District
Md	Midland silty clay loam
METRO	Metropolitan Transit Authority of Harris County
mi	mile(s)
mi^2	square mile
MOA	memorandum of agreement
MOU	memorandum of understanding
MOVES	Motor Vechile Emission Simulator
mpg	Miles per gallon
mph	miles per hour
MPO	metropolitan planning organization
MS4	Municipal Separate Storm Sewer

	System
MSA	metropolitan statistical area
MSAT(s)	mobile source air toxic(s)
MSWLF	Municipal Solid Waste Landfill
Mu	Midland-Urban land complex
MUD	municipal utility district
MVMT	million vehicle miles of travel
My	Mocarey-Yeaton complex
NAAQS	National Ambient Air Quality Standards
NAC	noise abatement criteria
NATA	National Air Toxics Assessment
NCHRP	National Cooperative Highway Research Program
NEPA	National Environmental Policy Act
NFIP	National Flood Insurance Program
NGL	Natural Gas Liquids
NGVD	National Geodetic Vertical Datum
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NOI	notice of intent
NO_x	nitrogen oxide
NO_2	nitrogen dioxide
NORM	Naturally Occurring Radioactive Material
NPL	National Priorities List
NRCS	Natural Resource Conservation Service
NRC	National Response Center
NRHP	National Register of Historic Places
NRI	National Rivers Inventory
NWI	National Wetland Inventory
NWP	Nationwide Permit
O_3	Ozone
Oa	Ozan loam
O&D	Origin and Destination Analysis
OHWM	Ordinary high water mark
On	Ozan-Urban land complex
OSHA	Occupational Safety and Health Administration
OTHM	Offical Texas Historical Marker
OyB	Otanya fine sandy loam
PADS	PCB Activity Database System
PALM	Potential Archeological Liability Map
PA-TU	Programmatic Agreement for Transportation Undertakings
Pb	lead
PDO	property damage only
PM	particulate matter
ppb	parts per billion
ppm	parts per million
PSL	project specific locations
Pt	Pits
Q3	Quality Level 3 Digital FIRM
Qal	Alluvium
Qb	Beaumont Formation
Qd	Deweyville Formation
Qi	Lissie Formation
RAZ	Regional Analysis Zone
RCRA	Resource Conservation and Recovery Act
RCRA-GEN	Resource Conservation and Recovery Act – Generators and Violators
RCRA-LQG	Resource Conservation and Recovery Act – Large Quantity Generators
RCRA Non-Gen	Resource Conservation and Recovery Act – NonGenerators
RCRA-SQG	Resources Conservation and Recovery Act – Small Quantity Generators
RCRA-TSDF	Resource Conservation and Recovery Act – Treatment Storage and Disposal Facilities
RIA	Regulatory Impact Analysis
RIBITS	Regulatory In-liue Fee and Band Information Tracking System
ROD	record of decision
ROW	right-of-way
RPST	Registered Petroleum Storage Tanks
RRC	Railroad Commission of Texas
RSA	Resource Study Area
RTHL	Recorded Texas Historic Landmark
RTP	regional transportation plan
SAFETEA-LU	The 2005 Safe, Accountable, Flexible,Efficient, Transportation Equity Act: A Legacy for Users
SAL	State Archeological Landmark
Sb	Sorter loam
Sd	Sorter-Dallardville complex
Se	Segno fine sandy loam

SH	State Highway
SHPO	State Historic Preservation Officer
SIP	state implementation plan
Sk	Sorter-Kirbyville complex
So	Sorter silt loam
SO_2	sulfur dioxide
SOC	Species of Concern
SOV	single-occupancy vehicle
Sp	Splendora fine sandy loam
SWPPP	Storm Water Pollution Prevention Plan
T	Threatened
T/SA	Threatened by Similarity of Appearance
TAZ	traffic analysis zone
TCEQ	Texas Commission on Environmental Quality (formerly Texas Natural Resource Conservation Commission)
TDM	travel demand model / travel demand management
THC	Texas Historical Commission
TIP	transportation improvement program
Tk	Tuckerman loam, heavy subtratum
TMA	transportation management area
TMDL	total maximum daily load
TNM	Traffic Noise Model
TNRIS	Texas Natural Resource Information System
TPDES	Texas Pollutant Discharge Elimination System
TPWD	Texas Parks and Wildlife Department
TRB	Transportation Research Board
TRIS	Toxic Chemical Release Inventory System
TSARP	Tropical Storm Allison Recovery Project
TSCA	Toxic Substance Control Act
TSM	Transportation System Management
TSS	Total Suspended Solids
TSWQS	Texas Surface Water Quality Standards
TWC	Texas Workforce Commission
TWDB	Texas Water Development Board
TxDOT	Texas Department of Transportation
TxNDD	Texas Natural Diversity Database
UPRR	Union Pacific Railroad
URARPA	Uniform Relocation Assistance and Real Properties Acquisitions Act
US	United States Highway
U.S.	United States
U.S.C.	United States Code
USACE	U.S. Army Corps of Engineers
USCG	U.S. Coast Guard
USDA	U.S. Department of Agriculture
USDOT	U.S. Department of Transportation
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
UST	underground storage tank
VaA	Vamont clay/Vaiden clay
VaB	Vaiden clay
v/c	vehcile to capacity
VCP	Voluntary Cleanup Program
Vd	Vamont silty clay
Ve	Verland clay loam
VHT	vehicle hours of travel
VMT	vehicle miles traveled
Vo	Voss fine sand, occasionally flooded
VOCs	volatile organic compounds
Vpd	vehicles per day
Vs	Voss fine sand, frequently flooded
Wa	Waller loam
Wc	Waller loam, depressional
Wd	Waller-Dallardsville complex
Wk	Waller-Kirbyville complex
WkD	Wicksburg loamy fine sand
Wn	Waller-Splendora complex
Wo	Wockley fine sand loam
WvB	Woodville fine sandy loam
WvD	Woodville fine sandy loam
Wy	Wockley-Urban land complex
Yr	Year

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EXECUTIVE SUMMARY

ES.1 INTRODUCTION

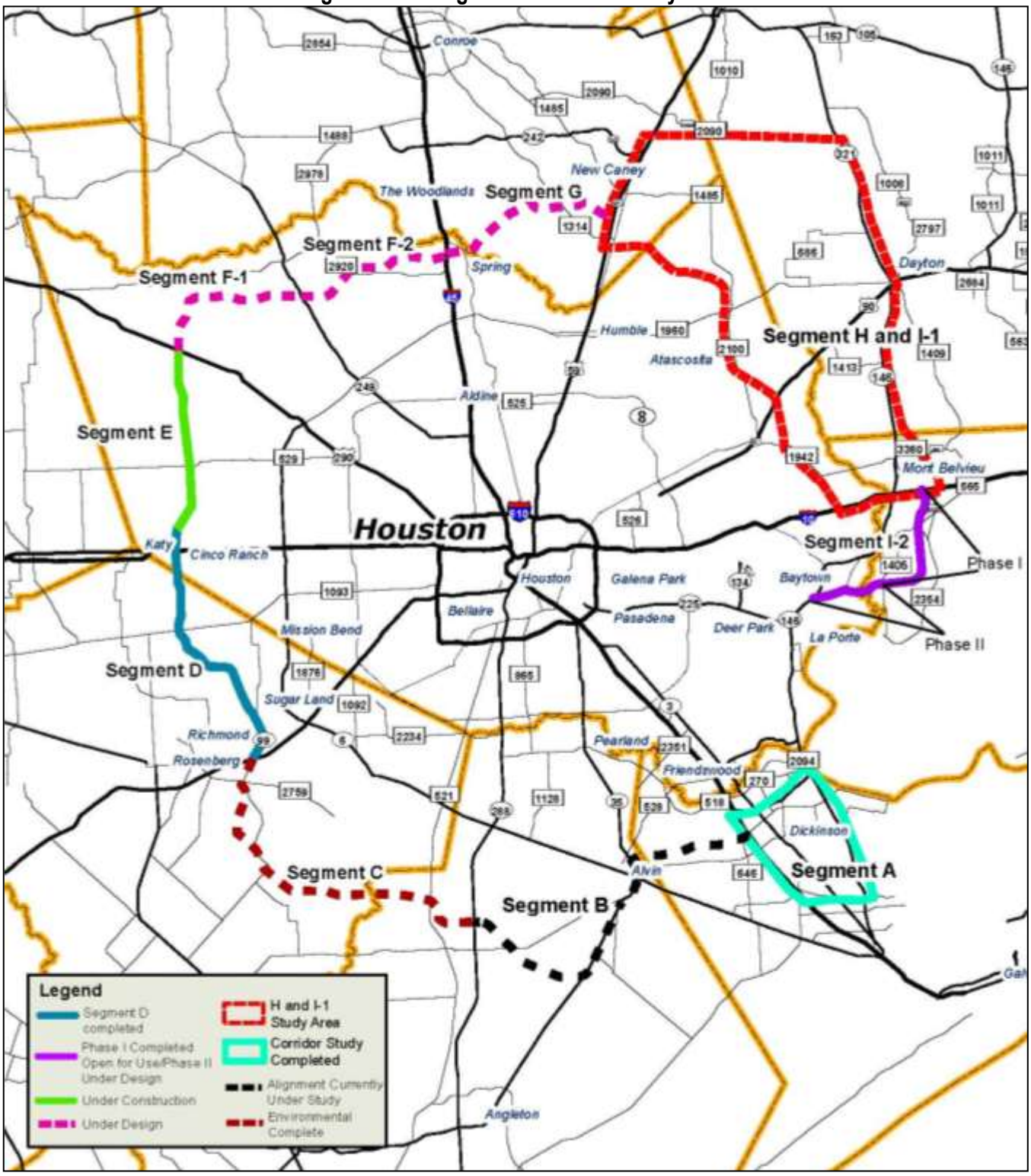
The Grand Parkway Segments H and I-1 are part of a planned 180+ mile (mi) circumferential loop around the greater Houston metropolitan area as shown in **Figure ES-1.** The Grand Parkway is divided into 11 segments, each of which has logical termini and can function separately to facilitate planning, design, and construction. 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."

A Grand Parkway Overview document was prepared by the Texas Department of Transportation (TxDOT) in 1992 to provide an overall assessment of the entire Grand Parkway outer loop facility. To date, Segment D, from United States Highway (US) 59/Interstate Highway (I) 69 to I-10 West (W), opened to traffic in 1994 and Phase I of Segment I-2, I-10 (E) to Farm-to-Market Road (FM) 1405, was opened to traffic in March 2008. The environmental review of Phase II of Segment I-2, FM 1405 to State Highway (SH) 146, is completed and currently under design. Segments E, F-1, F-2, and G have been let to construction. Segment C received a Record of Decision (ROD) on March 29, 2013. Segments B and Segments H and I-1 (this study) are in the route study and environmental documentation phase. Corridor studies began in September 2008 for Segment A and were completed in 2010.

ES.1.1 Project Description

The Grand Parkway Segments H and I-1 are two separate segments, but for the purposes of the Environmental Impact Statement (EIS) they were evaluated collectively from US 59/I-69 North (N) to I-10 East (E). Due to similarities of the study areas for Segments H and I-1, FHWA and TxDOT recommended that one document be prepared for both segments. The Segments H and I-1 study area is located on the northeast side of the greater Houston metropolitan area **(Figure ES-1)**. The study area is generally bound by FM 2090 on the north, I-10 (E) on the south, US 59/I-69 (N) and FM 2100 on the west and SH 146 on the east, in Montgomery, Harris, Liberty, and Chambers counties.

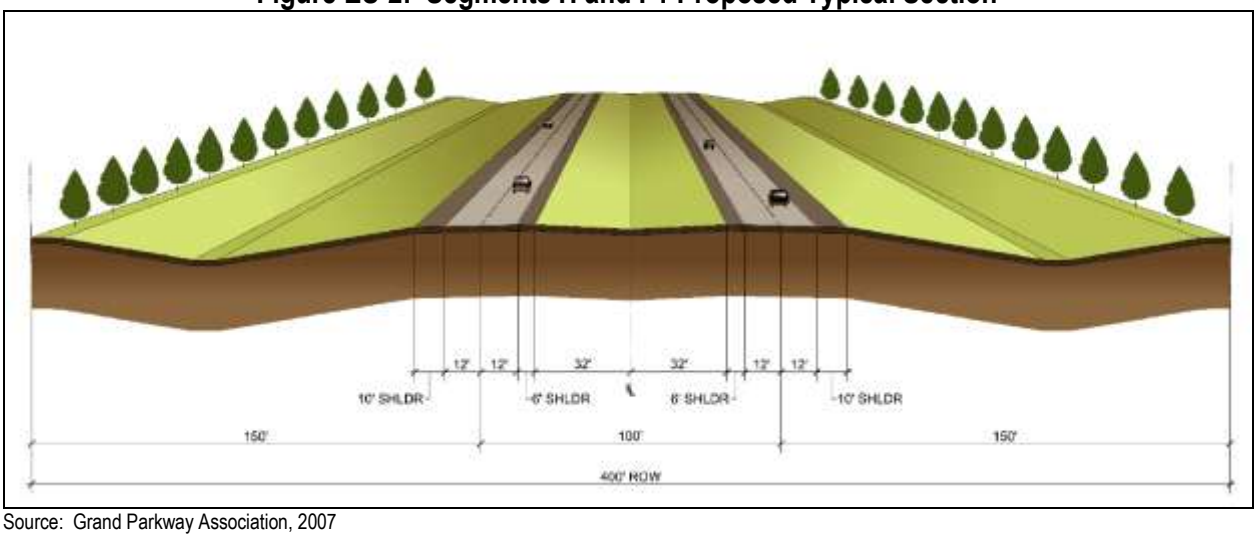
Figure ES-1: Segments H and I-1 Study Area



Source: Study Team, 2012

Segment H begins at US 59/I-69 North (N) near New Caney and continues south to US 90. Segment I-1 begins where Segment H ends at US 90 and continues south to I-10 (E) near Mont Belvieu. Both segments are proposed as a 4-mainlane at-grade controlled-access tollway with proposed grade separations at major intersections within a 400-foot (ft) right-of-way (ROW) width. See **Figure ES-2** below for a proposed typical section of Segments H and I-1.

Figure ES-2: Segments H and I-1 Proposed Typical Section



Source: Grand Parkway Association, 2007

ES.1.2 Document Organization and FEIS Approach

The Final EIS (FEIS) prepared for Segments H and I-1, is organized into a two-volume set. Volume I provides a detailed assessment of Segments H and I-1 relative to the study area. It presents issues, permits needed, and federal actions specific to Segments H and I-1, including the purpose and need, alternatives considered, affected environment, environmental consequences, avoidance, minimization, and mitigation measures, indirect and cumulative impacts, and agency and public coordination. It also contains the exhibits referenced throughout each chapter of Volume I. Volume II contains the appendices referenced throughout Volume I.

ES.1.3 Project Development Process

TxDOT and FHWA filed a Notice of Intent (NOI) for Segments H and I-1 in January of 2006. Two series of public scoping meetings were held on February 28 and March 1, 2006, and on May 8 and 9, 2007. Two public hearings were held on August 9 and August 11, 2011 to present a summary of findings from the Draft EIS (DEIS).

The project development process implemented for Segments H and I-1 consisted of studies to determine the purpose and need, alternatives development and analysis, affected environment (existing conditions), environmental consequences, and indirect and cumulative effects. Throughout the study process, numerous resource agency and elected official meetings were held to solicit input on the project development process. The Preferred Alternative developed during preliminary environmental studies along with input from the resource agencies, elected officials, and the public during the DEIS stage, is detailed in this FEIS.

Representatives of the U.S. Army Corps of Engineers (USACE), Texas Parks and Wildlife Department (TPWD), and U.S. Fish and Wildlife Service (USFWS) were particularly concerned with the identification and avoidance of wetlands; Lake Houston Wilderness Park; floodplains; rare, threatened, endangered or protected species; and special habitat areas. Tools such as a Geographic Information System (GIS) were used to map and identify the potential areas of concern. Sensitive resources were avoided to the maximum extent practicable during the project development process.

ES.2 PROJECT PURPOSE AND NEED

The Segments H and I-1 needs to be addressed 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 local needs of the Segments H and I-1 study area are further detailed in the following sections.

ES.2.1 Discontinuous System Linkage

The interstate and regional highways are predominantly oriented in either an east-west or a north-south direction, providing an opportunity to provide linkage via circumferential transportation infrastructure. I-10, US 90, and US 59/I-69 are three radial highways connecting Houston to its suburbs and beyond. No additional alternative connecting major radial facilities exists in the Segments H and I-1 study area. Currently, commuters utilize FM 1485, FM 1960, FM 2100, and SH 146 to make such connections.

Secondary roads include FM 3360, FM 1942, FM 1413, and FM 1314. The central portion of the study area, as shown in **Figure ES-1**, is especially deficient in transportation infrastructure to support circumferential and north-south mobility.

ES.2.2 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 and distribute it to points beyond.

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 is 2011. After meeting with FHWA, TxDOT, and the local Metropolitan Planning Organization (MPO), which is the Houston-Galveston Area Council (H-GAC), 2039 was selected as the horizon year (design year), with 2019 as the interim year (construction completion date for Phase I). The estimated time of completion for the Grand Parkway ultimate configuration is 2025. The H-GAC Travel Demand Model (TDM) utilized for analysis was based on the 2035 Regional Transportation Plan (RTP) which was adopted in August 2007 and updated in January of 2011. The 2035 traffic model used for analysis was provided by H-GAC in 2012. H-GAC has demographic forecasts through 2050 and, therefore, provided a year 2039 dataset which comprises 2039 travel demand on the 2035 RTP roadway network. The 2035 RTP roadway network includes all segments of the Grand Parkway. However, in evaluating the No-Build Alternative, Segments H and I-1 were deleted from the roadway network.

ES.2.3 Compromised Safety

The proposed project would improve safety within the study area for the traveling public by helping to reduce stop-and-go conditions, reduce crash rates, and congestion during emergency evacuations and peak travel times. During Hurricane Rita in 2005, hurricane evacuation was impeded by the lack of circumferential highways in this region. Traffic trying to evacuate to the north had limited choices on available facilities. SH 146 was backed up from Dayton south to Mont Belvieu due to limited capacity and connectivity with US 59/I-69 (N). The Grand Parkway Segments H and I-1 provides additional evacuation capacity and a direct route to US 59/I-69 (N), as well as connectivity to I-45 via connection to Segment G.

ES.2.4 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. Based on the H-GAC 2035 (2012) forecasts, population growth for the Segments H and I-1 study area is projected to increase by approximately 62 percent through the year 2039. 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.

ES.3 ALTERNATIVES ANALYSIS

ES.3.1 Corridor Study

The following multi-step process was used to determine the Preferred Alternative within the study area:

- The study area was defined and stakeholders were identified. A Project Coordination Plan was prepared listing stakeholders and the coordination process.
- Constraints mapping was prepared for the study area to identify sensitive resources including wetlands, parks, historic and archeological sites, existing and proposed development, potential environmental justice populations, neighborhoods, floodplains, streams and waterways, potential habitat for threatened and endangered species, churches, schools, and cemeteries.
- The universe of alternatives was identified. The universe of alternatives consisted of study team generated alternatives, Corridor Analysis Tool (CAT) alternatives, and publicly available and previously published alternatives.
- A fatal flaw analysis was conducted for the universe of alternatives resulting in a set of preliminary alternatives. The fatal flaw analysis eliminated any previously published alternatives that bisected Lake Houston Wilderness Park or impacted potential threatened and endangered species habitat. The study area was divided into three sections (A, B, and C) where the alternatives shared common points of intersection. The preliminary alternatives consisted of five alternatives in Section A (northern section), eight alternatives in Section B (middle section), and seven alternatives in Section C (southern section).
- Preliminary alternatives were evaluated and identified a set of reasonable alternatives. The set of reasonable alternatives consisted of 10 Build Alternatives, Alternatives 2 through 11, and a No-Build Alternative, Alternative 1, for a total of 11 reasonable alternatives.
- The reasonable alternatives were analyzed by desktop GIS evaluation and limited field verification and Recommended Alternative 10 was selected and shown at the public hearing.
- Following the public hearing, Recommended Alternative 10 was revised to create the Preferred Alternative 10R.

Throughout the process, input was solicited from the public, agencies, and elected officials and integrated into the various steps in the process. Evaluation criteria for the preliminary alternatives and the reasonable alternatives included environmental, traffic, engineering and public and agency input.

ES.3.2 Alternative Transportation Modes Considered

The following ranges of alternative transportation modes were considered in addition to the reasonable alternatives in order to fully evaluate the purpose and need of the proposed project:

- **Transportation System Management (TSM) Measures –** Examples of TSM measures include, but are not limited to, emergency management, incident management, road weather management, special events management, managed lanes, work zone management, demand management, congestion pricing, active transportation and demand management, and integrated corridor management (TRB 2012). TSM measures implemented at critical locations can improve traffic operations and safety of existing infrastructure through multimodal and intermodal systems and services (TRB 2012). While the TSM Alternative, including the TSM improvements in the 2035 RTP, is expected to ease congestion and travel time for local trips, this alternative does not adequately address critical issues identified in the project purpose and need statement such as inadequate system linkage, decreased regional mobility, compromised safety, and a lack of infrastructure to support population growth.
- **Travel Demand Management Alternatives (TDM) -** TDM measures are strategies and programs that encourage commuters to use alternatives to driving alone, especially during periods of heaviest congestion. TDM measures identified in the 2035 RTP Update for the Grand Parkway Segments H and I-1 study area include the Liberty County Park and Ride Facility to be located southwest of Dayton along US 90, and the Atascosita Park and Ride Facility to be located on FM 1960 west of Lake Houston Parkway. These measures would not be sufficient to effectively accommodate the projected increase in traffic demand through 2039. The TDM components would not address critical issues identified in the project purpose and need statement such as inadequate system linkage, decreased mobility, compromised safety, and a lack of infrastructure to support population growth.
- **Smart Street Alternatives -** Smart Street enhancements in the 2035 RTP Update focus on a range of operational management techniques to reduce delay including traffic light synchronization, deployment of roundabouts, medians, consolidation of duplicate driveways, and partial grade separation of traffic lanes at some intersections. Although the implementation of Smart Streets would improve traffic operations along these study area roadways, the enhancements would not address the study area linkage needs and would not provide the additional circumferential capacity to handle the projected traffic demand.
- **Modal Alternatives -** Modal transportation improvements include bus transit, rail transit, bicycle, pedestrian and high occupancy vehicle (HOV) lanes. The 2035 RTP Update incorporates the 2035 Metropolitan Transit Authority of Harris County (METRO) Long Range Plan, which include the 2025 METRO Solutions Plan and future mobility needs identified in regional planning efforts. This category of alternatives was eliminated from further consideration because of failure to meet the project purpose and need. Modal alternatives would not provide an alternate hurricane/emergency evacuation route to meet the

compromised safety component of the purpose and need. Bicycle and pedestrian treatments are not treated as a stand-alone alternative transportation mode but can be incorporated into the design phase.

- **Preferred Alternative -** Segments H and I-1 of the Grand Parkway are planned by TxDOT and the Grand Parkway Association (GPA) as a controlled-access toll facility to be constructed on new location, consistent with the 2035 RTP Update. The Preferred Alternative includes all committed improvements identified in the No-Build Alternative such as added capacity projects, TSM, TDM, and Smart Streets. The proposed project is specifically targeted at relieving local and regional congestion, improving mobility and system linkage, and improving safety on congested roadways within the region, including an improved emergency evacuation route. The Preferred Alternative is the only alternative that meets the purpose and need of the project. The Grand Parkway Segments H and I-1 are specifically included on the 2035 RTP as a four-lane tolled facility. Due to funding limitations, a free or non-tolled Preferred Alternative was not considered as part of this study.

ES.3.3 No-Build Alternative

The No-Build Alternative would not construct a new location toll facility; however, it includes all committed projects included in the 2035 RTP Update, with the exception of Segments H and I-1 of the Grand Parkway. The RTP improvements include added capacity projects (such as new roadways and roadway widening) as well as committed TSM, TDM, Smart Streets, and modal improvements such as transit. The improvements are already a part of the ongoing plan for upgrades to the existing roadway system. Although the No-Build Alternative would not satisfy the purpose and need of the proposed action, it was retained as a basis for comparison with the alternatives carried forward for detailed study. The No-Build Alternative was designated Alternative 1 as a part of the set of reasonable alternatives studied in the DEIS.

ES.3.4 Preferred Alternative

The Preferred Alternative 10R is the best alternative that fulfills the purpose and need of the proposed project. Ten reasonable alternatives were developed to analyze the physical, biological, and human environments that may be affected by the construction and operation of each alternative, shown in **Table ES-1**. Following the public hearing and a meeting with affected property owners, Recommended Alternative 10 was realigned to avoid impacts disclosed during the hearing, and renamed 10R.

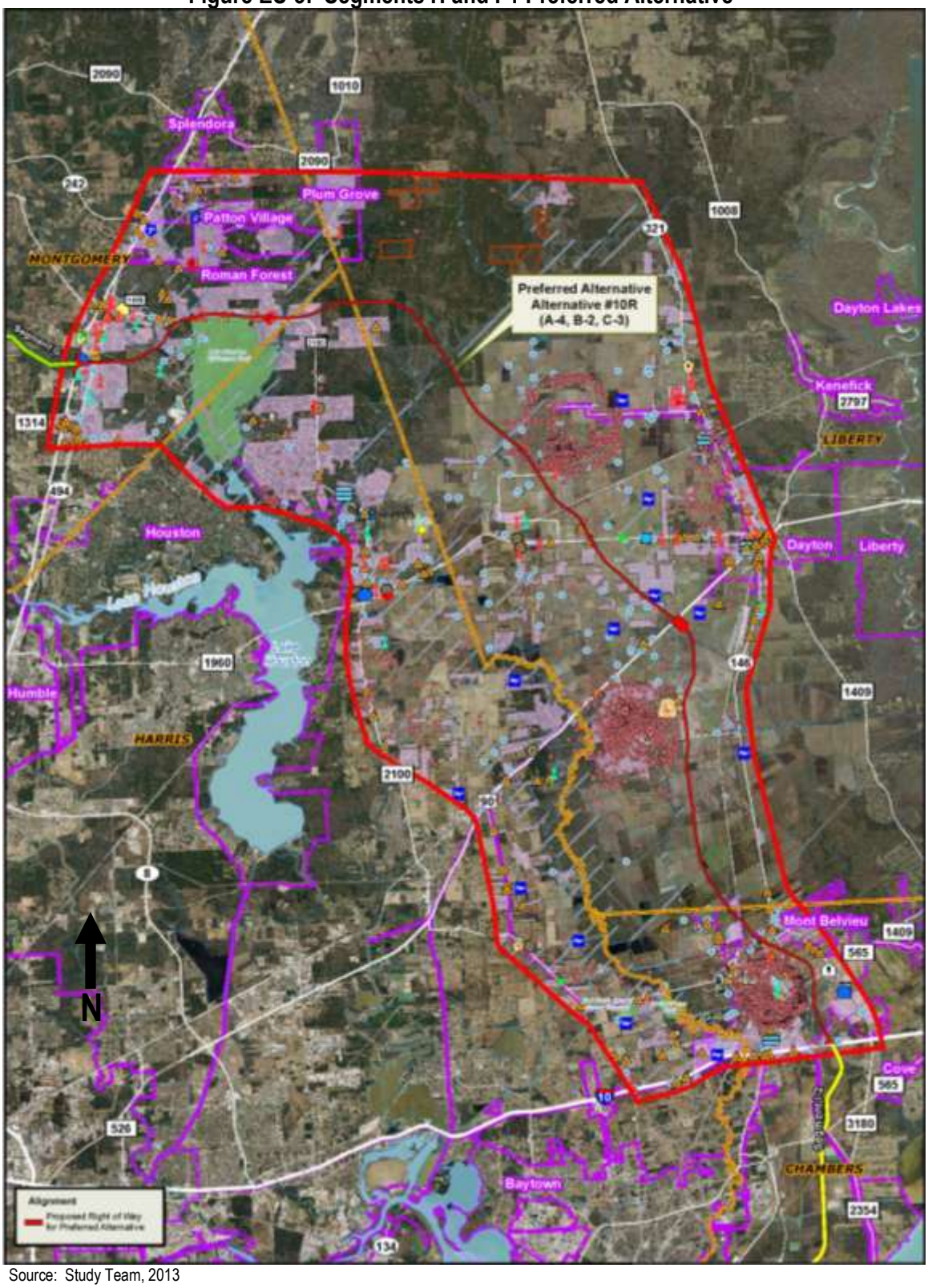
Table ES-1: Reasonable Alternatives

Alternative	Description	Length (miles)
1	No-Build	0
2	A-2, B-1, C-2	38.2
3	A-2, B-1, C-3	39.4
4	A-2, B-2, C-2	35.4
5	A-2, B-2, C-3	36.6
6	A-2, B-5, C-6	35.4
7	A-4, B-1, C-2	39.7
8	A-4, B-1, C-3	41.0
9	A-4, B-2, C-2	36.9
10	A-4, B-2, C-3	37.4
10R*	**A-4, B-2, C-3**	**37.4**
11	A-4, B-5, C-6	37.0

* Preferred Alternative
Source: Study Team, 2012

The Preferred Alternative combines sections A-4, B-2, and C-3 and is approximately 37.4 mi in length, and begins at Community Drive on US 59/I-69 (N), approximately 1.5 mi south of FM 1485. It then bridges over Loop 494 and the Union Pacific Railroad (UPRR) line and continues in a northeasterly direction for approximately 3 mi crossing Caney Creek. The alignment proceeds, turning east near Peach Creek where it overlaps with FM 1485 north of Lake Houston Wilderness Park for approximately 3.5 mi and also crosses the East Fork San Jacinto River. The Preferred Alternative continues east of FM 1485 for roughly 2.5 mi before turning southeast for approximately 13 mi crossing over the UPRR line, FM 1960, and US 90 approximately 3 mi east of Dayton. Approximately 3 mi south of US 90, it turns in a southwesterly direction crossing FM 1413 and traversing south while staying west of the UPRR line. It then turns east bridging over the railroad and crosses SH 146 and FM 565 west of Mont Belvieu, and eventually terminates at I-10 (E) near the I-2 segment of Grand Parkway. Approximately 3 mi of the Preferred Alternative follows existing FM 1485 with the remaining 34.4 mi on new location. The Preferred Alternative includes the reconstruction of FM 1485 from a two-lane roadway, to a pair of one-way non-tolled frontage roads with two travel lanes in each direction on either side of the Grand Parkway Segments H and I-1 toll facility. Both segments of the Grand Parkway are proposed as a toll facility, however the existing portion of FM 1485 would become part of the non-tolled frontage road system and would not be tolled. The Preferred Alternative would require approximately 1,933 acres (ac) of ROW.

Figure ES-3: Segments H and I-1 Preferred Alternative



Source: Study Team, 2013

ES.3.5 Traffic and Transportation Analysis

The study area is bound by US 59/I-69 (N) and I-10 (E) and these radial roadways are only circuitously connected by minor arterials and collector roadways within the study area, such as FM 1485, FM 2100, FM 3360, FM 1413, Loop 494, and SH 146. To accomplish circumferential movements to and from the study area, travelers must use the radial roadways, such as US 59/I-69 (N), US 90, and I-10 (E) to reach the minor arterial and collector roadways. The existing transportation system within the study area does not provide efficient connections to the suburban communities of Kingwood, New Caney, and Huffman, or to the cities of Dayton and Mont Belvieu.

Freight traffic is transported via trucks from I-10 (E) and the Port of Houston through the study area to the major industrial complexes, as well as to US 59/I-69 (N) for national distribution. Trucks currently use the existing two-lane local roadways in the study area which present traffic operation and safety issues. 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, Wal-Mart Distribution Center north of Dayton, and numerous gas storage facilities associated with two salt dome formations in Mont Belvieu and west of Dayton.

A summary of transportation benefits for the proposed Segments H and I-1 are listed as follows:

- The Grand Parkway would result in time savings for travel along study area interstates, arterials and collector roads. Daily vehicle hours traveled (VHT) along interstates is projected to reduce by 7 percent (1,265 hours) in 2039. Overall, these results show that the proposed Segments H and I-1 would improve mobility for the traffic study area and reduce congestion on the roadway network.
- Overall, the H-GAC 2035 travel demand model analysis results, extended to year 2039 (**Section 2.3**) demonstrate that the construction of the Preferred Alternative would result in reduced traffic volumes within the traffic study area roadway network ranging from 5 percent to 12 percent when compared to the No-Build Alternative. The No-Build Alternative includes all projects in the 2035 RTP Update excluding the Grand Parkway.
- Diverting traffic from collector roadways to a limited-access facility such as Grand Parkway Segments H and I-1 would be expected to reduce the study area roadway crash rates.

ES.4 ENVIRONMENTAL IMPACTS OF THE PREFERRED ALTERNATIVE

The FEIS document analyzes the Preferred Alternative (10R) for environmental impacts following the public hearing. The potential environmental impacts associated with the construction and operation of the Preferred Alternative have been evaluated and are summarized in **Table ES-2**. The information is divided

into the following technical disciplines: Land Use; Natural Resources; Cultural Resources; Noise; Socioeconomic/EJ; Water Wells, and Hazardous Materials.

Table ES-2: Environmental Impact Summary of the Preferred Alternative

		Environmental Impact	Alternative 10R Preferred Alternative
		Total Project Length (miles)	37
		Total Project ROW (acres)	1,933
Land Use		Commercial (acres)	7
		Agricultural (acres)	1,072
		Residential (acres)	130
		Schools (number)	2
		Churches (acres)	3
		Industrial (acres)	22
		Preliminary Platted (acres)	0
		Undeveloped Platted (acres)	0
		Managed Lands (acres)	11
		Other Undeveloped (acres)	687
		Visual and Potential Access Impacts (yes/no)	Yes
Natural Resources	Wetlands	Forested Wetlands (acres)	27
		Non-Forested Wetlands (acres)	16
		Agricultural wetlands (acres)	285
	Streams	Impaired Streams Impacted (number)	0
		Ecologically Significant Streams Crossed (number)	3
		Threatened and Endangered Species (number)	0
		Species of Concern (number)	0
		Wildlife Habitat (acres)	665
		Floodway (acres)	43
		100-Year Floodplain (acres)	158
		Prime Farmland (acres)	960
		Century Farms (number)	0
Cultural Resources		Recorded Archaeological Sites (number)	0
		Archeological High Probability Areas (acres)	1,696
		Historic Resources (number)	1
		Cemeteries (number)	0
Noise		Potential Noise Impacts (number)	38
Socioeconomic/EJ		Residential Displacements (number)	77
		Commercial Displacements (number)	19
		Churches Displaced (number)	1
		Changes in Community Cohesion (yes/no)	No
		Environmental Justice Issues (yes/no)	No
Water Wells		Public (number)	7
		Private (number)	0
HazMat		Regulated Sites (number)	9
		Oil Wells (number)	11
		Other Sites of Concern (number)	9

Source: Study Team, 2013

ES.4.1 Hydrology and Drainage

The Preferred Alternative would not impact hydrology and drainage.

ES.4.2 Waterbody Modifications

The Preferred Alternative would not impact waterbody modifications.

ES.4.3 Wild and Scenic Rivers

The Preferred Alternative would not impact wild and scenic rivers.

ES.4.4 Coastal Barriers

The Preferred Alternative would not impact coastal barriers.

ES.4.5 Coastal Zone Management

The Preferred Alternative would not impact coastal zone management.

ES.4.6 Essential Fish Habitat

The Preferred Alternative would not impact essential fish habitat.

ES.4.7 Threatened and Endangered Species

The Preferred Alternative would have no effect on any federally listed threatened or endangered species, nor would it adversely impact any state-listed species.

ES.4.8 Land Use

The Preferred Alternative would require 1,933 acres (ac) of proposed ROW. As a result of the predominance of agricultural land in the area, the Preferred Alternative would result in the reduction of agricultural and undeveloped land. Most of the land converted to highway ROW would be agricultural (1,072 ac) or undeveloped platted and other undeveloped (687 ac). The No-Build Alternative would have no impacts to land use associated with the proposed project.

ES.4.9 Soils and Farmland Impacts

The Preferred Alternative would impact 960 ac of prime farmland soils. The Preferred Alternative would be placed along property lines where possible to minimize the impacts to farms. The No-Build Alternative would not result in soils and/or prime farmland soils impacts associated with the construction or operation of the proposed project.

ES.4.10 Social Impacts

ES.4.10.1 Community Cohesion

The Preferred Alternative would be placed along existing transportation corridors, such as Community Drive and FM 1485, in the urban portion of the study area to avoid impacts to community cohesion. The No-Build Alternative would have no community cohesion impacts.

ES.4.10.2 Environmental Justice (EJ)

No environmental justice impacts would result from the proposed Grand Parkway Segments H and I-1 project. One residential displacement is anticipated within census blocks containing significant minority populations. However, none of the displacements are located within a block group with a median household income below that of the Department of Human Health Services 2013 poverty guideline of $23,550. No specific environmental justice issues have been raised throughout TxDOT or Grand Parkway Association's communication with adjacent property owners, adjacent municipalities, and other public agencies with interests along the proposed project's corridor.

The majority of trips originating or destined for Segments H and I-1 are not from areas with identified high proportions of EJ populations. Users would benefit from the proposed Grand Parkway project as a result of improved system linkage and mobility, enhanced safety and additional infrastructure to support population growth in the area. There do not appear to be any disproportionately high and adverse impacts on minority or low-income populations associated with the proposed project. The No-Build Alternative would have no impacts to environmental justice communities.

ES.4.10.3 Displacements

Small concentrations of potential residential and commercial displacements would occur in two areas. Section A-4, in the northern portion of the study area, could cause potential commercial and residential relocations along FM 1485. Section B-2 would potentially cause a small cluster of residential displacements on County Road (CR) 6022 between FM 1960 and US 90 in the central portion of the project area. The Preferred Alternative would displace 77 residences, 19 commercial businesses, and 1 church. No project-related residential or commercial displacements would occur as a result of the No-Build Alternative.

ES.4.11 Economic Impacts

Economic impacts related to the development of Segments H and I-1 include short-term construction-related employment, an increase in other forms of employment, a reduction in travel costs, and additional local and regional income generation from sources such as transportation-related taxes. Economic impacts estimated for the Preferred Alternative do not fluctuate substantially in magnitude and vary only in direct proportion to the level of proposed highway construction expenditures. The No-Build Alternative would have no economic impacts.

ES.4.12 Pedestrian and Bicyclist Impacts

"Proposed Shared-Use Path/Trails" as identified on H-GAC's Regional Bikeway Map (2007) would not be affected by the Preferred Alternative. These include a shared-use path/trail along FM 2100 that would begin near the intersection of FM 2100 with Huffman-Cleveland Road on the western edge of the study area, approximately 3 mi west of the Preferred Alternative, and head south.

The Grand Parkway Segments H and I-1 project, as proposed, 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. In the event that a bicycle or pedestrian facility is in place prior to the proposed project, the facility would be reconstructed to maintain continuity and function. The proposed project would minimize adverse effects to bicyclists and pedestrians by providing crosswalks walk signals, and appropriate signage at grade separated intersections (entrance ramp access points). The No-Build Alternative would result in higher traffic volumes on local roadways which would create safety issues for pedestrians and bicyclists.

ES.4.13 Visual and Aesthetic Impacts

The Preferred Alternative of Segments H and I-1 would be constructed predominately at-grade with vegetated roadsides, ROW, and medians. The amount of elevated roadway structure would be limited to areas where the proposed roadway would cross another roadway or a rail line. As currently proposed, the roadway lighting system would be restricted to those areas where entrance/exit ramps are located and would consist of low impact, downward directional lighting. The No-Build Alternative would not directly alter any visual resources; however, increased traffic congestion associated with the No-Build Alternative and the current development pressures in the region could lead to short-term and long-term impacts on the visual quality of the area road network and all viewers and users of roads in the network.

ES.4.14 Air Quality Impacts

The proposed project is consistent with the H-GAC's financially constrained 2035 RTP Update as revised and fiscal year (FY) 2013-2016 Transportation Improvement Program (TIP). The proposed project is located within Montgomery, Harris, Liberty, and Chambers counties, which are designated as nonattainment for ozone within the H-GAC's Transportation Management Area (TMA); therefore, the transportation conformity rule does apply. According to TxDOT's 2006 *Air Quality Guidelines*, a traffic air quality analysis is not required if the design year average daily traffic (ADT) is less than 140,000 vehicles per day (vpd). The 140,000 ADT threshold is based on a TxDOT modeling study which demonstrated that it is highly unlikely that the carbon monoxide (CO) standard would ever be exceeded on any project with traffic numbers below this level. According to the H-GAC Travel Demand Model (2012), the design year traffic (2039) is estimated to be approximately 31,443 vpd between US 59/I-69 and US 90 and 22,441 between US 90 and I-10; therefore, a traffic air quality analysis is not required.

Design year ADT volumes are less than 140,000 vpd for the Preferred Alternative; therefore, a qualitative mobile source air toxics (MSAT) analysis was performed. MSAT as a result of a proposed Grand Parkway are not expected to increase overall MSAT in the Houston area in the future years investigated. Under the No-Build Alternative, MSAT are expected to decline at nearly the same rate as the Preferred Alternative with no direct effect to air quality in the Houston area.

ES.4.15 Noise Analysis

As development and growth are projected to increase in the study area, it is expected that ambient noise levels would increase within areas of concentrated development associated with this projected growth. Noise levels were modeled for residential and commercial receivers adjacent to the Preferred Alternative. The Preferred Alternative would result in traffic noise impacts.

ES.4.16 Water Quality Impacts

The Preferred Alternative, 10R, crosses three ecologically substantial stream segments. Effects to surface water runoff and groundwater from the Preferred Alternative would be minimal. Quality and quantity of storm water runoff would be altered by the alternative in two ways: 1) direct effects from construction; and 2) effects from long-term operation of the roadway. Groundwater pollution prevention measures may be required for the public wells included in the Storm Water Pollution Prevention Plan (SWPPP) for which capture zones, defined by the Texas Commission on Environmental Quality (TCEQ), are overlapped by

alternatives; this includes seven public wells and three private wells. The Preferred Alternative would result in transverse floodplain encroachment crossings at each of the six streams within the Segments H and I-1 project area. No stream relocations are anticipated by the Preferred Alternative or the No-Build Alternative. The Preferred Alternative would impact 23 water resource crossings. The watersheds within the Segments H and I-1 project area are comprised of residential and commercial development and undeveloped acreage, such as farmlands and wooded areas. The Preferred Alternative would increase the amount of impervious areas within the watersheds, resulting in increased surface runoff. The increased surface runoff would not be considered substantial due to the required drainage (mitigation) facilities that would be incorporated into the project design. The Preferred Alternative has the potential to impact overland sheet flow patterns due to the construction of the roadway and associated structures. Therefore, sheet flow patterns would be considered during the design phase of the project. The No-Build Alternative would have no impacts to water quality.

ES.4.17 Wetlands Impacts

Site access has been obtained for 49 percent of the Preferred Alternative alignment. Potential wetland impacts were quantified by combining the results of the field delineation with review of color infrared aerial photographs, National Wetlands Inventory (NWI) maps, and published soil survey maps to determine the location of potential wetlands within the Preferred Alternative alignment. The Preferred Alternative would impact approximately 283 ac of adjacent agricultural wetlands, 16 ac of non-forested wetlands, and 39 ac of forested wetlands. The No-Build Alternative would have no impacts to wetlands.

ES.4.18 Permits

A Clean Water Act (CWA) Section 404 permit would be required by the USACE for the Preferred Alternative. Water quality certification from the TCEQ would also be necessary per Section 401 of the CWA prior to filling wetlands. No navigable Waters of the United States (U.S.) exist in the project area; therefore, the need for a Section 9 permit from the U. S. Coast Guard (USCG) or a Section 10 permit from the USACE is not anticipated.

Construction would impact greater than five acres; therefore, a Texas Pollutant Discharge Elimination System (TPDES) storm water discharge permit is required. The TPDES permit requires an NOI and completion of a SWPPP in order to avoid adverse impacts potentially resulting from storm water runoff discharges. There would be no anticipated permits under the No-Build Alternative.

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.

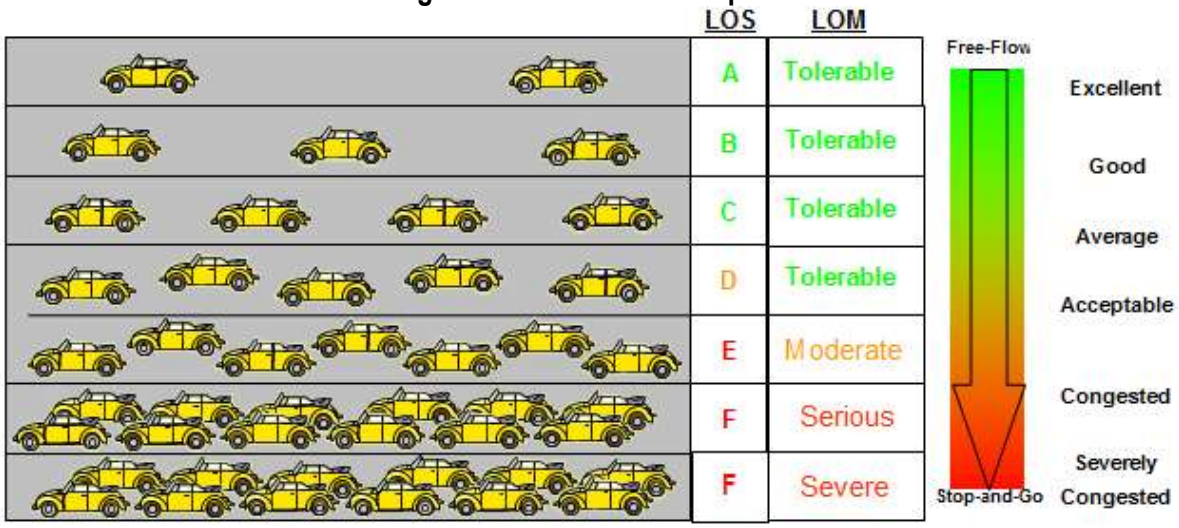
Source: TRB, 2000

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.

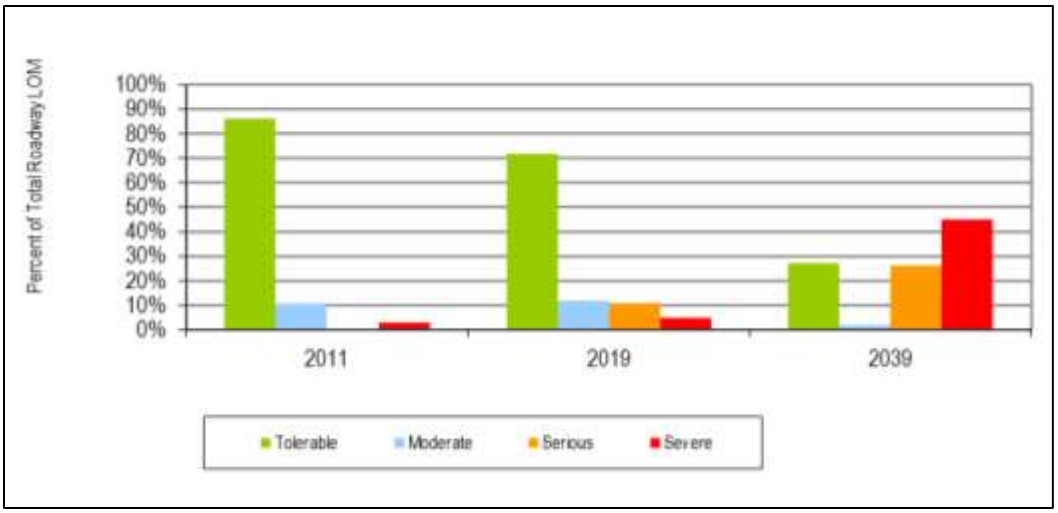
Level of Service for the Year 2039 No-Build scenario roadways, which excludes Segments H and I-1, is summarized in **Exhibit 1-7**. Base year and future No-Build LOM for years 2019 and 2039 are summarized in **Table 1-4** and **Figure 1-2** for the study area. The data shows that even with planned and 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

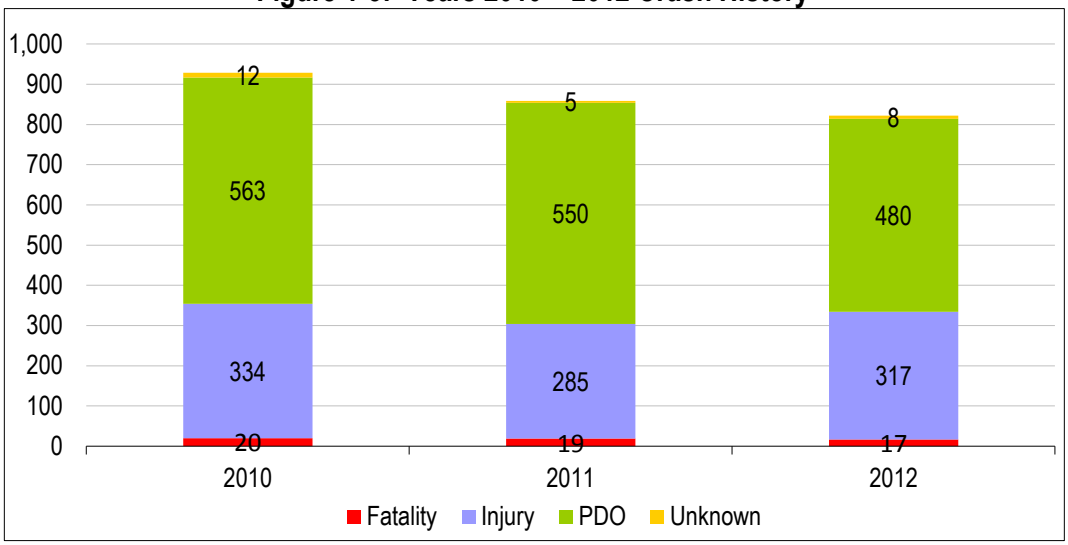
fatality, injury, or property damage only (PDO), as shown in **Table 1-11**. **Figure 1-3** illustrates crashes by type from 2010 to 2012 for the Segments H and I-1 study area. The total number of crashes over the three-year analysis period was 2,610 (**Table 1-11**), with the highest number of crashes,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

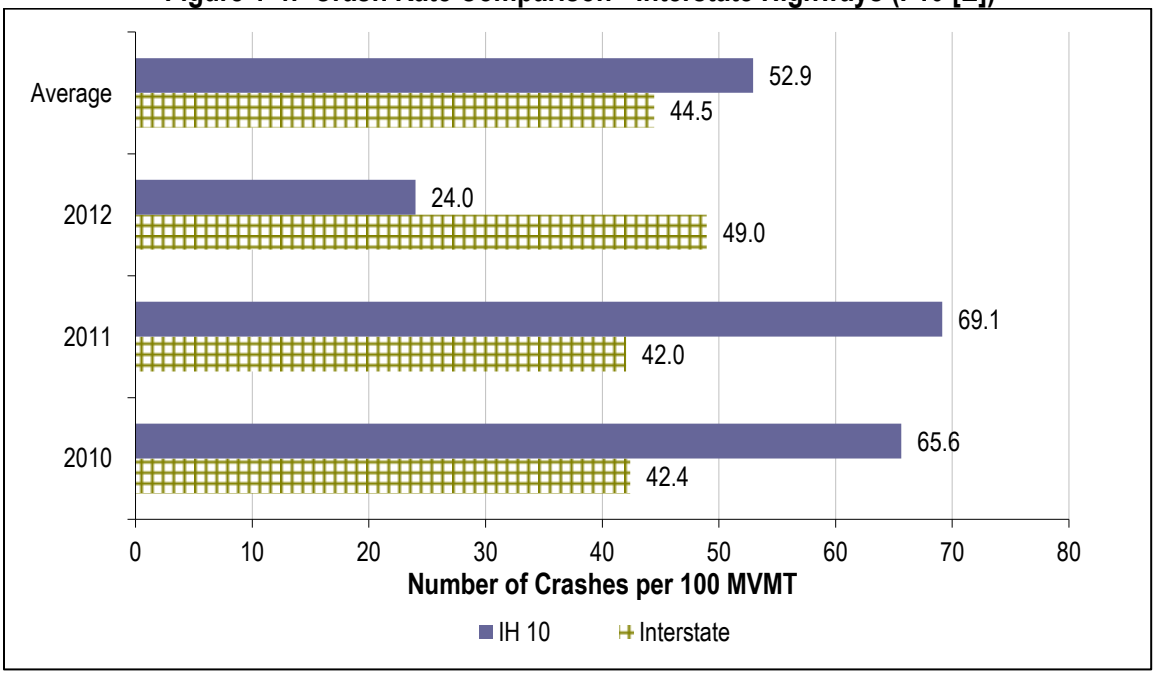
Source: TxDOT, 2013

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.

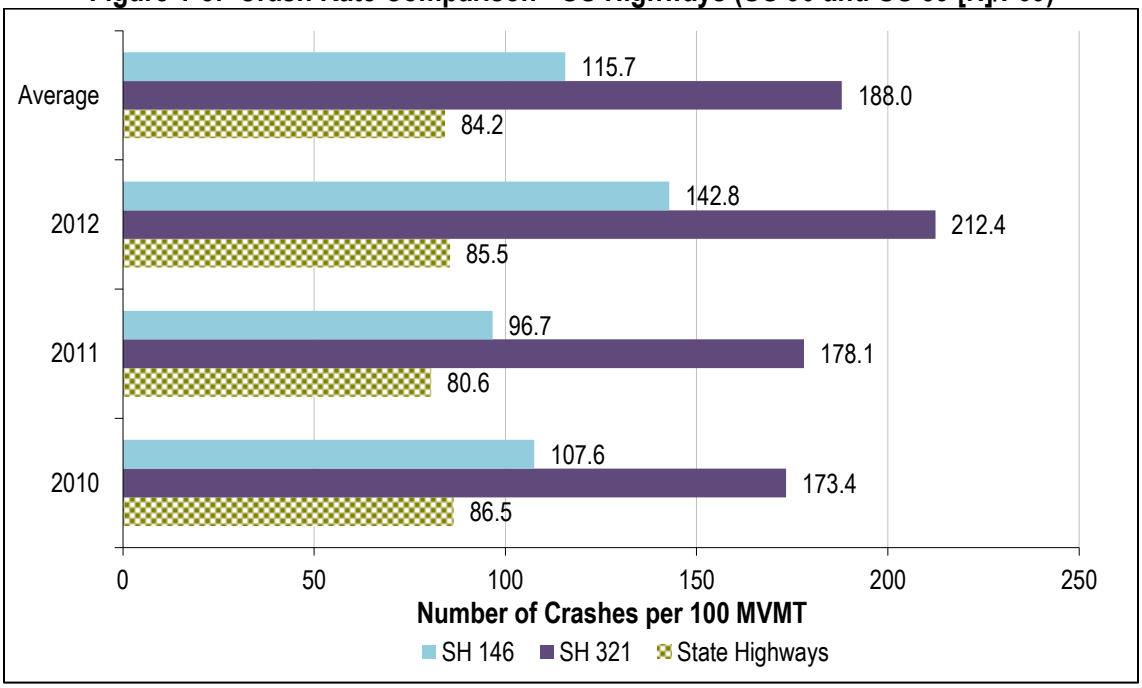
Local roads, collector facilities, and non-freeway principal arterials typically have much higher crash rates due to more frequent turns, stop-and-go conditions, roadway distractions, and lack of access control. Based on the data illustrated previously in **Table 1-5**, travel demand is projected to 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])



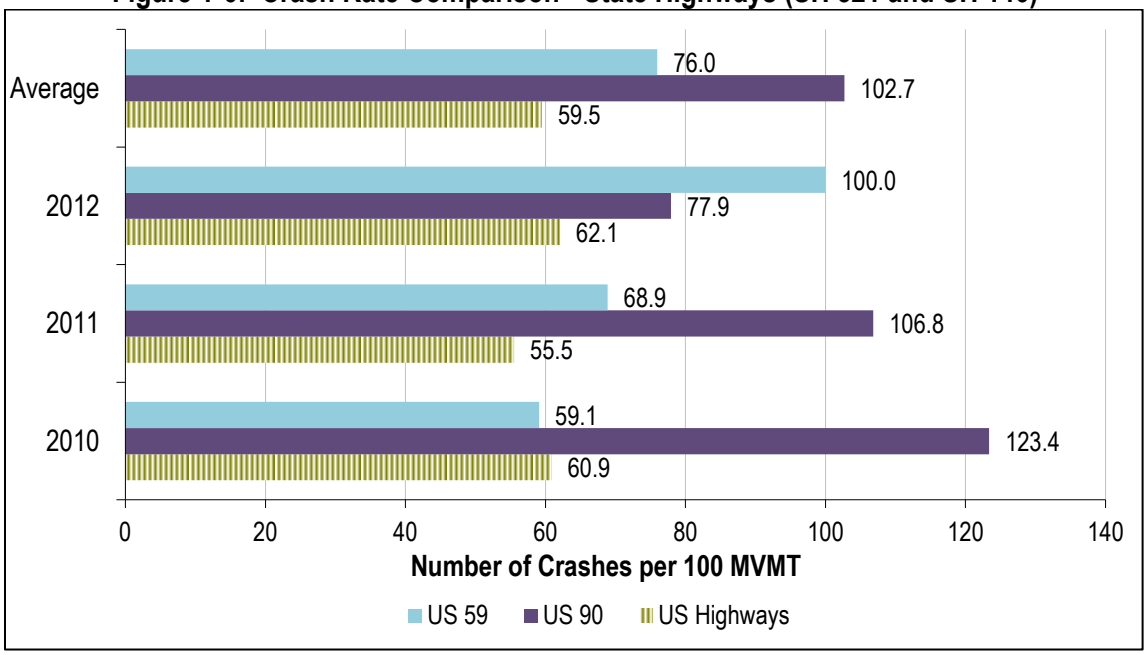
Source: CDM Smith and TxDOT, 2013

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



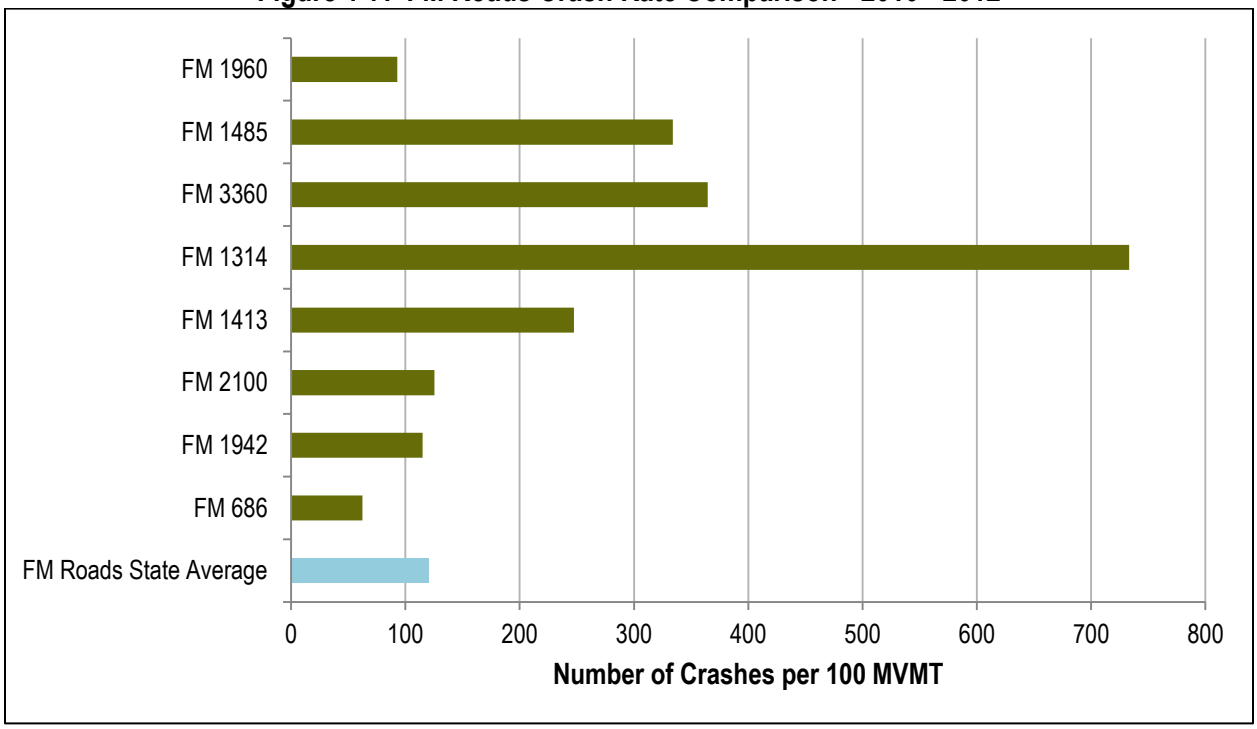
Source: CDM Smith and TxDOT, 2013

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

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CHAPTER 2
ALTERNATIVES ANALYSIS

Chapter 2 discusses the alternatives development, corridor-level analysis, and decision-making process utilized during the project planning phase. A full range of alternatives, including the No-Build Alternative, were analyzed during the study process. This chapter also summarizes the alternative selection criteria and its interdisciplinary approach involving analysis of environmental, traffic operations, and engineering aspects of each alternative. Input and comments from members of the public and local, state, and federal agencies were carefully considered during the evaluation process.

The environmental analysis was conducted thoroughly and systematically considering resource and constraints mapping, environmental issues, traffic, engineering, and public involvement. This process enabled the reviewers to compare and evaluate alternatives through an iterative series of evaluation criteria phases. It also provided the basis to select a single Preferred Alternative that best serves the proposed project's purpose and need and avoids or minimizes environmental impacts.

The identification of the Preferred Alternative in this Final Environmental Impact Statement (FEIS) was consistent with the guidelines and regulations that were set forth by the Federal Highway Administration (FHWA) and the Council on Environmental Quality (CEQ) (23 Code of Federal Regulations [CFR] 771.125, 40 CFR 1502, and FHWA, 1987). The multi-step development process also meets various requirements of the National Environmental Policy Act (NEPA) and Section 404 of the Clean Water Act (CWA).

2.1 UNIVERSE OF ALTERNATIVES

Prior to development of any alternatives, initial public scoping meetings were held on February 28 and March 1, 2006 to present project information to members of the public and governmental and agency officials, and thus receive feedback on resource mapping, schedule, and methodologies to be used in the development and analysis of alternatives. The constraints map was revised based on the input received during the scoping meetings. In addition, comments were received from members of the public and taken into consideration.

In addition to public comments, input was also obtained from agencies including the U.S. Army Corps of Engineers (USACE), Texas Parks and Wildlife Department (TPWD), Texas Commission on Environmental

Quality (TCEQ), the U.S. Fish and Wildlife Service (USFWS), and the U.S. Environmental Protection Agency (EPA). Useful information was received related to:

- Location of potential habitat for protected species;
- Distinction between floodplains and wetlands;
- Preferred locations for linear stream crossings; and
- Previous wetland mitigation sites.

The transportation build alternatives known as the "universe of alternatives" were developed from three sources:

- Results from the Corridor Analysis Tool (CAT), a Geographic Information System (GIS) based spatial analysis software (**Appendix C**);
- Existing and previously studied corridors, including those found in the Texas Department of Transportation's (TxDOT) Environmental Overview of the Grand Parkway, the City of Houston's 2007 Major Thoroughfare Map, the Mount Belvieu Comprehensive Plan, the Houston-Galveston Area Council's (H-GAC) 2035 Regional Transportation Plan (RTP) Update, and 2005 public hearing exhibits for transfer of the Lake Houston Wilderness Park from TPWD to the City of Houston; and
- Alternatives generated by the study team incorporating public and agency input.

Refer to **Exhibit 2-1** for previously mapped and publically available alternatives in the Segments H and I-1 study area.

Alternatives for Segments H and I-1 start at United States Highway (US) 59 North (N)/Interstate Highway (I) 69 just south of Splendora and continue southeast across US 90, ending at I-10 (E) near Mont Belvieu. Four beginning and four end points along US 59 (N)/I-69 and I-10 (E), respectively, were selected at logical points based on constraints and existing cross street locations. The CAT was used to map alternatives using GIS software that plotted alternatives while avoiding and minimizing impacts to environmental constraints. Refer to **Exhibit 2-2** for the CAT beginning and end points and alternatives. Similarly, the study team used the constraints map to develop other combinations of alternatives that would likely meet the purpose and need of the project. Constraints were considered at different levels of avoidance as described below:

- Schools, high density and clustered developments, archeological sites, cemeteries, parks, potential habitats of threatened and endangered species, a potential state superfund site, and clusters of oil/gas wells were considered as total avoidance constraints;

- Churches, 100-year floodplains, non-impaired and ecologically significant streams, individual oil wells, high-value wetlands, water/wastewater plants, electric substations, water wells, and other major utility facilities were considered points of high-value constraints for avoidance or minimization; and
- Public facilities, major roads, rail lines, impaired streams, hazardous materials locations, and medium-value wetlands were ranked as medium- to low-value constraints for avoidance or minimization.

The study team evaluated the maps from previous studies as well as the CAT-generated alternatives. Based on the CAT results, the study team made adjustments near the beginning and end points to improve feasibility of the initial alternatives. Although four end points were input into CAT, the resulting outcome yielded only two feasible connections to I-10 (E). To supplement the initial set of alternatives, the study team used the constraints map to generate additional alternatives across a wider range within the study area. In addition, the study team created alternatives using portions of the previously published alternatives (**Exhibit 2-1**) with adjustments to avoid impacts to the Lake Houston Wilderness Park. The alternatives generated by the study team are shown together with the previously published alternatives which yielded the 11 alternatives comprising the universe of alternatives (**Exhibit 2-3**).

To evaluate the universe of alternatives, a broad set of initial criteria was used. To be conservative, an 800-foot (ft) wide corridor was established for identifying potential impacts. The universe of alternatives was studied in multidiscipline team workshops using professional judgment and input received from the first series of public scoping meetings. The study team performed a constraints analysis on the universe of alternatives. Due to both agency and public input, it was determined early in scoping that parklands and any potential habitat for threatened and endangered species should be avoided whenever possible.

2.2 PRELIMINARY ALTERNATIVES

Corridors were assessed utilizing alternatives analysis screening criteria, and those warranting further study were assessed as preliminary alternatives. The preliminary alternatives traversed a wide band of the study area and were divided into three sections: A, B, and C, for further analysis (**Table 2-1**). The section limits were established where several alternatives passed through a common point of intersection before dispersing again. This common point was used as a natural divide between adjacent sections. The portions of the alternatives within each section were then independently studied and compared for impacts (**Exhibit 2-4**). This allowed the study team to compare the alternatives at a more detailed level and then combine various sections to create more flexibility in consideration of the overall alternatives.

Table 2-1: Description of Sections of Preliminary Alternatives

Section	Description of Section Limits	Avoided or Minimized Impacts to Constraints
A	Begins at US 59 (N)/I-69 and proceeds east, ending near the East Fork of the San Jacinto River, east of the Lake Houston Wilderness Park	The Lake Houston Wilderness Park, developed areas, wetlands, potential threatened and endangered species habitat, the confluence of streams, and forested habitat.
B	From Section A, proceeds southeast, crossing FM 1960, and staying southwest of Dayton to approximately 1 mile south of US 90	Developed areas, two salt domes, Cox Road Dump Site and minimizing impacts to other constraints such as floodplains, wetlands, oil and gas wells, schools, and churches.
C	From Section B, proceeds south through the City of Mont Belvieu to I-10 (E)	Developed areas, industrial areas, utility stations, floodplains, schools, and churches.

Source: Study Team, 2006

2.2.1 Preliminary Alternatives Evaluation

The purpose of the proposed facility is to improve the mobility of people and goods in the region by enhancing the existing transportation system in terms of discontinuous system linkage, decreased mobility, compromised safety, and a lack of infrastructure to support population growth while avoiding and/or minimizing adverse impacts to the community, natural resources, and existing infrastructure. The preliminary analysis was based on a broad range of multidisciplinary evaluation criteria including environmental, engineering, traffic/mobility, and public/agency input. Although a 400-ft wide corridor is proposed for Segments H and I-1, as a conservative approach, an 800-ft wide corridor was used to quantify the impacts of the preliminary alternatives for comparison. The 800-ft corridor allows for minor adjustments to the alignment to avoid and minimize impacts, if needed. The study team obtained outputs of all quantifiable impacts through CAT analysis.

The environmental criteria at this level evaluated the impacts on buildings, developed areas, floodplains, wetlands, managed land (parkland), hazardous materials sites, threatened and endangered species, and major streams. The Lake Houston Wilderness Park was a major constraint within the study area that was avoided during the development of the preliminary alternatives. The engineering criteria considered right-of-way (ROW) needs, construction complexity, and cost factors including length of alternative, floodplain crossings, road and railroad crossings, major utilities, and existing facilities to be reconstructed. Traffic and mobility criteria considered included emergency and hurricane evacuation facilitation, connectivity to existing roadway systems, travel time along alternatives, and conformance with area transportation plans. Following the technical evaluations, additional input was sought and gathered from the Fast-Track Advisory and Streamlining Team (FAST). The FAST included representatives from TxDOT Environmental Affairs

Division (TxDOT ENV), TxDOT Houston and Beaumont Districts, FHWA, Grand Parkway Association (GPA), and the consultant team.

To complete the evaluation of preliminary alternatives, a second series of public scoping meetings was held on May 8 and 9, 2007. The universe of alternatives and preliminary alternatives were presented, as well as the recommendations for reasonable alternatives. **Exhibit 2-4** shows the preliminary alternatives divided into three sections and in two colors to distinguish between those recommended to be carried forward for the second series of public scoping meetings. Feedback was received from the general public and public and agency officials on the alternatives shown within each of the three sections. **Section 2.2.2** discusses the outcome of the May 2007 public scoping meetings and preliminary alternatives evaluation.

2.2.2 Alternative Sections Not Recommended

The preliminary alternatives discussed below were shown at the second series of public scoping meetings held in May of 2007 as recommended reasonable alternatives. Upon completion of the preliminary alternatives evaluation and consideration of input received from the public, some of the preliminary alternatives were eliminated from further study as detailed below.

2.2.2.1 Section A

Preliminary Alternative A-1 was originally selected as a recommended reasonable alternative. However, it had the longest offset from Segment G, an adjacent Grand Parkway segment to the west under study (**Exhibit 2-4**), and was considered confusing and difficult to navigate by the general public because it connects to State Highway (SH) 242 on the west side of US 59 (N)/I-69. Further, Preliminary Alternative A-1 received low support from the public and elected officials.

Preliminary Alternative A-3 would require reconstruction of existing Farm-to-Market Road (FM) 1485 for its entire length, which also would result in impacts to developed areas; therefore, this alternative was not selected as a recommended reasonable alternative.

Preliminary Alternative A-5 was very similar to Preliminary Alternative A-4; however, Preliminary Alternative A-5 required ROW from the Lake Houston Wilderness Park which would result in approximately 5.7 acres of impacts to the park as compared to A-4 with 0 acres, according to information the study team had while the preliminary alternatives were being evaluated. Based on subsequent information provided regarding the revised park boundaries learned in 2011, Preliminary Alternatives A-4 and A-5 would impact the park. The

revised boundaries show that Preliminary Alternative A-4 would impact 10.74 acres and Preliminary Alternative A-5 would impact 16.44 acres. Because of these impacts, Preliminary Alternative A-5 was eliminated from further study. Additional coordination was completed with Lake Houston Wilderness Park personnel, and the preference was to maintain Preliminary Alternative A-4 due to the opportunity for improved access to the park.

In summary, Preliminary Alternatives A-1, A-3 and A-5 within Section A were eliminated from further detailed study.

2.2.2.2 Section B

Preliminary Alternative B-3 was originally selected as a recommended reasonable alternative; however, it was later eliminated from further study. Preliminary Alternative B-3 would require more permanent closures of existing local roadways than Preliminary Alternatives B-2 and B-5, which were carried forward. Preliminary Alternative B-3 would cross FM 686 at three separate locations and could result in portions of FM 686 being closed permanently due to engineering requirements. Impacts to FM 686 eliminated Preliminary Alternative B-3 from further study.

Preliminary Alternative B-4 crossed US 90 in close proximity to FM 1413 and would have significantly impacted future residential development. In addition, general comments were received at the public hearing concerning flooding along this alternative.

Preliminary Alternatives B-6, B-7, and B-8 follow existing roadways resulting in impacts to populated areas and received unfavorable public input. A large portion of Preliminary Alternative B-6 was within the floodplain, and a large portion of Preliminary Alternative B-8 impacted existing roadways.

In summary, due to potential impacts including displacements, Preliminary Alternatives B-3, B-4, B-6, B-7 and B-8 within Section B were eliminated from further detailed study.

2.2.2.3 Section C

Preliminary Alternative C-1 utilizes portions of the existing SH 146 facility; therefore would require reconstruction of SH 146 for approximately 4.4 miles. Utilizing SH 146 would not provide an additional alternate route that meets the mobility needs for this area due to the proximity to I-10 (E) and the elevated

traffic demands. In addition, Preliminary Alternative C-1 was very similar to Preliminary Alternative C-2 which received more public support, but did not require the use of SH 146.

Preliminary Alternatives C-4 and C-7 were offset approximately 4.5 miles from Grand Parkway Segment I-2 (adjacent Grand Parkway segment to the south), which could create traffic handling difficulties during evacuations and were considered confusing and difficult to navigate by the general public. The area within Preliminary Alternatives C-4 and C-7 is developed primarily as industrial, including oil and gas production; therefore, the cost, schedule, and potential hazardous material impacts to pipeline crossings would be significantly greater than that of other alternatives, further reducing the viability of Preliminary Alternatives C-4 and C-7. Local businesses and the public at-large expressed concerns at locations where the roadway would cross underground and aboveground pipelines. Most of the underground pipelines would have to be bridged as opposed to crossing at-grade, which would increase cost. These alternatives received unfavorable support from the public and elected officials.

Preliminary Alternative C-5 was similar to Preliminary Alternative C-6 but had more impacts to industrial and residential development and received less support from the public and elected officials than Preliminary Alternative C-6.

In summary, Preliminary Alternatives C-1, C-4, C-5, and C-7 within Section C were eliminated from further detailed study.

2.2.3 Alternative Sections Carried Forward for Further Analysis

Public input was evaluated and incorporated into the preliminary alternatives evaluation. Multidiscipline team workshops were conducted to review the technical analyses, public input, project purpose and need, and to recommend the alternatives to be carried forward for further study. Listed below are the alternatives recommended as reasonable within each of the three sections.

2.2.3.1 Section A

Preliminary Alternative A-2 received positive public feedback. Compared to the eliminated alternatives, it would have minimal impacts to the environmental and engineering criteria categories listed in **Section 2.2.1**. This alternative would avoid parklands and would not bisect any developed communities. However, Preliminary Alternative A-2 would bisect an undeveloped platted community (Kings Colony) that has been platted since the 1970s but has remained undeveloped.

Preliminary Alternative A-4 received the highest level of public support with no opposition from elected officials. During this stage of the analysis, impacts to the Lake Houston Wilderness Park property were not anticipated; however, a property survey later commissioned by the City of Houston determined the boundaries of the park extended north of FM 1485. Construction of this portion of Segments H and I-1 would affect 10.74 acres of parkland. However, construction would improve access to the park by enhancing the existing access point, which complies with the Lake Houston Park Master Plan dated March 24, 2009. The improved park entrance design would be determined further along in the project development process based on coordination between TxDOT, TPWD, and the City of Houston. At the time of the analysis of the alignment for Preliminary Alternative A-4, there were no relocations anticipated for any other sites within the project area. Additionally, this alternative would not bisect any communities. This alternative would meet the purpose and need of the project while minimizing impacts to the environmental and engineering criteria listed in **Section 2.2.1**. Preliminary Alternative A-4 would directly connect to the selected alternative alignment of Grand Parkway Segment G at US 59 (N)/I-69 and facilitate hurricane evacuation needs.

Within Section A, Preliminary Alternatives A-2 and A-4 were carried forward for further detailed study.

2.2.3.2 Section B

Preliminary Alternative B-1 received the highest level of support from the public and elected officials and would have minimal impacts to the environmental and engineering criteria categories listed in **Section 2.2.1**. Preliminary Alternative B-1 would serve Dayton and underserved populated areas in the eastern portion of the study area.

Preliminary Alternative B-2 received a high level of public support because it is centrally located and would serve the entire study area. Preliminary Alternative B-2 would have minimal impacts to the environmental and engineering criteria categories listed in **Section 2.2.1** and would contribute to an improved level of service (LOS) for study area traffic. It would also provide a transportation facility to underserved areas of Liberty County.

Preliminary Alternative B-5 received a moderate level of public support and little opposition and would provide an interchange at US 90. It would provide a transportation facility to underserved areas. This alternative would have minimal environmental impacts and would contribute to an improved LOS for study area traffic.

Within Section B, Preliminary Alternatives B-1, B-2, and B-5 were carried forward for further detailed study.

2.2.3.3 Section C

Preliminary Alternative C-2 received the highest level of public support and would follow the 2010 Mont Belvieu Thoroughfare Plan. Preliminary Alternative C-2 would have minimal impacts to existing developments in Mont Belvieu and would provide direct connectivity to the Grand Parkway Segment I-2, serving as an additional north-south evacuation route.

Preliminary Alternative C-3 received public support and would follow the 2010 Mont Belvieu Thoroughfare Plan. Preliminary Alternative C-3 would have minimal impacts to existing developments in Mont Belvieu and would provide direct connectivity to Grand Parkway Segment I-2, thus providing an additional north-south evacuation route. It would have minimal impacts to the environmental and engineering criteria categories listed in **Section 2.2.1** and would contribute to an improved LOS for study area traffic.

Preliminary Alternative C-6 received strong support from elected officials and would also follow the 2010 Mont Belvieu Thoroughfare Plan. Preliminary Alternative C-6 would have minimal impacts to existing developments in Mont Belvieu and would provide direct connectivity to Grand Parkway Segment I-2, serving as an additional north-south evacuation route.

Within Section C, Preliminary Alternatives C-2, C-3, and C-6 were carried forward for further detailed study.

2.2.4 Adjustments to Preliminary Alternative Sections

The universe and preliminary alternatives were developed using GIS as a series of line segments connected together. While this was acceptable for the scale and level of detail used for the screening process, the preliminary alternatives carried forward as reasonable were further refined using Computer Aided Design and Drafting (CADD) software to add curves between the lines and develop horizontal alignments that meet the TxDOT Roadway Design Manual (2010) criteria for a 70 mile-per-hour (mph) design speed. During the refinement process, the alternatives were adjusted where possible to further minimize potential impacts. Some of the adjustments are described below:

- Preliminary Alternative A-4 was better aligned to provide opportunities for continued adjacent development within the Grand Parkway dedicated corridor at Community Drive east of US 59 (N)/I-69. Where A-4 parallels FM 1485, the alignment was shifted slightly north to minimize impacts to the Lake Houston Wilderness Park.

- The northern portion of Preliminary Alternative B-1 was shifted south to minimize impacts to existing local roads and maintain access to farmlands.
- Preliminary Alternative B-2 was modified to reduce impacts to sensitive habitats near Cedar Bayou.
- Preliminary Alternative B-5, near the Harris County line, was shifted west to minimize Luce Bayou floodplain impacts.
- Preliminary Alternative C-3 was modified to address public input and avoid impacts to development in Mont Belvieu.

Refer to **Exhibit 2-5** for the locations of the reasonable alternatives.

2.2.5 Reasonable Alternatives

Following refinement, the preliminary alternatives recommended for further study within each of the three sections were combined to form complete end-to-end reasonable alternatives from US 59 (N)/I-69 to I-10 (E) for a comprehensive analysis of impacts for each alternative. All possible combinations from the three different sections were formed. The result was 10 reasonable build alternatives plus the No-Build Alternative, resulting in 11 total reasonable alternatives. The reasonable alternatives to be carried forward for further study are listed for future reference in **Table 2-2.**

Table 2-2: Reasonable Alternatives

Reasonable Alternative	Description
1	No-Build
2	A-2, B-1, C-2
3	A-2, B-1, C-3
4	A-2, B-2, C-2
5	A-2, B-2, C-3
6	A-2, B-5, C-6
7	A-4, B-1, C-2
8	A-4, B-1, C-3
9	A-4, B-2, C-2
10	A-4, B-2, C-3
11	A-4, B-5, C-6

Source: Study Team, 2007

Within the Segments H and I-1 study area, the 10 reasonable build alternatives would meet the purpose and need of the project while avoiding and/or minimizing potential environmental impacts. As the reasonable alternatives have common sections, they overlap each other demonstrating similar environmental and engineering impacts within those reaches. The end-to-end combinations for reasonable alternatives are shown in **Exhibit 2-5**.

2.3 TRANSPORTATION MODE STUDY

An analysis was conducted for 10 distinct reasonable build alternatives which were derived from the previous analysis of the preliminary alternatives. These 10 build alternatives were evaluated against the No-Build Alternative to evaluate the extent to which the stated purpose and need for the proposed project were met. Within this section, there are references to the Segments H and I-1 "traffic study area" for the proposed project. The traffic study area extends beyond the Segments H and I-1 study area. Because implementation of the proposed Segments H and I-1 would affect traffic beyond the Segments H and I-1 study area, it is necessary to quantify these effects when discussing traffic impacts and benefits. The traffic study area includes all roadways within the study area, as well as roadways outside the Segments H and I-1 study area that experience changes in traffic volumes of plus or minus 5 percent, based on the traffic model due to the addition of Segments H and I-1 (**Exhibit 1-4**).

2.3.1 No-Build Alternative

The No-Build Alternative comprises all committed projects included in the 2035 RTP Update with the exception of Segments H and I-1. The 2035 RTP Update is the H-GAC's transportation plan for the eight-county Houston area. These improvements include added-capacity projects such as new roadways and roadway widening, as well as modal improvements such as transit. These improvements are already a part of the ongoing plan for upgrades to the existing roadway system. Transportation system management (TSM), travel demand management (TDM), modal transportation improvements, and Smart Street components of the No-Build Alternative are detailed in the following sections.

Both SH 146 and FM 2100 are identified in the 2035 RTP Update for widening from two lanes to four lanes. For the traffic needs analysis, 2039 was selected as the horizon year (design year), with 2019 as the interim year (construction completion date for Phase I). The TDM utilized for analysis used the 2035 RTP Update, which was adopted in October 2010 and approved in January 2011. The H-GAC provided demographic forecasts through 2050 and, therefore, provided a 2039 dataset which comprises 2039 travel demand on the 2035 RTP Update roadway network. The 2035 Travel Demand Model used for analysis was obtained from H-GAC in June 2012. In the 2039 No-Build Alternative, SH 146 is projected to carry 29,174 vehicles per day (vpd) between US 90 and I-10 (E), which would result in a level of mobility (LOM) rating of *severe* (refer to **Chapter 1, Section 1.2.2.1** for a description of LOM).

2.3.1.1 Transportation System Management Measures

TSM measures implemented at critical locations can improve traffic operations and safety. These types of improvements are typically low-cost measures that improve traffic flow by making better use of the existing transportation system. They typically include intersection improvements, parking and turn restrictions, traffic signal upgrades, signal coordination, median improvements, and access-control improvements. TSM measures identified for the Segments H and I-1 traffic study area in the 2035 RTP Update are summarized in **Table 2-3**.

Table 2-3: TSM Projects in the 2035 RTP Update

Project ID	Description	Location
14552	Construct Railroad Grade Separation Structure And Approaches	On FM 1960 at Union Pacific Railroad (UPRR) in Liberty County
15178	Install Computerized Traffic Management System	On I-10 (E) from Spur 330 to Chambers County Line
15458	Install Left Turn Lane (Westbound – Southbound)	FM 1485 at Huffman New Caney Road
15459	Add Left Turn Lane on FM 1492 Eastbound To Bohemian Hall Road Northbound	FM 1492 at Bohemian Hall Road
15461	Install Southbound Left Turn Lanes	FM 2100 at Sundown Meadow

Source: H-GAC 2035 RTP Update

One of the major benefits of proposed Segments H and I-1 is the improvement of north-south mobility. Currently, north-south mobility in the study area is provided by SH 146, SH 321, and FM 2100. These roadways are located near the far ends of the study area and do not adequately serve the center of the study area or current regional radial network. FM 2100 is projected to carry 39,407 vpd between FM 1485 and US 90, which would result in a LOM rating of *severe* (refer to **Table 1-5**). Based on these projections, these facilities would not adequately handle projected average daily traffic (ADT), and because they are not controlled-access facilities, they would not be adequate or serve for long distance trips. The presence of traffic signals along these roadways would also result in more vehicular stops (a potential safety concern), and less mobility compared to the LOS that a controlled-access roadway such as Segments H and I-1 could provide. Additionally, because these roadways are not controlled-access, future development along the ROW would likely hamper mobility and result in reduced efficiency for local trips as well.

While the TSM improvements included in the 2035 RTP Update are expected to ease congestion and travel time for local trips, these improvements do not adequately address the critical issues identified in the proposed project's purpose and need.

2.3.1.2 Travel Demand Management Measures

TDM measures are strategies and programs that encourage commuters to use alternatives to driving alone, especially during periods of heavy congestion. These strategies typically contribute to reducing congestion along a corridor as they manage the demand placed on the transportation system. TDM measures are generally behavioral changes for the commuting public that result in modifications to travel patterns and modes. Examples of TDM measures include carpooling/vanpooling, park-and-pool/park-and-ride lots, flexible work hours, telecommuting, employer incentives, and transit. The TDM measure identified in the 2035 RTP Update for the Grand Parkway Segments H and I-1 study area is the Atascocita Park-and-Ride Facility to be located on FM 1960 west of Lake Houston Parkway.

Although TDM measures could help improve congestion in an urban area, these measures alone would not be sufficient to effectively accommodate the projected increase in travel demand through 2039. The TDM components of the No-Build Alternative, by themselves, would not address the critical issues identified in the proposed project's purpose and need.

A Congestion Mitigation Analysis (CMA) was conducted for parallel roadway facilities that would be impacted by the construction of Segments H and I-1. The CMA included TSM and TDM improvements too small to be incorporated into the H-GAC's regional travel demand model. The study revealed that both TSM and TDM measures alone would not sufficiently improve LOM for the study area.

2.3.1.3 Modal Transportation Improvements

Modal transportation improvements include bus transit, rail transit, and high-occupancy vehicle (HOV) lanes. The largest public transit provider in the region is the Metropolitan Transit Authority of Harris County (METRO). The 2035 RTP Update incorporates the 2035 METRO Long Range Plan, which is an iterative process incorporating the 2025 METRO Solutions Plan and future mobility needs identified in regional planning efforts. METRO's 2035 Long Range Plan recommends substantial expansion of the current transit system and includes a network of integrated high capacity transit facilities on major travel corridors; however, there are no improvements planned in the Segments H and I-1 study area.

Bus Transit

In addition to METRO, public transit services in the H-GAC Transportation Management Area are provided by the Brazos Transit District, Island Transit, and Connect Transportation. Neither METRO nor any of

these other transit providers currently serve the immediate study area or have documented plans to do so in the near future.

Rail Transit

METRO Solutions does not include improvements in the Segments H and I-1 study area. Currently, there are no plans to serve the study area with rail transit.

High-Occupancy Vehicle/High-Occupancy Toll Lanes

The TDM toolbox includes the HOV lane which is a roadway lane(s) reserved for exclusive use by cars with a driver and one or more passengers and by buses and vanpools. It is a congestion mitigation measure typically utilized on an existing highway facility to improve traffic operation particularly for commuting traffic during the peak hours. Closely related to the HOV concept is the implementation of high-occupancy toll (HOT)/managed lanes. A HOT lane is a designated lane for high-occupancy vehicles (2 or more passengers) as well as for toll-paying vehicles that do not meet the required occupancy. This concept is seen as especially important in congested corridors with limited potential for the building of additional lanes. The 2035 RTP Update identifies regional increases in HOT-lane and regular toll-lane miles. METRO currently operates a number of HOT/HOV lanes in the H-GAC area.

The only highways in the Grand Parkway Segments H and I-1 traffic study area are US 59 (N)/I-69 and I-10 (E). The 2035 RTP Update shows plans for HOT/managed lanes along US 59 (N)/I-69 north of FM 1960. The 2035 RTP Update does not show any HOV or HOT/managed lanes along I-10 (E) in the study area.

2.3.1.4 No-Build Alternative Summary

The No-Build Alternative includes all improvements identified in the 2035 RTP Update, with the exception of Segments H and I-1, and includes all TSM, TDM, and modal transportation improvements. Based on analysis of these components individually and collectively, it was found that although the No-Build Alternative would result in some improvements to regional congestion due to planned improvements to the existing roadway network listed in the 2035 RTP Update, it would not adequately address the purpose and need for the proposed project.

2.3.2 Build Alternatives

Segments H and I-1 are planned by TxDOT and the GPA as a controlled-access toll facility to be constructed on new location, consistent with the 2035 RTP Update. The build alternatives are proposed to complement the No-Build Alternative, not replace any of the improvements identified therein. The build alternatives include all improvements identified in the No-Build Alternative such as added capacity projects, TSM, and TDM. All build alternatives meet the purpose and need of the proposed project.

Funding for new roadways through traditional means has become difficult as travel demand has outpaced roadway network improvements. This trend is projected to continue, and as such, the 2035 RTP Update identifies the key role that toll roads and other managed facilities would play in the expansion of the regional roadway system. Segments H and I-1 are specifically included in the 2035 RTP Update as a four-lane toll facility.

2.3.2.1 Alternative Transportation Improvement Measures Eliminated from Detailed Study

The alternatives analysis process followed a sequential and logical methodology designed to evaluate alternatives for their ability to meet the purpose and need of the proposed project. Other considerations included avoidance and/or minimization of adverse environmental impacts and public input. Alternatives that met these criteria were advanced to the next phase of study. Alternative improvement measures comprising TSM, TDM, bus transit, rail transit, and HOV/HOT lanes alternatives were eliminated from detailed study.

TSM Alternatives

Although TSM measures are designed to relieve congestion and improve traffic flow, they are generally most effective in areas with a roadway system that is operating at or above design capacity. Without a roadway system in place that serves the circumferential travel demands of the study area, implementation of additional TSM measures on existing roadways would not adequately accommodate the projected travel demands. Without increased circumferential roadway capacity, TSM alternatives would not sufficiently improve the congestion projected for the No-Build Alternative.

TDM Alternatives

TDM measures rely heavily on behavioral changes by commuters and other roadway users. These improvements would not provide the magnitude of benefits needed to accommodate the local and regional

demands for improved transportation system linkage, improved mobility, enhanced safety, emergency evacuation, and infrastructure to provide support for population growth.

Bus Transit

There are no plans for bus transit service in the study area. Although implementation of bus transit could potentially provide congestion relief on some sections of existing roadways, it would not address the absence of a circumferential roadway to meet the needs for improved transportation system linkage, improved mobility, enhanced safety, emergency evacuation, and infrastructure to provide support for population growth.

Rail Transit

Rail alternatives have been found to be most effective when oriented radially to serve commuters traveling during peak hours into and out of the central business core of a city. A rail transit alternative positioned radially or circumferentially, as would be required in the Segments H and I-1 study area, would not be anticipated to serve enough of the study area to satisfy the purpose and need of the project.

Smart Street Alternatives

It was found that the Smart Street component of the No-Build Alternative had substantial deficiencies in meeting the demand for circumferential travel within the Segments H and I-1 study area. This alternative would provide some improvement for existing roadways, but would neither provide circumferential connectivity nor meet the identified need for enhanced safety and improved mobility to accommodate projected travel demand.

2.3.2.2 Alternative Transportation Improvement Measures Advanced for Further Study

The alternatives analysis process followed a sequential and logical methodology designed to evaluate alternatives for their ability to meet the purpose and need of the proposed project. Other considerations included avoidance and/or minimization of adverse environmental impacts and public input. Alternatives that met these criteria were advanced to the next phase of study.

No-Build Alternative

Although the No-Build Alternative would not satisfy the proposed project's purpose and need, it was retained and utilized as the basis of comparison for the build alternatives and further consideration as required by CEQ regulations.

Build Alternatives

The build alternatives are approximately 35-41 miles in length. For all proposed build alternatives, the facility would consist of a four-lane controlled-access toll road within 400 ft of ROW. The proposed facility would have logical termini at US 59 (N)/I-69 and I-10 (E) and provide access via interchanges to highways and major cross streets such as US 90, FM 1960, and others. As described in **Section 2.2**, 10 build alternatives were developed through a cooperative process of public outreach, agency coordination, and avoidance and minimization of impacts to various resources. All projects in the No-Build Alternative are also part of the Build Alternative, including added-capacity improvements, TSM, TDM, and other improvement measures. The build alternatives would provide the system linkage lacking in the No-Build Alternative, accommodate circumferential travel demand, improve mobility, enhance safety, provide a new emergency evacuation route, and provide the infrastructure to support population growth in a previously underserved area.

2.3.2.3 Traffic and Transportation Analysis

Discontinuous System Linkage

The existing transportation system in the Segments H and I-1 study area does not have efficient circumferential connections to major radial roadways such as US 59 (N)/I-69 and I-10 (E). The interstate and regional highways are predominantly oriented in either an east-west or a north-south direction at the boundaries of the Segments H and I-1 study area. I-10, US 90, and US 59/I-69 are three radial facilities connecting Houston to its suburbs and further destinations. Beyond Beltway 8, these radial facilities become increasingly further apart and there are limited connecting facilities within the Segments H and I-1 study area. Below are additional existing system linkage conditions within the 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;
- 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 two salt dome formations in Mont Belvieu and west of Dayton. The study area

lacks an efficient circumferential connection for these industrial complexes to US 59 (N)/I-69 and I-10 (E);

- The study area is bound by radial roadways, US 59 (N)/I-69 and I-10 (E), which are circuitously connected by minor arterials and collector roadways within the study area, such as FM 1485, FM 2100, FM 3360, FM 1413, Loop 494, and SH 146. To accomplish circumferential movements across the study area, travelers must use the radial roadways to reach the minor arterial and collector roadways; and
- Freight traffic is transported via trucks from the Port of Houston through the study area to the major industrial complexes, as well as to US 59 (N)/I-69 for national distribution. Trucks currently use the existing two-lane local roadways in the study area for long trips which present traffic operation and safety issues.

Table 2-4 summarizes daily Vehicle Hours of Travel (VHT) per 24 hours for the No-Build Alternative and the build alternatives for 2019 and 2039. The change in daily VHT varies depending on the facility type. The proposed Segments H and I-1 would reduce VHT on arterials and collector roads as trips would be attracted to the more efficient controlled-access toll facility.

The proposed Grand Parkway Segments H and I-1 would result in time savings across the entire traffic study area. Daily VHT in 2039 is projected to reduce by approximately 7 percent (31,265 hours) along interstates, 16 percent (49,945 hours) along principal arterials, 5 percent (39,019 hours) along minor arterials, and 4 percent (16,165 hours) along collector roads.

Table 2-4: Daily VHT by Facility Type in the Segments H and I-1 Traffic Study Area

Facility	2011 (Hours)	2019			2039		
		No-Build (Hours)	Build (Hours)	% Change (Hours)	No-Build (Hours)	Build (Hours)	% Change (Hours)
Interstates	150,724	202,406	201,001	-0.7%	436,213	404,948	-7.2%
Principal Arterials	62,456	87,264	84,468	-3.2%	310,259	260,314	-16.1%
Proposed Grand Parkway (H and I-1)	N/A	N/A	5,646	N/A	N/A	14,915	N/A
Minor Arterials	107,930	160,290	158,754	-1.0%	783,834	744,815	-5.0%
Collector Roads	27,537	43,768	42,595	-2.7%	375,519	359,354	-4.3%
Total	348,647	493,728	492,464		1,905,825	1,784,346	

Source: Study Team, 2012; H-GAC, 2012

Decreased Mobility

The H-GAC regional travel demand model for the eight-county greater Houston metropolitan area was utilized in estimating base- and future- year traffic volumes for the No-Build Alternative and build alternatives. The model incorporates existing and planned roadway infrastructure as well as existing and

forecasted demographics for the region. **Table 2-5** summarizes ADT volumes and LOM for the No-Build Alternative and the build alternatives for Segments H and I-1 and other major roadways in the traffic study area. The time horizons utilized for comparison are base year (2011), opening year (2019), and design year (2039). The No-Build Alternative includes all projects in the 2035 RTP Update, excluding Segments H and I-1.

Table 2-5: Segments H and I-1 Traffic Study Area Base and Future ADT and LOM

Facility	From	To	2011 Base Year		2019					2039				
			ADT (vpd)	LOM	No-Build ADT (vpd)	No-Build LOM	Build ADT (vpd)	Build LOM	% ADT Change	No-Build ADT (vpd)	No-Build LOM	Build ADT (vpd)	Build LOM	% ADT Change
US Highways and Interstates														
US 59 (N)/I-69	SH 105	Community Dr.	54,805	*Tolerable*	71,466	*Tolerable*	69,831	*Tolerable*	-2%	122,890	*Serious*	108,510	*Moderate*	-12%
US 59 (N)/I-69	Community Dr.	BW 8	136,406	*Tolerable*	163,971	*Tolerable*	166,212	*Tolerable*	1%	270,392	*Serious*	270,332	*Serious*	0%
I-10 (E)	BW 8	FM 2100	103,510	*Tolerable*	124,974	*Tolerable*	121,709	*Tolerable*	-3%	199,291	*Serious*	182,838	*Serious*	-8%
I-10 (E)	FM 2100	SH 146	67,327	*Tolerable*	78,035	*Tolerable*	74,659	*Tolerable*	-4%	117,302	*Serious*	94,583	*Moderate*	-19%
I-10 (E)	SH 146	FM 1410	64,131	*Tolerable*	73,048	*Tolerable*	73,036	*Tolerable*	0%	102,778	*Serious*	103,154	*Serious*	0%
BW 8	US 59/I-69	West Lake Houston Pkwy	42,865	*Tolerable*	60,716	*Tolerable*	59,060	*Tolerable*	-3%	125,175	*Serious*	112,460	*Moderate*	-10%
BW 8	West Lake Houston Pkwy	US 90	41,669	*Tolerable*	56,802	*Tolerable*	52,690	*Tolerable*	-7%	112,746	*Moderate*	98,886	*Tolerable*	-12%
BW 8	US 90	I-10 (E)	49,674	*Tolerable*	65,660	*Tolerable*	63,395	*Tolerable*	-3%	141,367	*Moderate*	131,905	*Tolerable*	-7%
Grand Parkway	I-45 (N)	US 59 (N)/I-69	N/A	N/A	37,513	*Tolerable*	42,635	*Tolerable*	14%	74,714	*Moderate*	81,898	*Serious*	10%
Grand Parkway	US 59 (N)/I-69	US 90	N/A	N/A	0	N/A	13,519	*Tolerable*	N/A	N/A	N/A	31,443	*Tolerable*	N/A
Grand Parkway	US 90	I-10 (E)	N/A	N/A	0	N/A	6,687	*Tolerable*	N/A	N/A	N/A	22,441	*Tolerable*	N/A
Grand Parkway	I-10 (E)	SH 146	N/A	N/A	2,908	*Tolerable*	3,264	*Tolerable*	12%	25,016	*Tolerable*	41,773	*Tolerable*	67%
Principal Arterials														
US 90	BW 8	FM 2100	33,185	*Tolerable*	49,547	*Tolerable*	47,702	*Tolerable*	-4%	106,319	*Severe*	102,976	*Severe*	-3%
US 90	FM 2100	SH 321	21,712	*Moderate*	24,531	*Serious*	25,734	*Serious*	5%	30,304	*Severe*	36,782	*Severe*	21%
US 90	SH 321	SH 61	15,441	*Moderate*	17,397	*Moderate*	17,918	*Serious*	3%	21,418	*Serious*	23,542	*Severe*	10%
FM 1960	BW 8	FM 2100	20,364	*Severe*	33,132	*Serious*	32,641	*Serious*	-1%	51,504	*Severe*	45,842	*Severe*	-11%
FM 1960	FM 2100	SH 321	3,864	*Tolerable*	12,249	*Serious*	13,150	*Serious*	7%	16,469	*Severe*	16,548	*Severe*	0%
Kingwood Drive/ Treaschwig Rd.	US 59 (N)/I-69	FM 2100	17,642	*Tolerable*	24,612	*Tolerable*	24,231	*Tolerable*	-2%	24,073	*Tolerable*	46,567	*Severe*	93%
Kingwood Drive	FM 2100	FM 686	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	27,941	*Tolerable*	N/A

Table 2-5: Segments H and I-1 Traffic Study Area Base and Future ADT and LOM

Facility	From	To	2011 Base Year		2019					2039				
			ADT (vpd)	LOM	No-Build ADT (vpd)	No-Build LOM	Build ADT (vpd)	Build LOM	% ADT Change	No-Build ADT (vpd)	No-Build LOM	Build ADT (vpd)	Build LOM	% ADT Change
SH 105	SH 321	FM 2518	7,482	*Tolerable*	9,292	*Moderate*	8,880	*Tolerable*	-4%	13,832	*Severe*	11,947	*Serious*	-14%
SH 105	FM 2518	SH 146	6,056	*Tolerable*	7,751	*Tolerable*	7,310	*Tolerable*	-6%	12,482	*Serious*	11,341	*Serious*	-9%
West Lake Houston Pkwy.	FM 1485	Kingwood Dr.	13,629	*Tolerable*	14,459	*Tolerable*	14,468	*Tolerable*	0%	13,026	*Tolerable*	30,609	*Severe*	135%
West Lake Houston Pkwy.	Kingwood Dr.	BW 8	25,401	*Moderate*	32,505	*Serious*	32,717	*Serious*	1%	49,939	*Severe*	47,560	*Severe*	-5%
SH 146	FM 787	US 90	5,471	*Tolerable*	6,050	*Tolerable*	5,947	*Tolerable*	-2%	7,981	*Tolerable*	7,721	*Tolerable*	-3%
SH 146	US 90	I-10 (E)	8,983	*Tolerable*	12,323	*Tolerable*	12,624	*Tolerable*	2%	29,174	*Severe*	28,610	*Severe*	-2%
SH 146	I-10 (E)	SH 99	27,883	*Tolerable*	36,921	*Tolerable*	36,647	*Tolerable*	-1%	63,821	*Tolerable*	61,238	*Tolerable*	-4%
SH 321	US 59/I-69	US 90	8,210	*Tolerable*	10,047	*Moderate*	8,760	*Tolerable*	-13%	16,268	*Severe*	13,304	*Serious*	-18%
Spur 330	I-10 (E)	SH 146	32,537	*Tolerable*	39,563	*Tolerable*	39,310	*Tolerable*	-1%	50,088	*Tolerable*	53,059	*Tolerable*	6%
Minor Arterials														
FM 787	SH 321	SH 146	7,189	*Tolerable*	8,587	*Tolerable*	8,541	*Tolerable*	-1%	14,471	*Severe*	12,647	*Serious*	-13%
FM 1008	SH 321	US 90	3,499	*Tolerable*	4,226	*Tolerable*	4,062	*Tolerable*	-4%	6,786	*Tolerable*	6,541	*Tolerable*	-4%
FM 1010	SH 321	FM 1485	3,598	*Tolerable*	4,592	*Tolerable*	5,393	*Tolerable*	17%	11,206	*Serious*	9,945	*Moderate*	-11%
FM 1405	SH 146	FM 2354	1,579	*Tolerable*	2,071	*Tolerable*	1,958	*Tolerable*	-5%	2,936	*Tolerable*	2,356	*Tolerable*	-20%
FM 1409	US 90	FM 565	4,486	*Tolerable*	4,820	*Tolerable*	4,008	*Tolerable*	-17%	16,172	*Severe*	13,556	*Severe*	-16%
FM 1485	US 59 (N)/I-69	W. Lake Houston Pkwy.	9,113	*Tolerable*	12,045	*Serious*	11,191	*Moderate*	-7%	14,253	*Severe*	17,285	*Severe*	21%
FM 1485	West Lake Houston Pkwy.	FM 2100	7,057	*Tolerable*	10,812	*Serious*	12,560	*Tolerable*	16%	15,101	*Severe*	19,253	*Serious*	27%
FM 1942	Crosby Lynchburg	SH 146	8,246	*Tolerable*	10,235	*Serious*	10,207	*Serious*	0%	19,551	*Severe*	19,120	*Severe*	-2%
FM 2100	FM 1485	US 90	14,706	*Moderate*	20,099	*Severe*	19,642	*Severe*	-2%	39,407	*Severe*	37,885	*Severe*	-4%
FM 2354	FM 565	FM 1405	814	*Tolerable*	1,240	*Tolerable*	1,249	*Tolerable*	1%	3,254	*Tolerable*	1,976	*Tolerable*	-39%

Table 2-5: Segments H and I-1 Traffic Study Area Base and Future ADT and LOM

Facility	From	To	2011 Base Year		2019					2039				
			ADT (vpd)	LOM	No-Build ADT (vpd)	No-Build LOM	Build ADT (vpd)	Build LOM	% ADT Change	No-Build ADT (vpd)	No-Build LOM	Build ADT (vpd)	Build LOM	% ADT Change
FM 3180	I-10 (E)	FM 2354	2,004	*Tolerable*	2,997	*Tolerable*	2,890	*Tolerable*	-4%	14,612	*Severe*	4,804	*Tolerable*	-67%
FM 3360	SH 146	I-10 (E)	2,026	*Tolerable*	3,497	*Tolerable*	3,237	*Tolerable*	-7%	11,167	*Serious*	8,615	*Tolerable*	-23%
FM 563	US 90	I-10 (E)	4,014	*Tolerable*	4,994	*Tolerable*	5,060	*Tolerable*	1%	13,539	*Severe*	12,236	*Serious*	-10%
FM 565	Loop 207	SH 146	7,999	*Tolerable*	8,921	*Moderate*	8,692	*Tolerable*	-3%	13,961	*Severe*	12,898	*Severe*	-8%
Collector Roads														
FM 1410	Kingwood Dr.	I-10 (E)	1,937	*Tolerable*	2,327	*Tolerable*	2,323	*Tolerable*	0%	7,613	*Serious*	5,595	*Tolerable*	-27%
FM 1413	US 90	SH 146	2,680	*Tolerable*	4,954	*Tolerable*	4,758	*Tolerable*	-4%	12,757	*Severe*	13,142	*Severe*	3%
FM 2090	US 59/I-69	FM 1010	3,864	*Tolerable*	5,826	*Tolerable*	4,673	*Tolerable*	-20%	14,352	*Severe*	8,392	*Moderate*	-42%
FM 686	FM 1960	SH 321	1,195	*Tolerable*	1,486	*Tolerable*	1,919	*Tolerable*	29%	3,500	*Tolerable*	12,537	*Severe*	258%
FM 770	SH 105	FM 563	2,564	*Tolerable*	3,405	*Tolerable*	3,388	*Tolerable*	-1%	8,411	*Tolerable*	7,402	*Tolerable*	-12%
Roman Forest Blvd	US 59/I-69	Tram (Galaxy)	10,170	*Tolerable*	13,904	*Tolerable*	12,283	*Tolerable*	-12%	28,213	*Severe*	23,057	*Severe*	-18%
Tram (Galaxy)	FM 2090	Roman Forest Blvd	2,157	*Tolerable*	3,388	*Tolerable*	5,293	*Tolerable*	56%	7,299	*Tolerable*	9,804	*Tolerable*	34%

Source: H-GAC, 2012

Overall, the results summarized in **Table 2-5** demonstrate that the construction of the Build Alternative would result in reduced traffic volumes on the traffic study area roadway network. **Table 2-5** shows that in 2039 construction of the proposed Grand Parkway Segments H and I-1 would result in a 12 percent reduction in ADT along US 59 (N)/I-69 (SH 105 to Community Drive). Without the Grand Parkway Segments H and I-1, there is limited north-south access in the study area. There are proposed ramp connections for FM 1010 (Huffman/Cleveland Road) at the Grand Parkway Segments H and I-1. For example, traffic from Cleveland headed south could use FM 1010 to travel to proposed Grand Parkway Segments H and I-1 and travel south, rather than use US 59 (N)/I-69. The same holds true for traffic headed to Cleveland from the east along major routes such as I-10 (E), FM 1960, and US 90. These diversions would result in a reduction in volume on US 59 (N)/I-69. Additionally, the Build Alternative would result in a 19 percent reduction in ADT along I-10 (E) (FM 2100 to SH 146) and a 12 percent reduction in ADT along Beltway 8 (W Lake Houston Parkway to US 90). The proposed Grand Parkway Segments H and I-1 are projected to reduce daily traffic along SH 321, a principal arterial, by up to 18 percent in 2039. LOM on this facility is projected to improve from *severe* without the Grand Parkway to *serious* with the Grand Parkway. Traffic volumes in 2039 are also projected to be reduced up to 11 percent and 14 percent along sections of FM 1960 and SH 105 respectively, as a result of the Build Alternative.

In general, minor arterials and collector roadways are projected to experience reduced traffic volumes as a result of the proposed Grand Parkway Segments H and I-1. Assuming the Build Alternative in 2039, FM 3180 is projected to experience a reduction in ADT of up to 67 percent. FM 3360, FM 2354, FM 1405, FM 563, FM 1410, and Roman Forest Boulevard, among others, are projected to experience a reduction in ADT of up to 39 percent.

Traffic volumes on some arterials and collectors are projected to increase with the construction of the Grand Parkway Segments H and I-1. For example, assuming the Build Alternative in 2039, FM 1413 is projected to experience a 3 percent increase in ADT, Tram (Galaxy) a 34 percent increase, West Lake Houston a 135 percent increase, and FM 686 a 258 percent increase. However, this is attributable to their unique function in the roadway network within the study area. As currently proposed, all of these roadways would provide direct access to the Grand Parkway, hence the projected increase in traffic volumes. Others, such as Spur 330 with a projected increase of 6 percent in 2039, do not have a direct connection to the Grand Parkway but serve as the primary roadway connection to roads such as SH 146 which connect to

the Grand Parkway. The projected increase in traffic volume along these roadways is therefore reflective of the desire of traffic to utilize the more efficient Grand Parkway Segments H and I-1 for longer trips.

Compromised Safety

A crash analysis was conducted to determine how travel safety would be affected by a new circumferential highway. According to TxDOT, highways have lower crash rates than lower classified roads due to the design of the highways, fewer access points, fewer driver distractions, and less stop-and-go conditions. Therefore, diverting traffic from collector roadways to a controlled-access facility such as Segments H and I-1, would be expected to reduce the crash rates within the study area.

Crash rates were previously calculated for roadways within the study area based on the number of crashes per 100 Million Vehicle Miles Traveled (MVMT). Crash rates are influenced by traffic volume, roadway segment length, roadway type, conditions, travel speed, and accessibility. 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 2-6** shows the roadways that were found to have a crash rate more than double the statewide average. The table also shows the amount of projected traffic that would be diverted by Segments H and I-1.

Table 2-6: Crash Rates within the Segments H and I-1 Study Area (2010 - 2012)

Roadway Segment	Limits	Length (Miles)	Crash Rate (crashes/ 100 MVMT)	Statewide Average (crashes/ 100 MVMT)	ADT and % Change with Construction of Segments H and I-1					
					2019			2039		
					No-Build ADT (vpd)	Build ADT (vpd)	% Change	No-Build ADT (vpd)	Build ADT (vpd)	% Change
FM 1485	US 59/I-69 to FM 2100	8.96	333.9	120.26	11,261	12,062	7%	14,792	18,536	25%
FM 3360	FM 565 to SH 146	2.28	364.5	120.26	1,672	1,512	-10%	3,970	1,494	-62%
FM 1314	Loop 494 to Andrew Lane	1.8	733.2	120.26	27,860	25,674	-8%	38,420	36,546	-5%
SH 321	US 90 to FM 1008	14.03	188.0	84.19	8,477	6,977	-18%	13,487	10,967	-19%
Loop 494	Northpark Dr to US 59/I-69	7.15	277.9	97.81	9,352	9,540	2%	15,191	15,591	3%

Note: This table includes facilities with crash rates more than or close to double the statewide average
Source: TxDOT, 2012

As shown in **Table 2-6**, traffic volumes on these roadways with high crash rates would be reduced by as much as 10 percent in 2019 and by as much as 62 percent in 2039. These are facilities that would have traffic diverted onto the proposed Segments H and I-1, thereby potentially improving safety. It should be noted that traffic along FM 1485 is projected to increase by approximately 7 percent in 2019 under the Build Alternative. The additional capacity would therefore be expected to positively impact crash rates.

Segments H and I-1 would provide additional evacuation capacity and a direct route to US 59 (N)/I-69, as well as connectivity to Grand Parkway Segment G. The No-Build Alternative does not address this need. During a hurricane or emergency evacuation, it is anticipated that tolls would be waived for the proposed Segments H and I-1.

2.3.2.4 Preferred Alternative Transportation Improvement Measures

The results of the traffic and transportation analysis for the Segments H and I-1 study area are summarized in **Chapter 1** with regard to discontinuous system linkage, decreased mobility, and compromised safety. The lack of infrastructure to support population growth was not included in the traffic and transportation analysis because this need is based on population projections instead of traffic projections.

Discontinuous System Linkage

The Segments H and I-1 study area is served by only two highways: US 59 (N)/I-69 and I-10 (E). US 59 (N)/I-69 provides north-south mobility on the northwestern edge of the study area, and I-10 (E) provides east-west mobility along the southern edge. Principal arterials include SH 146/SH 321, US 90, and FM 1960. SH 146 and SH 321 are two-lane, north-south roadways along the eastern edge of the study area. US 90 is a four-lane roadway and FM 1960 is a two-lane roadway. Both serve east-west movements in the study area.

No current facility connecting all major radial facilities exists in the Segments H and I-1 study area. Currently, travelers utilize FM 1485, FM 1960, FM 2100, and SH 146 to make such connections. Secondary roads include FM 3360, FM 1942, FM 1413, and FM 1314. The central portion of the study area is especially deficient in good transportation infrastructure to support north-south and circumferential mobility. Although the 2035 RTP Update identifies plans to upgrade some of the existing facilities, the roadway network would not be sufficient to handle the projected traffic volumes.

Decreased Mobility

Under the No-Build Alternative, which includes the existing roadway infrastructure and committed improvements, congestion on the roadway network would increase as the study area experiences growth. **Table 2-7** summarizes the percentage of roadway miles, by functional classification, operating at different levels of mobility for 2011, 2019, and 2039. The percent of interstate miles operating at a *tolerable* LOM is projected to decrease from 100 percent in 2011 to zero in 2039 under the No-Build Alternative, while the build alternatives maintain 13 percent at *tolerable* LOM. For minor arterials, the percentage operating at

serious and *severe* LOM is projected to improve from 79 percent (11 percent operating at an LOM of *serious* and 68 percent operating at an LOM of *severe*) under the No-Build Alternative to 66 percent (26 percent operating at an LOM of *serious* and 40 percent operating at an LOM of *severe*) assuming the Build Alternative in 2039.

Table 2-7: LOM by Percentage of Roadway Miles for Segments H and I-1 Traffic Study Area

LOM	2011 Base Year	2019		2039	
		No-Build	Build	No-Build	Build
Interstates					
Tolerable	100%	100%	100%	0%	13%
Moderate	0%	0%	0%	13%	26%
Serious	0%	0%	0%	87%	61%
Severe	0%	0%	0%	0%	0%
Principal Arterials					
Tolerable	75%	57%	68%	33%	25%
Moderate	16%	24%	0%	0%	0%
Serious	0%	19%	28%	16%	22%
Severe	9%	0%	0%	51%	53%
Proposed Grand Parkway					
Tolerable	N/A	N/A	100%	N/A	100%
Moderate	N/A	N/A	0%	N/A	0%
Serious	N/A	N/A	0%	N/A	0%
Severe	N/A	N/A	0%	N/A	0%
Minor Arterials					
Tolerable	85%	66%	77%	21%	26%
Moderate	15%	9%	1%	0%	8%
Serious	0%	10%	7%	11%	26%
Severe	0%	15%	15%	68%	40%
Collector Roadways					
Tolerable	100%	100%	100%	58%	64%
Moderate	0%	0%	0%	0%	8%
Serious	0%	0%	0%	20%	0%
Severe	0%	0%	0%	22%	28%
Total Roadway Miles					
Tolerable	86%	72%	82%	27%	28%
Moderate	11%	12%	0%	2%	8%
Serious	0%	11%	13%	26%	27%
Severe	3%	5%	5%	45%	37%

Source: H-GAC, 2012

Currently, 3 percent of all roadway miles within the study area operate at *serious* and *severe* LOM. Assuming that all programmed improvements are implemented, excluding the proposed Segments H and I-1, it is projected that 71 percent (26 percent operating at an LOM of *serious* and 45 percent operating at an LOM of *severe*) of the roadway miles within the study area would operate at *serious* and *severe* LOM by 2039, in contrast to the build alternatives for which only 64 percent (27 percent operating at LOM *serious* and 37 percent at LOM *severe*) would operate at *serious* and *severe* LOM. In addition, 29 percent (27 percent operating at LOM *tolerable* and 2 percent at LOM *moderate*) of all the roadway miles within the study area would operate at *tolerable* and *moderate* LOM by 2039 under the No-Build Alternative while construction of Segments H and I-1 would result in 36 percent (28 percent operating at LOM *tolerable* and 8 percent at LOM *moderate*) of all roadway miles within the study area operating at a *tolerable* and *moderate* LOM.

Compromised Safety

Nationally, highways have lower crash rates than lower classified roads due to the design of the highways, fewer access points, fewer driver distractions, and less stop-and-go conditions. Therefore, diverting traffic from collector roadways to a controlled-access facility, such as the proposed Segments H and I-1, is expected to reduce roadway crash rates within the study area. In addition, Segments H and I-1 would provide additional emergency evacuation capacity and a direct route to US 59 (N)/I-69, as well as connectivity to Grand Parkway Segment G. The No-Build Alternative does not address this need.

Conclusion

Given the above results, the build alternatives were advanced for further study. Although the No-Build Alternative would not satisfy the purpose and need of the proposed project, it was retained and utilized as the basis of comparison for the build alternatives and for further consideration as required by CEQ regulations. The next section summarizes analyses conducted for the individual build alternatives selected as reasonable alternatives within the Segments H and I-1 study area.

2.4 REASONABLE ALTERNATIVES

2.4.1 Description of Reasonable Alternatives

Refer to **Exhibit 2-5** for an illustration of the section alignments that create the reasonable alternatives described in detail below.

2.4.1.1 Alternative 1

The No-Build Alternative does not satisfy the purpose and need for the proposed improvements and it is not consistent with the 2035 RTP Update; however, FHWA (1987), TxDOT (2012), and CEQ (1978) guidelines for the preparation of environmental documents require that the No-Build Alternative be carried forward as the basis of comparison for all reasonable alternatives.

The No-Build Alternative involves the construction of other projects currently planned and programmed in the H-GAC's 2035 RTP Update. The No-Build Alternative would offer no additional capacity and only minor mobility improvements to the study area. In addition, the No-Build Alternative would not provide an additional evacuation route to enhance safety or provide additional infrastructure to support population growth.

2.4.1.2 Alternative 2

Alternative 2 combines Alignments A-2, B-1, and C-2, and is approximately 38.2 miles in length. Alternative 2 begins at Roman Forest Boulevard and US 59 (N)/I-69, approximately 1.5 miles north of FM 1485. After bridging over Loop 494 and the Union Pacific Railroad (UPRR), it travels east crossing Peach Creek and the East Fork San Jacinto River to the Liberty County line. Alternative 2 traverses further east for approximately 9 miles before turning south and traversing 7 miles while crossing over the UPRR, FM 1960, and US 90 approximately 3 miles east of Dayton. Alternative 2 crosses FM 1413 and the UPRR and then travels south between the railroad and SH 146. It then turns southeast crossing SH 146 and FM 565 east of Mont Belvieu before terminating at I-10 (E), 2 miles east of SH 146. All 38.2 miles of Alternative 2 would be on a new location. Alternative 2 would require approximately 1,852 acres (ac) of ROW.

2.4.1.3 Alternative 3

Alternative 3 combines Alignments A-2, B-1, and C-3, and is approximately 39.4 miles in length. Alternative 3 begins at Roman Forest Boulevard on US 59 (N)/I-69, approximately 1.5 miles north of FM 1485. After bridging over Loop 494 and the UPRR, it travels east crossing Peach Creek and the East Fork San Jacinto River to the Liberty County line. Alternative 3 traverses further east for approximately 9 miles before turning south and traversing 7 miles while crossing over the UPRR, FM 1960, and US 90, approximately 3 miles east of Dayton. Approximately 3 miles south of US 90, Alternative 3 turns in a southwesterly direction, crossing FM 1413, and traversing south while staying west of the UPRR. It then turns east bridging over the UPRR, intersects with SH 146, FM 565 east of Mont Belvieu, and eventually

terminates at I-10 (E). All 39.4 miles of Alternative 3 would be on new location. Alternative 3 would require approximately 1,910 ac of ROW.

2.4.1.4 Alternative 4

Alternative 4 combines Alignments A-2, B-2, and C-2, and is approximately 35.4 miles in length. Alternative 4 begins at Roman Forest Boulevard on US 59 (N)/I-69, approximately 1.5 miles north of FM 1485. After bridging over Loop 494 and the UPRR, it travels east crossing Peach Creek and the East Fork San Jacinto River to the Liberty County line. Alternative 4 traverses further east for approximately 1.5 miles before turning southeast for approximately 13 miles, crossing over the UPRR, FM 1960, and US 90 approximately 3 miles east of Dayton. Alternative 4 crosses FM 1413 and the UPRR, and then travels south between the railroad and SH 146. It then turns southeast crossing SH 146 and FM 565 east of Mont Belvieu before terminating at I-10 (E), 2 miles east of SH 146. All 35.4 miles of Alternative 4 would be on new location. Alternative 4 would require approximately 1,716 ac of ROW.

2.4.1.5 Alternative 5

Alternative 5 combines Alignments A-2, B-2, and C-3, and is approximately 36.6 miles in length. Alternative 5 begins at Roman Forest Boulevard on US 59 (N)/I-69, approximately 1.5 miles north of FM 1485. After bridging over Loop 494 and the UPRR, it travels east crossing Peach Creek and the East Fork San Jacinto River to the Liberty County line. Alternative 5 traverses further east for approximately 1.5 miles before turning southeast for approximately 13 miles, crossing over the UPRR, FM 1960, and US 90 approximately 3 miles east of Dayton. Approximately 3 miles south of US 90, Alternative 5 turns in a southwesterly direction crossing FM 1413 and traversing south while staying west of the UPRR. It then turns east bridging over the UPRR, intersects with SH 146, FM 565 east of Mont Belvieu, and eventually terminates at I-10 (E). All 36.6 miles of Alternative 5 would be on new location. Alternative 5 would require approximately 1,775 ac of ROW.

2.4.1.6 Alternative 6

Alternative 6 combines Alignments A-2, B-5, and C-6, and is approximately 35.4 miles in length. Alternative 6 begins at Roman Forest Boulevard on US 59 (N)/I-69, approximately 1.5 miles north of FM 1485. After bridging over Loop 494 and the UPRR, it travels east crossing Peach Creek and the East Fork San Jacinto River to the Liberty County line. Alternative 6 traverses further east for approximately 1 mile before turning south where it traverses approximately 7 miles before crossing FM 1960 and the UPRR. It

continues southeast for approximately 6 miles to its crossing with US 90 near the Liberty/Harris County line. Alternative 6 traverses for another 6 miles southeast in Liberty and Harris counties before entering Chambers County. Alternative 6 then turns east north of Mont Belvieu, crosses the UPRR, SH 146, FM 565 east of Mont Belvieu, and eventually terminates at I-10 (E). All 35.4 miles of Alternative 6 would be on new location. Alternative 6 would require approximately 1,716 ac of ROW.

2.4.1.7 Alternative 7

Alternative 7 combines Alignments A-4, B-1, and C-2, and is approximately 39.7 miles in length. Alternative 7 begins at Community Drive on US 59 (N)/I-69, approximately 1.5 miles south of FM 1485. It then bridges over Loop 494 and the UPRR and continues east for approximately 3 miles. Alternative 7 then crosses Caney Creek before turning northeast near Peach Creek where it overlaps with FM 1485 north of the Lake Houston Wilderness Park for approximately 3.5 miles, crossing the East Fork San Jacinto River. Alternative 7 continues east of FM 1485 for roughly 10.5 miles before turning south and traversing 7 miles while crossing over the UPRR, FM 1960, and US 90, approximately 3 miles east of Dayton. Alternative 7 crosses FM 1413 and the UPRR and then travels south between the UPRR and SH 146. It then turns southeast crossing SH 146 and FM 565 east of Mont Belvieu before terminating at I-10 (E), 2 miles east of SH 146. Approximately 3.5 miles of Alternative 7 follows existing FM 1485, with the remaining 36.2 miles on new location. Alternative 7 would require approximately 1,925 ac of ROW.

2.4.1.8 Alternative 8

Alternative 8 combines Alignments A-4, B-1, and C-3, and is approximately 41.0 miles in length. Alternative 8 begins at Community Drive on US 59 (N)/I-69, approximately 1.5 miles south of FM 1485. It then bridges over Loop 494 and the UPRR and continues east for approximately 3 miles. Alternative 8 then crosses Caney Creek before turning northeast near Peach Creek, where it overlaps with FM 1485 north of the Lake Houston Wilderness Park for approximately 3.5 miles, crossing the East Fork San Jacinto River. Alternative 8 continues east of FM 1485 for roughly 10.5 miles before turning south and traversing 7 miles while crossing over the UPRR, FM 1960, and US 90, approximately 3 miles east of Dayton. Approximately 3 miles south of US 90, Alternative 8 turns in a southwesterly direction crossing FM 1413 and traversing south while staying west of the UPRR. It then turns east bridging over UPRR, crosses SH 146, FM 565 east of Mont Belvieu, and eventually terminates at I-10 (E). Approximately 3.5 miles of Alternative 8 follows existing FM 1485, with the remaining 37.5 miles on new location. Alternative 8 would require approximately 1,988 ac of ROW.

2.4.1.9 Alternative 9

Alternative 9 combines Alignments A-4, B-2 and C-2, and is approximately 36.9 miles in length. Alternative 9 begins at Community Drive on US 59 (N)/I-69, approximately 1.5 miles south of FM 1485. It then bridges over Loop 494 and the UPRR and continues east for approximately 3 miles. Alternative 9 then crosses Caney Creek before turning northeast near Peach Creek, where it overlaps with FM 1485 north of the Lake Houston Wilderness Park for approximately 3.5 miles, crossing the East Fork San Jacinto River. Alternative 9 continues east of FM 1485 for roughly 2.5 miles before turning southeast for approximately 13 miles, crossing over the UPRR, FM 1960, and US 90, approximately 3 miles east of Dayton. Alternative 9 crosses FM 1413 and UPRR and then travels south between the UPRR and SH 146. It then turns southeast crossing SH 146 and FM 565 east of Mont Belvieu before terminating at I-10 (E), 2 miles east of SH 146. Approximately 3.5 miles of Alternative 9 follows existing FM 1485, with the remaining 33.4 miles on new location. Alternative 9 would require approximately 1,789 ac of ROW.

2.4.1.10 Alternative 10

Alternative 10 combines Alignments A-4, B-2, and C-3, and is approximately 37.4 miles in length. Alternative 10 begins at Community Drive on US 59 (N)/I-69, approximately 1.5 miles south of FM 1485. It then bridges over Loop 494 and the UPRR and continues east for approximately 3 miles. Alternative 10 then crosses Caney Creek before turning northeast near Peach Creek where it overlaps with FM 1485 north of the Lake Houston Wilderness Park for approximately 3.5 miles, crossing the East Fork San Jacinto River. Alternative 10 continues east of FM 1485 for roughly 2.5 miles before turning southeast for approximately 13 miles crossing over the UPRR, FM 1960, and US 90, approximately 3 miles east of Dayton. Approximately 3 miles south of US 90, Alternative 10 turns in a southwesterly direction crossing FM 1413 and traversing south while staying west of the UPRR. It then turns east bridging over the UPRR and crossing the Alternative 2 proposed location and SH 146, FM 565 east of Mont Belvieu, and eventually terminates at I-10 (E). Approximately 3.5 miles of Alternative 10 follows existing FM 1485, with the remaining 33.9 miles on new location. Alternative 10 would require approximately 1,813 ac of ROW.

2.4.1.11 Alternative 11

Alternative 11 combines Alignments A-4, B-5, and C-6, and is approximately 37.0 miles in length. Alternative 11 begins at Community Drive on US 59 (N)/I-69, approximately 1.5 miles south of FM 1485. It then bridges over Loop 494 and the UPRR and continues east for approximately 3 miles. Alternative 11 then crosses Caney Creek before turning northeast near Peach Creek where it overlaps with FM 1485

north of the Lake Houston Wilderness Park for approximately 3.5 miles, crossing the East Fork San Jacinto River. Alternative 11 continues east of FM 1485 for roughly 2.5 miles before turning south where it traverses approximately 7 miles before crossing FM 1960 and the UPRR. It continues southeast for approximately 6 miles to its crossing with US 90 near the Liberty/Harris County line. Alternative 11 traverses for another 6 miles southeast in Liberty and Harris counties before entering Chambers County and turning east where it joins the Alternative 2 proposed location north of Mont Belvieu crossing the UPRR, SH 146, FM 565 east of Mont Belvieu, and eventually terminates at I-10 (E). Approximately 3.5 miles of Alternative 11 follows existing FM 1485, with the remaining 33.5 miles on new location. Alternative 11 would require approximately 1,794 ac of ROW.

2.4.2 Evaluation of Reasonable Alternatives

The environmental criteria listed along the top of **Table 2-8** were used to evaluate the potential impacts of the reasonable alternatives on the natural and human environment. When possible, the CAT was used to quantify impacts. Desktop aerial interpretation with limited field visits for data verification facilitated the evaluation. The desktop aerial interpretation consisted of using a GIS software program to view mapped environmental constraints that were layered on top of the H-GAC aerial photographs of the study area. Input from the public, agencies (such as FHWA and TxDOT), and elected officials was also considered during the selection of Reasonable Alternative 10 as the Recommended Preferred Alternative prior to the release of the DEIS and public hearings. The reasonable alternatives were evaluated following FHWA Technical Advisory T 6640.8A guidance and other applicable regulations.

The public and elected agency officials supported the build alternatives versus the No-Build Alternative. All build alternatives that provided system connectivity with Grand Parkway Segments G and I-2 received positive feedback from the public. These included Reasonable Alternatives 7-11 (all including Preliminary Alternative A-4). Reasonable Alternative 8 (A-4, B-1, C-3) had the highest public and agency support.

Environmental evaluation criteria included: impacts to land use; total proposed ROW; visual and potential access impacts; impacts to natural resources including forested and non-forested wetlands, impaired and ecologically significant streams, threatened and endangered species, species of concern, wildlife habitat, floodways and 100-year (yr) floodplains, prime farmlands and century farms; impacts to cultural resources including recorded archeological sites, archeological high probability areas, historic resources, and cemeteries; impacts to air quality sensitive receptors and traffic noise receivers; socioeconomic impacts

including residential and commercial displacements, churches displaced, changes in community cohesion, and environmental justice issues; impacts to public and private water wells; and hazmat issues including regulated sites, oil and gas wells, and other sites of concern. All of these constraints were evaluated equally for comparison purposes in selection of the Recommended Preferred Alternative. Refer to **Table 2-8** for the matrix that documented the results of the reasonable alternatives environmental evaluation.

Engineering evaluation criteria included estimated ROW cost, major utility lines impacted, complexity of drainage consisting of the number and length of floodplain crossings and length of the corridor with limited access to outfalls, and finally construction cost, excluding ROW, utilities and special drainage facilities accounted for in the other three criteria. Refer to **Table 2-9** for a matrix with the results of the engineering evaluation for each of the reasonable alternatives.

Traffic and mobility evaluation criteria included: emergency evacuation consisting of evacuation efficiency, population served, and average study area travel speed; transportation system connections including average daily volume on the proposed alternative, regional VMT and street closures; travel efficiency measured by LOS on study area roadways, vehicle hours of travel reductions in study area and in region, and travel time on alternative; and conformance with transportation plans. Reasonable alternatives that would result in high numbers of street closures were considered less favorable than alternatives with low numbers of proposed street closures. Refer to **Table 2-10** for a matrix with the results of the traffic evaluation for each of the reasonable alternatives.

Table 2-8: Environmental Evaluation Matrix of Reasonable Alternatives

Reasonable Alternative	Length (miles)	Land Use												Natural Resources											Cultural Resources				Noise	Socioeconomic/EJ					Water Wells		Hazmat		
														Wetlands		Streams																							
		Commercial (acres)	Agricultural (acres)***	Residential (acres)	Schools (acres)	Churches (acres of parcels)**	Industrial (acres)	Preliminary Platted (acres)	Undevelped Platted (acres)	Managed Lands (acres)	Other Undeveloped (acres)	Total Proposed ROW (acres)	Visual and Potential Access Impacts	Forested Wetlands (acres)	Non-Forested Wetlands (acres)	Impaired Streams Crossed	Ecologically Significant Streams Crossed	Threatened and Endangered Species	Species of Concern	Wildlife Habitat****	Floodway	100-Year Floodplain (acres)	Prime Farmlands (acres)	Century Farms	Recorded Archeological Sites	Archeological High Probability Areas (acres)	Historic Resources	Cemeteries	Number of Representative Noise Receivers	Residential Displacements	Commercial Displacements	Churches Displaced	Changes in Community Cohesion	Environmental Justice Issues	Public	Private	Regulated Sites	Oil Wells	Other sites of Concern
1	0	0	0	0	0	0	0	0	0	0	0	0	No	0	0	-	-	-	-	0	0	0	0	-	0	0	0	0	0	0	0	0	No	No	0	0	0	0	0
2	38.2	0	1008	56	0	0	31	22	132	0	603	1852.1	Yes	4.4	40.9	-	2	-	-	674.9	38.5	84.1	906	-	0	1981	0	0	48	6	0	0	Yes	Yes	5	2	4	8	2
3	39.4	0	1058	56	0	0	34	22	132	0	608	1910.3	Yes	23.7	38.6	-	2	-	-	694.8	38.5	84.1	917	-	0	996	0	0	49	6	0	0	Yes	Yes	5	2	8	9	2
4	35.4	0	922	41	0	0	31	22	132	0	568	1716.4	Yes	2.8	19.1	-	2	-	-	635.5	46.4	129.0	900	-	0	1622	0	0	7	10	0	0	Yes	Yes	3	2	3	15	2
5	36.6	0	972	41	0	0	34	22	132	0	574	1774.5	Yes	22.1	16.8	-	2	-	-	655.4	46.4	129.0	911	-	0	1637	0	0	8	10	0	0	Yes	Yes	3	2	7	16	2
6	35.4	0	634	53	0	0	32	37	132	0	827	1715.0	Yes	27.3	23.1	3^	2	-	-	808.6	57.9	183.0	1071	-	0	1180	0	0	35	7	0	0	Yes	Yes	3	1	6	13	2
7	39.7	6	1008	152	0	7	35	0	0	0	717	1924.8	Yes	6.1	41.2	-	3	-	-	663.9	35.4	113.6	941	-	0	2040	1	0	120	37	3	2	Yes	Yes	9	3	7	8	4
8	41.0	6	1058	152	0	7	38	0	0	0	727	1987.9	Yes	25.4	38.8	-	3	-	-	683.7	35.4	113.6	952	-	0	2055	1	0	121	37	3	2	Yes	Yes	9	3	11	9	4
9	36.9	6	922	138	0	7	35	0	0	0	681	1789.1	Yes	4.5	19.3	-	3	-	-	824.4	43.3	158.6	935	-	0	1681	1	0	79	41	3	2	Yes	Yes	7	3	6	15	4
10	37.4	6	972	138	0	7	29	0	0	0	595	1813.3	Yes	23.8	17.0	-	3	-	-	644.3	36.2	158.6	946	-	0	1696	1	1	80	41	3	2	Yes	Yes	7	3	10	16	4
10R*	37.4	7	1072	130	2	3	22	0	0	11	687	1813.3	Yes	26.5	15.5	-	3	-	-	664.75	43.26	158.6	960	-	0	1696	1	0	38	77	19	1	No	No	7	0	9	11	9
11	37.0	6	634	150	0	7	36	16	0	0	944	1793.9	Yes	28.9	23.3	3^	3	-	-	797.5	54.5	212.5	1106	-	0	1239	1	0	107	38	3	2	Yes	Yes	7	2	9	13	4

Source: Study Team, 2007

^ The same stream (Cedar Bayou) is crossed 3 different times

"-" No resource located within alternative

* Preferred Alternative

** 7 acres of church parcels consist of 2 separate parcels that contain 1 church each that would be displaced; 10R would displace 3 acres of church property, but only one church structure

*** Acreages have been determined using H-GAC data

**** Acreages presented are a summary of wetlands, forested wetlands, non-forested wetlands, and forested areas. These acreages exclude agricultural land

Table 2-9: Engineering Evaluation Matrix of Reasonable Alternatives

Data Category		Data Description	Reasonable Alternatives										
			1	2	3	4	5	6	7	8	9	10	11
			No-Build	A-2 B-1 C-2	A-2 B-1 C-3	A-2 B-2 C-2	A-2 B-2 C-3	A-2 B-5 C-6	A-4 B-1 C-2	A-4 B-1 C-3	A-4 B-2 C-2	A-4 B-2 C-3	A-4 B-5 C-6
ROW	Cost	Total cost of ROW required from different land uses (in Millions)	0.00	8.28	8.77	7.79	8.28	8.93	12.95	13.44	12.46	12.95	13.60
UTILITIES	Major Utility Lines	Major Pipelines, Electric Transmission Lines (Number of Crossings)	0	313	492	313	492	456	318	497	318	497	461
DRAINAGE	Outfall Spacing	Total length of sections between canals with inadequate outfalls (in Miles)	0.00	22.00	23.10	13.90	15.00	3.60	22.00	23.10	13.90	15.00	3.60
	Number of Floodplain Crossings	Total number of sites requiring mitigation for fill in floodplain	0	5	5	7	7	13	5	5	7	7	13
	Total Length of Floodplain Crossings	Total length of floodplain crossings indicating amount/cost of mitigation (in Miles)	0.00	2.61	2.61	3.47	3.47	5.28	2.94	2.94	3.79	3.79	5.67
CONSTRUCTION	Cost	Roadway, Bridges, Ret Walls, Ditches, Signing, Lighting, TCP, Misc (in Millions)	0.00	506.80	513.50	497.90	504.60	516.20	526.00	532.70	517.20	523.90	535.50

Source: Study Team, 2007

Table 2-10: Traffic Evaluation Matrix of Reasonable Alternatives

Criteria	Measure	Reasonable Alternatives										
		1	2	3	4	5	6	7	8	9	10	11
		No-Build	A-2 B-1 C-2	A-2 B-1 C-3	A-2 B-2 C-2	A-2 B-2 C-3	A-2 B-5 C-6	A-4 B-1 C-2	A-4 B-1 C-3	A-4 B-2 C-2	A-4 B-2 C-3	A-4 B-5 C-6
Emergency Evacuation	Evacuation efficiency (Qualitative)		Medium	Medium	Medium	Medium	Medium	High	High	High	High	High
	Population Served (persons)		76,900	74,100	77,800	75,000	106,200	106,800	104,000	107,700	104,900	136,100
	Average Study Area Travel Speed (mph)	41.0	44.1	43.9	43.9	44.0	44.2	44.1	44.0	44.0	44.0	43.5
Transportation System Connections	Average Daily Volume on the Grand Parkway H and I-1 (vpd)		12,533	11,203	17,729	16,480	17,908	14,467	13,263	19,591	18,312	19,236
	Regional VMT Reduction (over No-Build)		-8,065,600	-7,962,900	-7,979,500	-8,003,400	-7,923,400	-8,060,000	-8,080,800	-7,951,000	-8,095,100	-7,918,700
	Street Closures		29	30	30	31	39	10	11	11	12	20
Travel Efficiency	LOS by Study Area Roadway Miles											
	% Roadway Miles LOS A-C	19%	39%	39%	40%	41%	40%	38%	39%	39%	42%	41%
	% Roadway Miles LOS E-F	65%	46%	47%	50%	49%	48%	47%	47%	50%	48%	49%
	VHT Reduction (over No-Build)											
	Study Area VHT Reduction		-2,700	-2,800	-2,600	-3,400	-2,500	-3,400	-3,600	-3,300	-3,727	-1,200
	Regional VHT Reduction		-347,100	-338,700	-343,400	-342,600	-338,700	-348,900	-346,900	-342,000	-340,614	-341,300
	Travel Time (minutes) on Grand Parkway		36.0	37.0	33.7	34.7	34.1	33.4	34.4	31.1	32.0	31.5
Coformance with Transportation Plans	Degree of Conformity/Compliance	0.0	Medium	Medium	Medium	Medium	Medium	High	High	High	High	High

Source: Study Team, 2007

2.5 RECOMMENDED ALTERNATIVE AND PREFERRED ALTERNATIVE

During the evaluation of the reasonable alternatives, emphasis was placed on criteria distinguishing those alternatives which best met the proposed project's purpose and need. The traffic/mobility criteria provided the strongest measure with regard to meeting the purpose and need, while the engineering and environmental criteria provided a measure of cost. These combined criteria provided a measure of comparison for each reasonable alternative. However, in most instances, the differences in the engineering and environmental evaluation were not large enough to clearly distinguish one particular alternative over another. The alternatives discussed below did not meet the evaluation criteria and were eliminated from further consideration. Refer to **Table 2-8**, **Table 2-9**, and **Table 2-10** for the evaluation matrices comparing the impacts for each of the alternatives discussed below.

2.5.1 Reasonable Alternatives Not Recommended

Reasonable Alternatives 2 through 6 were not recommended because they have undesirable traffic and mobility effects as a result of a lack of connectivity with Grand Parkway Segment G and, therefore, provide a lower level of regional transportation system connectivity. Reasonable Alternatives 2 through 6 are located far north of the Lake Houston Wilderness Park and do not improve access to the park. Improved access was requested by the City of Houston during the study. These alternatives also traverse through the Roman Forest residential neighborhood and would have a higher number of street closures.

Reasonable Alternatives 2, 3, 7, and 8 were not recommended because they are located near the northeastern limits of the study area, thereby attracting fewer travelers than alternatives more centrally located within the study area. These alternatives included the B-1 alignment, which when modeled, caused longer travel times than the other alternatives and approximately 5,000 to 6,000 fewer vpd than the other alternatives.

Reasonable Alternatives 2, 4, 7, and 9 are confined between the UPRR and SH 146. This narrow area is constrained with very limited grade separations to cross the UPRR. The area east of the railroad is currently served by SH 146, but there is no major roadway which serves the area immediately west of the UPRR. These alternatives do not adequately serve the large portion of the study area west of the railroad and may hinder additional forecasted development, and, thus, were eliminated from further consideration.

Alternatives 6 and 11 were not recommended due to the substantially higher number of floodplain impacts throughout the study area and particularly in the vicinity of Cedar Bayou near the Liberty/Harris County line. These impacts would result in a greater amount of floodplain mitigation, detention ponds, and longer bridges, all resulting in higher costs.

2.5.2 Selection of the Recommended and Preferred Alternative

After careful review of public and agency input and environmental, engineering, and traffic criteria, Reasonable Alternative 10 (A-4, B-2, C-3) was selected as the Recommended Alternative to be carried forward into the FEIS for further detailed evaluation (**Exhibit 2-6**). A discussion of the reasons for selection of Alternative 10 is discussed below.

The northern portion of the Recommended Alternative provides direct connectivity with Grand Parkway Segment G. This connection to Segment G is important as it allows traffic direct access to I-45 which is officially designated as an evacuation route. Without a direct connection to Segment G, evacuating traffic from Segment H headed to I-45 would have to exit onto US 59 (N)/I-69 and travel south in order to get to Grand Parkway Segment G. The southern portion of the Recommended Alternative also provides a direct connection to Grand Parkway Segment I-2. This also provides improved connectivity during evacuations.

Description of the Recommended Alternative Alignment

On the north end, the Recommended Alternative follows the existing FM 1485 alignment. This is beneficial for the Lake Houston Wilderness Park as it provides direct access for traffic to and from the Grand Parkway Segments H and I-1. An important benefit of the Recommended Alternative on the north end is the safety improvement to FM 1485. The Recommended Alternative includes the reconstruction of FM 1485 from a two-lane roadway, to a pair of one-way non-tolled frontage roads with two travel lanes in each direction on either side of the Grand Parkway Segments H and I-1 toll facility. In addition to increasing the capacity on FM 1485, the Recommended Alternative is projected to reduce the ADT on FM 1485 from 28,800 vpd in 2039 under the No-Build Alternative to 22,400 vpd in the Build Alternative. The increase in capacity for FM 1485 and the reduction in traffic volume would result in a reduction in the crash rate and an improvement in safety. These benefits are applicable to Reasonable Alternatives 7-11. The central portion of the Recommended Alternative is located closer to the center of the study area, which has the benefit of serving a greater portion of the study area. This is directly reflected by the higher travel demand attracted by Reasonable Alternatives 4, 5, 6, 9, 10, and 11. This is evident when comparing Reasonable Alternative 8

and the Recommended Alternative, for example. These alternatives follow the same alignment in the north and south and the only difference is in the central portion of the alternative where Reasonable Alternative 8 is comprised of Preliminary Alternative B-1 (closer to Dayton) and the Recommended Alternative is comprised of Preliminary Alternative B-2. The weighted average daily traffic volume for the Recommended Alternative as a whole is 5,000 vpd more than for Reasonable Alternative 8 in the year 2039.

The southern portion of the Recommended Alternative lies west of the UPRR, improving transportation system connections for what is currently an underserved area. With SH 146 located east of the UPRR, a new facility located west of the UPRR would help support the economic growth this area is anticipated to experience in the future. Location of the proposed Grand Parkway Segments H and I-1 at a distance greater than 1 mile from SH 146 would better complement the area transportation network than having the Grand Parkway Segments H and I-1 either along or immediately adjacent to the existing SH 146 facility. As such, the Recommended Alternative, which passes west of the UPRR and SH 146, is more favorable than Reasonable Alternatives 2, 4, 7 and 9, which all pass between the UPRR and SH 146. The Recommended Alternative is also more favorable than Reasonable Alternatives 6 and 11, the western-most corridors closer to Cedar Bayou, due to the floodplain and drainage impacts associated with these alternatives. All of the benefits described in the southern portion of the study area are realized by Reasonable Alternatives 3, 5, 8 and 10.

Considering the benefits in the northern, central, and southern portions of the study area discussed above, the Recommended Alternative is the alternative which best realizes the benefits described in all three portions of the study area.

The Recommended Alternative (A-4, B-2, C-3) is proposed as a four-lane rural controlled-access toll road on new location and would meet the purpose and need of the proposed project. The Recommended Alternative would begin at US 59 (N)/I-69 and continue to I-10 (E), and would consist of an open-ditch design within a 400-ft wide ROW. Refer to **Exhibit 2-7** for a proposed typical section for Segments H and I-1. The Recommended Alternative is proposed as a toll road in order to be consistent with the H-GAC 2035 RTP Update that identifies the addition of tolled facilities, including the Grand Parkway Segments H and I-1, as necessary to address congestion and future growth in the H-GAC planning region.

2.5.3 Selection of the Preferred Alternative

Subsequent to the August 2011 public hearings, coordination with the public, stakeholders and adjacent property owners resulted in a slightly modified or revised alignment of Recommended Alternative 10 to create the Preferred Alternative 10R (**Exhibit 2-8**). The primary goal in the consideration of an alignment revision was to continue to practice avoidance as well as working with property owners to determine the alignment that best fit the purpose and need of the proposed project as well as accommodating the property owners' plans for their tracts. A Meeting with Affected Property Owners (MAPO) was held in May 2013 to present an alignment shift in the proximity of FM 1960. This alignment shift was made to address comments received from the public hearing, as well as the opportunity to practice avoidance of impacts to residential properties. The MAPO was held to inform the newly impacted property owners of the alignment shift. The property owners that were previously impacted were also invited to attend the meeting. The Preferred Alternative 10R has been carried forward into the FEIS for further detailed evaluation.

Description of the Preferred Alternative Alignment Revisions

The revisions creating the Preferred Alternative 10R include two separate alignment revisions on FM 1485, two separate alignment revisions due to development north and south of FM 1960, and two separate alignment revisions south of US 90 as detailed below. The Preferred Alternative includes the reconstruction of FM 1485 from a two-lane roadway, to a pair of one-way non-tolled frontage roads with two travel lanes in each direction on either side of the Grand Parkway Segments H and I-1 toll facility.

- An alignment revision on FM 1485, approximately 0.67 miles in length, is necessary to avoid a cemetery that was previously not identified within the ROW presented in the DEIS Recommended Alternative.
- A second revision on FM 1485 begins at the Harris County line and shifts the alignment north by approximately 3,500 ft for a distance of 3.95 miles. This revision was requested to accommodate planned development within the Houston Green Land Tract.
- An alignment revision extending on both sides of FM 1960 is needed to avoid new development and reduce impacts, and is approximately 2.96 miles in length.
- An alignment revision between FM 1960 and US 90 totals approximately 1.11 miles in length and would avoid potential displacements shown in the DEIS Recommended Alternative. This change shifts the alignment on the same property parcels.
- The alignment revision south of US 90 and north of FM 1413 totals 2.28 miles in length and is necessary to provide better alignment geometry due to a previous avoidance constraint being removed while still remaining within the original tract.

- An alignment revision south of US 90 begins just south of FM 1413 within the original tract and continues approximately 3.72 miles south to the Chambers County line. This revision was requested to accommodate planned rail development on the original tract.

Access has been reviewed for conflicts, and local access roads or frontage roads would be added where necessary to maintain local road connectivity. Alternative 10R is the alternative which best realizes the benefits described in all three portions of the study area. Refer to **Table 2-11** for the evaluation matrix comparing the impacts for the Recommended and Preferred Alternatives.

Preferred Alternative 10R is proposed as a four-lane rural controlled-access toll road on new location and would fulfill the purpose and need of the proposed project. The Preferred Alternative 10R would begin at US 59 (N)/I-69 and continue to I-10 (E) and would consist of an open-ditch design within a 400-ft wide ROW. The total length of the Preferred Alternative 10R is approximately 37.4 miles, and would require approximately 1,933 ac of ROW. Refer to **Exhibit 2-7** for a proposed typical section for Segments H and I-1.

The Preferred Alternative 10R is proposed as a toll road in order to be consistent with the H-GAC 2035 RTP Update that identifies the addition of tolled facilities, including the Grand Parkway Segments H and I-1, as necessary to address congestion and future growth in the H-GAC planning region. The estimated construction cost for the proposed Segments H and I-1, per the 2035 RTP Update (January 25, 2011), is approximately $1.2 billion. Construction for Phase I is estimated to begin in 2016, with a projected opening year of 2019. Construction of the ultimate project would be completed with construction of Phase II, with a projected construction completion year and open to traffic in 2025.

Table 2-11: Environmental Impact Summary for the Recommended and Preferred Alternatives*

		Environmental Impact	Recommended Alternative 10	Preferred Alternative 10R
		Total Project Length (miles)	37	37
		Total Project ROW (acres)	1,813	1,933
Land Use		Commercial (acres)	6	7
		Agricultural (acres)	1,038	1,072
		Residential (acres)	138	130
		Government Building (ac)	0	2
		Churches (acres)	7	3
		Industrial (acres)	29	22
		Preliminary Platted (acres)	0	0
		Undeveloped Platted (acres)	0	0
		Managed Lands (acres)	0	11
		Other Undeveloped (acres)	535	537
		Visual and Potential Access Impacts (yes/no)	Yes	Yes
Natural Resources	Wetlands	Forested Wetlands (acres)	24	27
		Non-Forested Wetlands (acres)	17	16
		Agricultural wetlands (acres)	228	285
	Streams	Impaired Streams Impacted (number)	0	0
		Ecologically Significant Streams Crossed (number)	3	3
		Threatened and Endangered Species (number)	0	0
		Species of Concern (number)	0	0
		Wildlife Habitat (acres)	644	665
		Floodway (acres)	43	43
		100-Year Floodplain (acres)	159	158
		Prime Farmland (acres)	947	960
		Century Farms (acres)	0	0
Cultural Resources		Recorded Archaeological Sites (number)	0	0
		Archeological High Probability Areas (acres)	1,696	1,696
		Historic Resources (number)	1	1
		Cemeteries (number)	1	0
Noise		Representative Noise Impacts (number)	80	38
Socioeconomic/ EJ		Residential Displacements (number)	41	77
		Commercial Displacements (number)	5	19
		Churches Displaced (number)	2	1
		Changes in Community Cohesion (yes/no)	Yes	No
		Environmental Justice Issues (yes/no)	Yes	No
Water Wells		Public (number)	7	7
		Private (number)	3	0
HazMat		Regulated Sites (number)	10	9
		Oil Wells (number)	16	11
		Other Sites of Concern (number)	4	9

Source, Study Team, 2013
*The values within this table have been updated to reflect the analysis impacts discussed in Chapter 4

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CHAPTER 3
AFFECTED ENVIRONMENT

The proposed project (Grand Parkway Segments H and I-1) is located on the northeast side of the greater Houston metropolitan area from United States Highway (US) 59 North (N)/Interstate Highway (I) 69 to I-10 (E) generally between Farm-to-Market Road (FM) 2100 and State Highway (SH) 146 (**Exhibit 2-5**). The total distance of Segments H and I-1 is approximately 37 miles (mi). Segment H extends from US 59 (N)/I-69 (near Community Drive) to US 90. Segment I-1 continues south from US 90 to I-10 (E). Due to the similarities between Segment H and Segment I-1, it was agreed upon by the Federal Highway Administration (FHWA) and the Texas Department of Transportation (TxDOT) that these segments could be studied as one project for the purposes of evaluating environmental impacts. Segments H and I-1 collectively constitute the proposed project evaluated in this Final Environmental Impact Statement (FEIS).

The proposed project traverses through Montgomery, Harris, Liberty, and Chambers counties. Cities within the study area include Mont Belvieu, Dayton, Plum Grove, Patton Village, Roman Forest, and Woodbranch. The unincorporated community of New Caney is also located within the study area. The study area includes the northeastern portion of Lake Houston, Caney and Peach Creeks, the East Fork of the San Jacinto River, Luce Bayou, Cedar Bayou, and several drainage and irrigation canals.

3.1 LAND USE

The Segments H and I-1 study area is mostly in agricultural usage or is undeveloped (78 percent) with about 15 percent residential development, 1 percent industrial, 1 percent commercial development, and 5 percent other (**Table 3-1**). Most of the developed land is within and adjacent to the northern portion of the study area along US 59 (N)/I-69 and FM 1485 and along the southern portion in Mont Belvieu. The 4,990-acre (ac) Lake Houston Wilderness Park, operated by the City of Houston Parks and Recreation Department, is a major constraint within the study area. **Exhibit 3-1** outlines the boundaries of the study area used to examine land use. Refer to **Exhibit 2-6** for the location of parks and cities within the study area. Other land uses within the study area include the following:

- Dempsey Henley State Prison is located north of Dayton on the eastern edge of the study area.
- Two salt domes, the Esperson Dome northwest of Dayton and the Barbers Hill Dome near Mont Belvieu.
- Several oil fields are located throughout the study area, including in the area of Splendora, Dayton, and Mont Belvieu.

- There is one state Superfund site in the study area, the Cox Road Dump (also known as Liberty Waste Disposal Landfill), which is located 1 mi north of FM 1413 on the west side of County Road (CR) 491 (Cox Road) in Dayton (Liberty County).
- A number of primarily residential developments stretch between the east shore of Lake Houston and FM 2100. The largest of these is The Commons of Lake Houston, a large lot subdivision.
- Large expanses of agricultural land are located throughout the study area.

The bulk of the proposed project would be constructed in Liberty County. While a substantial portion of the county is devoted to agriculture, it is a part of the Houston metropolitan statistical area (MSA) and is experiencing the advancement of urban development outward from Harris County. Between 1997 and 2002, Liberty County experienced a reduction of 2,209 ac of farmland. During this five-year period, the number of farms actually increased, resulting in a reduction in the average size of farms from 270 ac in 1997 to 191 ac in 2002. More than 53 percent of the principal farm operators have a non-farming principal occupation and more than 44 percent of the principal farm operators worked more than 200 days out of the year off the farm.

Land use designations and geographic information system (GIS) data were obtained from the Houston-Galveston Area Council (H-GAC), as well as recent aerial photography (2009 & 2010), and field reconnaissance of the study area. Refer to **Exhibit 3-1** for the general land use types within the study area and **Appendix D** for photographs of the study area. The H-GAC land use designations described below are limited to commercial, residential, industrial, other, and open space (agricultural and undeveloped).

Commercial

The commercial category includes businesses, restaurants, retail centers, entertainment-oriented businesses, convenience stores, and other similar structures or uses.

Residential

The residential category includes single and multi-family dwellings including both permanent and non-fixed structures.

Industrial

The industrial category includes large refineries, warehouses, distribution centers, and oil and gas production facilities.

Other

The other category includes land devoted to recreational and outdoor leisure activities such as sports facilities, public parks, nature centers, etc.

Open Space (Agricultural and Undeveloped)

The open space category includes land with few or no permanent structures present, evidence of cultivated crops, rangeland, orchards, plant production, or timber production. This category includes land that would be considered undeveloped or agricultural.

Table 3-1: General Land Use Within the Study Area

Land Use	Acreage Within the Study Area	% of Study Area
Commercial	2,278	1
Industrial	1,203	1
Other	10,721	5
Residential	34,905	15
Open Space (Agricultural and Undeveloped)	175,734	78

Source: H-GAC, 2009 & 2010

Historical aerial photography and GIS data obtained from the H-GAC show that within the study area from 1970 to 2010, residential growth, as represented by households, has occurred primarily in unincorporated Harris County, Liberty County, and Montgomery County. Growth in Chambers County represented less than 1 percent of the metropolitan growth in households, while Liberty County accounted for 1.3 percent of the household growth during the 1970s, 1.0 percent in the 1980s and 1.6 percent during the 1990s.

3.1.1 Section 4(f) Properties

The Lake Houston Wilderness Park covers approximately 4,990 ac in the northwest portion of the study area, just south of FM 1485. Ownership was transferred from the Texas Parks and Wildlife Department (TPWD) to the City of Houston in 2006, and the park is now operated by the City of Houston Parks and Recreation Department. There are no other Section 4(f) resources located within the study area. In addition, there are no areas of unique scenic beauty or other lands of national, state, or local importance.

3.1.2 Existing Utilities

A visual survey and secondary source data review was performed to identify the major utilities within the study area. Based on the visual observation, the following utilities were observed in the study area: pipelines, cable, conduit, fiber, water lines, sanitary sewer lines, cell towers, water and sewer plants, refineries, metering stations, and overhead transmission lines. Pipelines were further researched based on recorded data provided by the Texas Railroad Commission. Refer to **Table 3-2** for a listing of the major pipeline companies with line diameter sizes ranging from 2.38 inch (in.) to 40 in. within the study area.

Table 3-2: Pipelines Within the Study Area

Owner/Operator	Diameter	Commodity Description
ExxonMobil Pipeline Company	6.63”	Propylene
Gulf Coast Pipeline, L.P.	8.63”	Crude Butadiene
Mobil Vanderbilt-Beaumont P/L Co.	4.50”	Natural Gas
Mobil Pipeline Company	8.63”	Refined Products
Duke Energy Field Services, L.P.	12.75”	Natural Gas Liquids
Citgo Products Pipeline Company	12.75”	Liquefied Petroleum Gas
Houston Pipeline Company L.P.	12.75”	Natural Gas
Sunoco Pipeline L.P.	6.63”	Crude Oil
Shell Pipeline Company L.P.	20.00”	Crude Oil
Kinder Morgan Tejas Pipeline, L.P.	2.38”	Natural Gas
Kinder Morgan Tejas Pipeline, L.P.	8.63”	Natural Gas
El Paso Field Services, L.P.	8.63”	Natural Gas
Natural Gas Pipeline Co. of Amer.	30.00”	Natural Gas
Black Hills Operating Co. LLC	10.75”	Crude Oil
Dynegy NGL Pipeline Company, LLC	12.75”	Natural Gas Liquids
Colonial Pipeline Company	40.00”	Gasoline/Fuel Oil/Kerosene
Explorer Pipeline Company	28.00”	Refined Petroleum Products
Valero Logistics Operations L.P.	8.63”	Propylene
Enterprise Products Operating L.P.	14.00”	Natural Gas Liquids
Koch Pipeline Company, L.P.	12.75”	Crude Oil
TE Products Pipeline Co. L.P.	10.75”	Liquefied Petroleum Gas
Exxon Corp.	2.38”	Crude Oil
Buckeye Gulf Coast Pipelines, L.P.	8.63”	Ethylene
Equistar Chemicals, L.P.	6.63”	Butane
Buckeye Gulf Coast Pipelines, L.P.	6.63”	Propylene
Mustang Pipeline Company	6.63”	Propylene
Trunkline Gas Company, LLC	24.00”	Natural Gas
Transcontinental Gas Pipeline Corp.	30.00”	Natural Gas
Chevron Pipeline Company	8.63”	Refined Products
BP Pipelines (North America), Inc.	4.50”	Empty
Dow Pipeline Company	8.63”	Liquefied Petroleum Gas
Phillips Pipeline Company	8.63”	EP Mix/Propane
Seadrift Pipeline Corporation	12.75”	Ethane
Texas Genco, L.P.	24.00”	Natural Gas
Teppco	12.75”	Crude Oil
Phoenix Hydrocarbons Operating	4.50”	Natural Gas

Source: RRC, 2012

3.2 COMMUNITY RESOURCES

3.2.1 Social and Economic Conditions

This section discusses the social and economic conditions within the study area, focusing on population, demographic, employment, and income characteristics. Socioeconomic information was collected from the United States (U.S.) Census Bureau *2010 Census* for census blocks (CB) and census block groups (BG) that comprise the study area. If *2010 Census* data was not available, either the *2007-2011 American Community Survey* (ACS) or the *2006-2010 ACS* data was used, depending on the availability of data. It should be noted that ACS data are estimates, not actual counts. The availability of census data for median household income and Limited English Proficiency (LEP) is limited to the BG level; therefore, only race/ethnicity data are presented at both the CB and BG level.

Municipal Characteristics

The following profiles describe the existing demographic make-up of the six municipalities located within the study area, as well as general business trends and current major planned development. The community of New Caney is not included in the following profiles because it is unincorporated. However, New Caney is discussed in the following sections and community impacts are described. The (limited) data described throughout this discussion represents the best available data for the study area.

City of Dayton

According to the U.S. Census Bureau's *2010 Census*, the City of Dayton has a total population of 7,242 and a median household income of $50,625. The city encompasses approximately 11.4 square miles (mi^2). The City of Dayton is located on the very eastern edge of the central portion of the study area. Located roughly midway between Houston and Beaumont, Dayton is located at the key intersection of four important highways including US 90, SH 146, SH 321, and FM 1960. The City of Dayton is also served by an extensive freight rail transportation system, with Union Pacific Rail Road (UPRR) and Burlington Northern/Santa Fe Railroad (BNSF) operating facilities in the area.

City of Mont Belvieu

The City of Mont Belvieu has a total population of 3,835 and a median household income of $67,714, according to the *2010 Census*. The city encompasses approximately 14.5 mi^2, and is located at the southern end of the study area near I-10 (E). Located on a salt dome in Chambers County, the city's economy is deeply tied to the petroleum industry, and the salt dome storage of petroleum products. Due to

its proximity and its location at the junction of I-10 (E) and SH 146, the city is also closely tied to the Houston-Baytown area. Mont Belvieu is home to the Eagle Pointe Golf Club and Recreation Complex, one of the premier golf and recreation facilities in the Houston area.

City of Patton Village

The City of Patton Village has a total population of 1,557 and a median household income of $33,500, according to the *2010 Census*. The city encompasses approximately 2 mi^2 on the eastern side of Montgomery County. The City of Patton Village is located in the extreme northwestern corner of the study area by US 59 (N)/I-69.

City of Plum Grove

The City of Plum Grove has a total population of 600 and a median household income of $39,464, according to the *2010 Census*. The city encompasses approximately 7.3 mi^2 on the western edge of Liberty County. The City of Plum Grove is located on the far northern edge of the study area.

City of Woodbranch

The City of Woodbranch has a total population of 1,282 and a median household income of $68,750, according to the *2010 Census*. The city encompasses approximately 2 mi^2 on the eastern side of Montgomery County. The City of Woodbranch is located in the northwest corner of the study area on US 59 (N)/I-69.

City of Roman Forest

The City of Roman Forest has a total population of 1,538 and a median household income of $88,125, according to the *2010 Census*. The city encompasses approximately 1.5 mi^2 in eastern Montgomery County. The City of Roman Forest is located in the northwest corner of the study area.

Community of Huffman

The community of Huffman is an unincorporated community with a total population of 4,797 and a median household income of approximately $80,090 according to the *2010 Census*. The community of Huffman encompassed approximately 54 mi^2 in northeastern Harris County. The community of Huffman is located in the western edge of the study area near FM 2100 and FM 1960. The community of Huffman consists largely of established subdivisions, scattered farms, apartments, and small business.

Population and Demographic Characteristics

The study area includes, 1,804 CBs, of which 918 contain resident populations, 56 BGs, and 25 Census Tracts (CT). BGs either partially or wholly contained within the study area are included in this analysis and are shown on **Exhibit 3-2.** The proposed project falls within the Houston MSA, which is defined as the 10 counties of Austin, Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, San Jacinto, and Waller. The study area is located east of the City of Houston and within four counties – Montgomery, Harris, Liberty, and Chambers counties. Twenty-five CTs are all or partially located within the study area. The study area boundary for social and economic conditions was determined by examining the CTs that are all or partially located within the project limits outlined in **Exhibit 1-2**. These CTs are identified in **Exhibit 3-2**.

For statistical purposes, the BGs are used to describe the social and economic characteristics of the study area. BGs provide the appropriate level of detail for an area that is sufficiently small to characterize the area of impact. Population data at the BG level for the year 2010 from the U.S. Census Bureau has been used in this socioeconomic analysis. County data from the *2010 Census* is used throughout the population and employment projection analysis.

A more detailed profile of the study area reveals a total population of 126,709 spanning across 56 BGs. Overall, minorities account for 30 percent of the study area population. Five of the BGs in the study area have a minority population percentage greater than 50 percent (**Exhibit 3-2**). The term minority is defined by FHWA as a person who is Black, Hispanic, Asian American, American Indian/Alaskan Native, or Pacific Islander. The two largest minority groups of the study area include Hispanics (21 percent) and Blacks (6 percent). Additionally, the minority groups American Indian and Alaska Native alone; Asian alone; Native Hawaiian and Other Pacific Islander alone; Some Other Race alone; and Two or More Races make up 3 percent of the study area population. The federal government considers race and Hispanic origin to be two separate and distinct concepts. The *2010 Census* uses the Office of Management and Budget definition of Hispanic or Latino to be "a person of Cuban, Mexican, Puerto Rican, South or Central American, or other Spanish culture or origin regardless of race."

Table 3-3 contains the percent minority population for each BG within the study area. The total minority population for the study area at the BG level is 30 percent.

Table 3-3: Racial and Ethnic Composition of Population - 2010

2010 Census Geography	Total Population	Not Hispanic or Latino														Hispanic or Latino of Any Race		Total Minority	
		White		Black*		Indian*		Asian		Islander*		Other*		Two*					
		#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
Place																			
City of Dayton	7,242	4,587	63.3	1,309	18.1	21	0.3	87	1.2	2	0	8	0.1	118	1.6	1,110	15.3	2,655	36.7
City of Mont Belvieu	3,835	3,153	82.2	101	2.6	30	0.8	22	0.6	5	0.1	0	-	46	1.2	478	12.5	682	17.8
City of Patton Village	1,557	1,171	75.2	14	0.9	14	0.9	7	0.4	1	0.1	4	0.3	23	1.5	323	20.7	386	24.8
City of Plum Grove	600	520	86.7	2	0.3	1	0.2	0	-	0	-	0	-	3	0.5	74	12.3	80	13.3
City of Roman Forest	1,538	1,314	85.4	19	1.2	6	0.4	29	1.9	0	-	0	-	12	0.8	158	10.3	224	14.6
City of Woodbranch	1,282	1,121	87.4	16	1.2	6	0.5	4	0.3	1	0.1	0	-	31	2.4	103	8	161	12.6
Study Area																			
CT 2509.00	**8,569**	**7,459**	**87**	**181**	**2.1**	**24**	**0.3**	**205**	**2.4**	**2**	**-**	**21**	**0.2**	**81**	**0.9**	**596**	**7**	**1,110**	**13.0**
BG 3	1,151	995	86.4	12	1	3	0.3	40	3.5	0	-	0	-	13	1.1	88	7.6	156	13.6
CT 2515.01	**4,807**	**3,652**	**76**	**128**	**2.7**	**19**	**0.4**	**351**	**7.3**	**4**	**0.1**	**5**	**0.1**	**88**	**1.8**	**560**	**11.6**	**1,155**	**24.0**
BG 1	4,807	3,652	76	128	2.7	19	0.4	351	7.3	4	0.1	5	0.1	88	1.8	560	11.6	1,155	24.0
CT 2516.00	**5,750**	**4,872**	**84.7**	**144**	**2.5**	**37**	**0.6**	**34**	**0.6**	**1**	**-**	**8**	**0.1**	**59**	**1**	**595**	**10.3**	**878**	**15.3**
BG 1	1,695	1,433	84.5	14	0.8	10	0.6	11	0.6	0	-	0	-	32	1.9	195	11.5	262	15.5
BG 2	4,055	3,439	84.8	130	3.2	27	0.7	23	0.6	1	-	8	0.2	27	0.7	400	9.9	616	15.2
CT 2517.00	**8,069**	**6,494**	**80.5**	**222**	**2.8**	**33**	**0.4**	**83**	**1**	**5**	**0.1**	**17**	**0.2**	**76**	**0.9**	**1,139**	**14.1**	**1,575**	**19.5**
BG 1	1,583	1,286	81.2	50	3.2	4	0.3	29	1.8	1	0.1	1	0.1	21	1.3	191	12.1	297	18.8
BG 2	3,214	2,619	81.5	43	1.3	11	0.3	36	1.1	2	0.1	0	-	35	1.1	468	14.6	595	18.5
BG 3	1,211	1,031	85.1	9	0.7	7	0.6	3	0.2	1	0.1	0	-	5	0.4	155	12.8	180	14.9
BG 4	2,061	1,558	75.6	120	5.8	11	0.5	15	0.7	1	-	16	0.8	15	0.7	325	15.8	503	24.4
CT 2518.00	**1,847**	**1,450**	**78.5**	**40**	**2.2**	**2**	**0.1**	**5**	**0.3**	**0**	**-**	**3**	**0.2**	**15**	**0.8**	**332**	**18**	**397**	**21.5**
BG 1	1,847	1,450	78.5	40	2.2	2	0.1	5	0.3	0	-	3	0.2	15	0.8	332	18	397	21.5
CT 2519.01	**9,353**	**7,237**	**77.4**	**478**	**5.1**	**45**	**0.5**	**39**	**0.4**	**1**	**-**	**17**	**0.2**	**144**	**1.5**	**1,392**	**14.9**	**2,116**	**22.6**
BG 2	759	598	78.8	5	0.7	6	0.8	9	1.2	0	-	3	0.4	6	0.8	132	17.4	161	21.2
BG 4	2,914	2,382	81.7	47	1.6	8	0.3	6	0.2	0	-	3	0.1	40	1.4	428	14.7	532	18.3

Table 3-3: Racial and Ethnic Composition of Population - 2010

2010 Census Geography	Total Population	Not Hispanic or Latino														Hispanic or Latino of Any Race		Total Minority	
		White		Black*		Indian*		Asian		Islander*		Other*		Two*					
		#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
CT 2527.00	**4,163**	**2,684**	**64.5**	**244**	**5.9**	**6**	**0.1**	**18**	**0.4**	**4**	**0.1**	**4**	**0.1**	**50**	**1.2**	**1,153**	**27.7**	**1,479**	**35.5**
BG 1	1,425	904	63.4	162	11.4	2	0.1	9	0.6	0	-	2	0.1	28	2	318	22.3	521	36.6
BG 2	1,704	957	56.2	44	2.6	4	0.2	7	0.4	4	0.2	0	-	17	1	671	39.4	747	43.8
BG 3	1,034	823	79.6	38	3.7	0	-	2	0.2	0	-	2	0.2	5	0.5	164	15.9	211	20.4
CT 2528.00	**5,882**	**1,748**	**29.7**	**2,623**	**44.6**	**9**	**0.2**	**12**	**0.2**	**0**	**-**	**6**	**0.1**	**60**	**1**	**1,424**	**24.2**	**4,134**	**70.3**
BG 2	2,048	1,122	54.8	122	6	0	-	6	0.3	0	-	0	-	18	0.9	780	38.1	926	45.2
CT 2531.00	**8,439**	**2,962**	**35.1**	**1,592**	**18.9**	**13**	**0.2**	**348**	**4.1**	**2**	**-**	**20**	**0.2**	**126**	**1.5**	**3,376**	**40**	**5,477**	**64.9**
BG 1	4,690	1,745	37.2	804	17.1	9	0.2	213	4.5	1	-	14	0.3	60	1.3	1,844	39.3	2,945	62.8
CT 2532.00	**9,429**	**5,141**	**54.5**	**1,355**	**14.4**	**51**	**0.5**	**99**	**1**	**3**	**-**	**15**	**0.2**	**88**	**0.9**	**2,677**	**28.4**	**4,288**	**45.5**
BG 2	2,595	1,108	42.7	593	22.9	11	0.4	47	1.8	0	-	5	0.2	28	1.1	803	30.9	1,487	57.3
BG 3	1,273	829	65.1	162	12.7	7	0.5	3	0.2	0	-	0	-	11	0.9	261	20.5	444	34.9
CT 6923.00	**15,803**	**9,014**	**57**	**764**	**4.8**	**95**	**0.6**	**350**	**2.2**	**19**	**0.1**	**33**	**0.2**	**161**	**1**	**5,367**	**34**	**6,789**	**43.0**
BG 5	5,320	3,502	65.8	251	4.7	14	0.3	158	3	11	0.2	8	0.2	54	1	1,322	24.8	1,818	34.2
CT 6924.00	**8,609**	**5,861**	**68.1**	**465**	**5.4**	**45**	**0.5**	**335**	**3.9**	**11**	**0.1**	**10**	**0.1**	**159**	**1.8**	**1,723**	**20**	**2,748**	**31.9**
BG 1	2,099	1,409	67.1	40	1.9	14	0.7	4	0.2	0	-	0	0	39	1.9	593	28.3	690	32.9
BG 2	1,353	1,075	79.5	7	0.5	8	0.6	5	0.4	3	0.2	0	-	22	1.6	233	17.2	278	20.5
CT 6925.00	**8,331**	**6,017**	**72.2**	**192**	**2.3**	**38**	**0.5**	**29**	**0.3**	**4**	**-**	**5**	**0.1**	**95**	**1.1**	**1,951**	**23.4**	**2,314**	**27.8**
BG 1	1,195	986	82.5	39	3.3	7	0.6	2	0.2	1	0.1	0	-	12	1	148	12.4	209	17.5
BG 2	1,756	1,302	74.1	55	3.1	4	0.2	10	0.6	0	-	0	-	28	1.6	357	20.3	454	25.9
BG 3	1,794	1,271	70.8	24	1.3	10	0.6	2	0.1	1	0.1	0	-	15	0.8	471	26.3	523	29.2
BG 4	3,586	2,458	68.5	74	2.1	17	0.5	15	0.4	2	0.1	5	0.1	40	1.1	975	27.2	1,128	31.5
CT 6926.02	**10,150**	**6,389**	**62.9**	**216**	**2.1**	**35**	**0.3**	**68**	**0.7**	**1**	**-**	**5**	**-**	**129**	**1.3**	**3,307**	**32.6**	**3,761**	**37.1**
BG 2	5,107	3,345	65.5	143	2.8	11	0.2	55	1.1	0	-	5	0.1	72	1.4	1,476	28.9	1,762	34.5
BG 3	2011	1181	58.7	49	2.4	19	0.9	4	0.2	0	-	0	-	27	1.3	731	36.4	830	41.3
CT 6927.00	**7,058**	**5,456**	**77.3**	**117**	**1.7**	**38**	**0.5**	**34**	**0.5**	**5**	**0.1**	**16**	**0.2**	**69**	**1**	**1,323**	**18.7**	**1,602**	**22.7**
BG 2	2,114	1,738	82.2	29	1.4	14	0.7	9	0.4	5	0.2	11	0.5	18	0.9	290	13.7	376	17.8
BG 3	2,587	1,966	76	71	2.7	11	0.4	16	0.6	0	-	5	0.2	31	1.2	487	18.8	621	24.0
CT 6928.01	**8,647**	**7,110**	**82.2**	**79**	**0.9**	**36**	**0.4**	**47**	**0.5**	**2**	**-**	**8**	**0.1**	**113**	**1.3**	**1,252**	**14.5**	**1,537**	**17.8**

Table 3-3: Racial and Ethnic Composition of Population - 2010

2010 Census Geography	Total Population	Not Hispanic or Latino														Hispanic or Latino of Any Race		Total Minority	
		White		Black*		Indian*		Asian		Islander*		Other*		Two*					
		#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
BG 1	2,344	2,041	87.1	24	1	7	0.3	27	1.2	2	0.1	0	-	49	2.1	194	8.3	303	12.9
BG 2	2,820	2,353	83.4	20	0.7	3	0.1	11	0.4	0	-	0	-	27	1	406	14.4	467	16.6
BG 4	1,798	1,366	76	15	0.8	15	0.8	7	0.4	0	-	7	0.4	22	1.2	366	20.4	432	24.0
CT 6928.02	**3,745**	**2,618**	**69.9**	**84**	**2.2**	**33**	**0.9**	**14**	**0.4**	**0**	**-**	**4**	**0.1**	**31**	**0.8**	**961**	**25.7**	**1,127**	**30.1**
BG 1	1,508	954	63.3	47	3.1	13	0.9	6	0.4	0	-	1	0.1	21	1.4	466	30.9	554	36.7
BG 2	1,282	879	68.6	27	2.1	12	0.9	2	0.2	0	-	3	0.2	10	0.8	349	27.2	403	31.4
BG 3	955	785	82.2	10	1	8	0.8	6	0.6	0	-	0	-	0	-	146	15.3	170	17.8
CT 7003.00	**9,514**	**6,390**	**67.2**	**478**	**5**	**40**	**0.4**	**37**	**0.4**	**1**	**-**	**13**	**0.1**	**97**	**1**	**2,458**	**25.8**	**3,124**	**32.8**
BG 4	752	707	94	4	0.5	1	0.1	0	-	0	-	0	-	11	1.5	29	3.9	45	6.0
BG 5	2,257	1,342	59.5	18	0.8	9	0.4	0	-	0	-	3	0.1	15	0.7	870	38.5	915	40.5
CT 7004.00	**6,334**	**5,953**	**94**	**31**	**0.5**	**11**	**0.2**	**8**	**0.1**	**0**	**-**	**3**	**-**	**47**	**0.7**	**281**	**4.4**	**381**	**6.0**
BG 2	1,502	1,358	90.4	11	0.7	1	0.1	2	0.1	0	-	3	0.2	5	0.3	122	8.1	144	9.6
CT 7008.00	**8,892**	**7,047**	**79.3**	**664**	**7.5**	**49**	**0.6**	**65**	**0.7**	**4**	**-**	**5**	**0.1**	**96**	**1.1**	**962**	**10.8**	**1,845**	**20.7**
BG 1	1,858	1,716	92.4	13	0.7	4	0.2	22	1.2	1	0.1	0	-	9	0.5	93	5	142	7.6
BG 2	2,688	1,717	63.9	530	19.7	7	0.3	30	1.1	0	-	1	-	40	1.5	363	13.5	971	36.1
BG 3	829	611	73.7	52	6.3	4	0.5	7	0.8	1	0.1	4	0.5	16	1.9	134	16.2	218	26.3
BG 4	1,429	1,261	88.2	32	2.2	23	1.6	3	0.2	1	0.1	0	-	8	0.6	101	7.1	168	11.8
BG 5	2,088	1,742	83.4	37	1.8	11	0.5	3	0.1	1	-	0	-	23	1.1	271	13	346	16.6
CT 7009.00	**6,059**	**2,948**	**48.7**	**1,534**	**25.3**	**13**	**0.2**	**19**	**0.3**	**0**	**-**	**17**	**0.3**	**45**	**0.7**	**1,483**	**24.5**	**3,111**	**51.3**
BG 1	765	509	66.5	49	6.4	2	0.3	0	0	0	-	2	0.3	20	2.6	183	23.9	256	33.5
BG 2	1,303	918	70.5	178	13.7	7	0.5	7	0.5	0	-	2	0.2	18	1.4	173	13.3	385	29.5
BG 3	3,991	1,521	38.1	1,307	32.7	4	0.1	12	0.3	0	-	13	0.3	7	0.2	1,127	28.2	2,470	61.9
CT 7010.00	**6,216**	**3,044**	**49**	**518**	**8.3**	**26**	**0.4**	**30**	**0.5**	**2**	**-**	**2**	**-**	**67**	**1.1**	**2,527**	**40.7**	**3,172**	**51.0**
BG 1	2,913	1,604	55.1	122	4.2	17	0.6	9	0.3	0	-	0	-	23	0.8	1,138	39.1	1,309	44.9
BG 2	810	368	45.4	280	34.6	2	0.2	15	1.9	0	-	1	0.1	21	2.6	123	15.2	442	54.6
BG 3	2,493	1,072	43	116	4.7	7	0.3	6	0.2	2	0.1	1	-	23	0.9	1,266	50.8	1,421	57.0
CT 7011	**6,954**	**5,595**	**80.5**	**400**	**5.8**	**43**	**0.6**	**19**	**0.3**	**10**	**0.1**	**5**	**0.1**	**114**	**1.6**	**768**	**11**	**1,359**	**19.5**
BG 2	2,698	2,305	85.4	55	2	12	0.4	3	0.1	7	0.3	1	-	41	1.5	274	10.2	393	14.6

Table 3-3: Racial and Ethnic Composition of Population - 2010

2010 Census Geography	Total Population	Not Hispanic or Latino														Hispanic or Latino of Any Race		Total Minority	
		White		Black*		Indian*		Asian		Islander*		Other*		Two*					
		#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
BG 3	874	655	74.9	39	4.5	3	0.3	5	0.6	1	0.1	1	0.1	15	1.7	155	17.7	219	25.1
CT 7101	**6,502**	**5,496**	**84.5**	**208**	**3.2**	**34**	**0.5**	**26**	**0.4**	**5**	**0.1**	**0**	**-**	**77**	**1.2**	**656**	**10.1**	**1,006**	**15.5**
BG 1	2,830	2,194	77.5	147	5.2	11	0.4	19	0.7	5	0.2	0	-	55	1.9	399	14.1	636	22.5
BG 2	1,740	1,570	90.2	11	0.6	19	1.1	3	0.2	0	-	0	-	8	0.5	129	7.4	170	9.8
CT 7102	**15,543**	**11,025**	**70.9**	**1,039**	**6.7**	**46**	**0.3**	**176**	**1.1**	**6**	**-**	**16**	**0.1**	**159**	**1**	**3,076**	**19.8**	**4,518**	**29.1**
BG 2	4,944	2,519	51	558	11.3	22	0.4	92	1.9	0	-	8	0.2	62	1.3	1,683	34	2,425	49.0
BG 3	5,276	4,289	81.3	165	3.1	12	0.2	45	0.9	0	-	3	0.1	47	0.9	715	13.6	987	18.7
BG 5	2,971	2,240	75.4	179	6	8	0.3	26	0.9	0	-	5	0.2	30	1	483	16.3	731	24.6

* The complete Census race descriptions are as follows: White alone; Black or African American alone; American Indian and Alaska Native alone; Asian alone; Native Hawaiian and Other Pacific Islander alone; Some Other Race alone; and Two or More Races

Source: 2010 Census Summary File 1—Texas [machine-readable data files]/prepared by the U.S. Census Bureau, 2011. Table P9

3.2.1.1 Environmental Justice

Executive Order (EO) 12898 *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations* requires each federal agency to "make achieving Environmental Justice (EJ) part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies and activities on minority populations and low-income populations". The FHWA has identified three fundamental principles of environmental justice:

- To avoid, minimize, or mitigate disproportionately high and adverse human health or environmental effects, including social and economic effects, on minority populations and low-income populations;
    - To ensure the full and fair participation by all potentially affected communities in the transportation decision-making process; and
    - To prevent the denial of, reduction in, or significant delay in the receipt of benefits by minority populations and low-income populations.

Disproportionately high and adverse human health or environmental effects are defined by FHWA as adverse effects that:

- Are predominately borne by a minority population and/or a low-income population; or
- Will be suffered by the minority population and/or low-income population and are appreciably more severe or greater in magnitude than the adverse effects that will be suffered by the nonminority population and/or non-low-income populations.

Minority means a person who is:

- Black (having origins from any of the black racial groups of Africa);
- Hispanic/Latino (of Mexican, Puerto Rican, Cuban, Central or South American, or other Spanish culture or origin, regardless of race);
- Asian-American (having origins from any place of the original peoples of the Far East, Southeast Asia, the Indian Subcontinent, or the Pacific Islands); or
- American Indian and Alaskan Native (having origins from any of the original people of North America and now maintains cultural identification through tribal affiliation or community recognition).

Minority Population means any readily identifiable group of minority persons who live in geographic proximity, and, if circumstances warrant, geographically dispersed/transient persons (such as migrant workers or Native Americans) who will be similarly affected by a proposed program, policy, or activity. Minority populations were identified based on the federal Council on Environmental Quality's (CEQ's)

guidance document *Environmental Justice*: *Guidance Under the National Environmental Policy Act* (CEQ 1997). Based on this guidance:

"Minority populations should be identified where either: (a) the minority population of the affected area exceeds 50 percent or (b) the minority population percentage of the affected area is meaningfully greater than the minority population percentage in the general population or other appropriate unit of geographic analysis…"

Low-Income means a household income for a family of four at or below the Department of Health and Human Services (HHS) poverty guidelines (i.e. $23,550 in 2013) for a family of four.

Low-Income Population means any readily identifiable group of low-income persons who live in geographic proximity, and, if circumstances warrant, geographically dispersed/transient persons (such as migrant workers or Native Americans) who would be similarly affected by a proposed FHWA program, policy or activity.

Unlike the CEQ guidance (1997) on minority population, no EJ order or guidance document contains a quantitative definition of how many low-income individuals constitute low-income populations. In the absence of guidance for the analysis, one of the measures used to identify low-income populations was the median household income for the inclusive CT and/or BGs.

The primary source of demographic data was the *2010 Census* and the *2006-2010 ACS* because it is the most comprehensive, complete and detailed data source currently available. Five of the study area BGs show minority populations above 50 percent (refer to **Table 3-3**). None of the 56 BGs have a household median income below that of the HHS 2013 poverty guidelines (refer to **Table 3-8**). Percentages of minority populations in CBs containing resident populations within the study area are provided in **Appendix E**. 164 of the 918 CBs containing resident populations in the study area reflect racial or ethnic minority percentages greater than 50 percent.

Origin-Destination Analysis

Origin-destination (O&D) data secured from H-GAC may be used for further analysis of "user impacts" of the Grand Parkway Segments H and I-1 on low-income and minority populations. Studying O&D data can

determine travel patterns of traffic along a transportation facility during a typical day. Trips are defined as a one-way movement from where a person starts (origin) to where the person is going (destination).

The O&D data presented in **Chapter 4 (Environmental Consequences)** is normalized for BGs using Traffic Analysis Zones (TAZ). TAZs are small geographic units of area that are developed as a basis for estimate of travel. TAZs may vary in size, are determined by the roadway network and homogeneity of development, and directly reflect demographic data generated by the U.S. Census Bureau. Delineated by state and/or transportation officials for tabulating traffic-related data, TAZs usually consist of one or more CBs, BGs, or CTs.

3.2.1.2 Limited English Proficiency (LEP)

EO 13166, "*Improving Access to Services for Persons with Limited English Proficiency,*" requires agencies to examine the services they provide, identify the need for services, and develop and implement a system to provide those services so that LEP persons can have meaningful access to them.

An analysis was conducted to identify residents in the study area that may have LEP. The analysis was conducted at the BG level, the smallest geographic area for which LEP data is provided by the U.S. Census Bureau. The results are presented in **Table 3-4**.

LEP persons were identified within the BGs throughout the study area. According to the *2006-2010 ACS* data, Spanish is the predominate language spoken by residents within the study area who speak English "less than well," "not well," or "not at all." This data indicates that 2.7 percent of the population (5 years and older) within the study area BGs speak English "less than well," "not well," or "not at all". **Table 3-4** contains the percent LEP population for each CT and BG in the study area. **Exhibit 4-3** shows the locations of the LEP BGs. Thirty-six of the BGs contain a LEP population. These BGs are scattered throughout the study area, but are mostly concentrated in the center of the study area. Both CT 2527.00-BG 2 and CT 7010.00-BG 3 report a higher than average percent (17.6 percent for both) LEP population than the other BGs in the study area. In a windshield survey along the proposed study area, English and Spanish were observed on billboards and signs.

Table 3-4: Percentage LEP Population - 2010

Census 2010 Geography	Population 5 years & over	Total Number Who Speak English "Less than Well," "Not Well," or "Not at All""	% LEP
CT 2509.00	**14,055**	**232**	**1.7**
BG 3	1,357	0	-
CT 2515.01	**4,758**	**59**	**1.2**
BG 1	4,758	59	1.2
CT 2516.00	**4,912**	**57**	**1.2**
BG 1	1,294	21	1.6
BG 2	3,618	36	1.0
CT 2517.00	**7,473**	**26**	**0.3**
BG 1	1,827	0	-
BG 2	2,846	11	0.4
BG 3	1,226	15	1.2
BG 4	1,574	0	-
CT 2518.00	**1,672**	**31**	**1.9**
BG 1	1,672	31	1.9
CT 2519.01	**7,961**	**48**	**0.6**
BG 2	537	12	2.2
BG 4	2,438	0	-
CT 2527.00	**3,474**	**303**	**8.7**
BG 1	802	0	-
BG 2	1,719	303	17.6
BG 3	953	0	-
CT 2528.00	**4,260**	**198**	**4.6**
BG 2	1,690	137	8.1
CT 2531.00	**6,196**	**158**	**2.6**
BG 1	3,401	68	2.0
CT 2532.00	**7,676**	**532**	**6.9**
BG 2	1,943	131	6.7
BG 3	1,368	0	-
CT 6923.00	**13,869**	**1099**	**7.9**
BG 5	4,652	260	5.6
CT 6924.00	**7,232**	**219**	**3.0**
BG 1	1,871	128	6.8
BG 2	1,201	67	5.6
CT 6925.00	**6,955**	**21**	**0.3**
BG 1	1,506	0	-
BG 2	1,122	0	-
BG 3	1,269	0	-
BG 4	3,058	21	0.7

Table 3-4: Percentage LEP Population - 2010

Census 2010 Geography	Population 5 years & over	Total Number Who Speak English "Less than Well," "Not Well," or "Not at All""	% LEP
CT 6926.02	**8,142**	**454**	**5.6**
BG 2	4,477	250	5.6
BG 3	1,266	12	0.9
CT 6927.00	**6,973**	**43**	**0.6**
BG 2	2,144	0	-
BG 3	1,786	0	-
CT 6928.01	**7,136**	**138**	**1.9**
BG 1	2,239	18	0.8
BG 2	2,268	82	3.6
BG 4	1,219	21	1.7
CT 6928.02	**3,448**	**103**	**3.0**
BG 1	1,792	103	5.7
BG 2	758	0	-
BG 3	898	0	-
CT 7003.00	**8,860**	**689**	**7.8**
BG 4	652	0	-
BG 5	1,528	93	6.1
CT 7004.00	**5,433**	**0**	**-**
BG 2	1,684	0	-
CT 7008.00	**8,319**	**136**	**1.6**
BG 1	1,846	6	0.3
BG 2	1,840	36	2.0
BG 3	435	0	-
BG 4	1,542	0	-
BG 5	2,656	94	3.5
CT 7009.00	**6,141**	**86**	**1.4**
BG 1	449	36	8.0
BG 2	968	0	-
BG 3	4,724	50	1.1
CT 7010.00	**5,127**	**514**	**10.0**
BG 1	2,975	227	7.6
BG 2	627	18	2.9
BG 3	1,525	269	17.6
CT 7011.00	**5,890**	**106**	**1.8**
BG 2	3,164	77	2.4
BG 3	566	20	3.5
CT 7101.00	**6,320**	**42**	**0.7**
BG 1	2,250	4	0.2

Table 3-4: Percentage LEP Population - 2010

Census 2010 Geography	Population 5 years & over	Total Number Who Speak English "Less than Well," "Not Well," or "Not at All""	% LEP
BG 2	1,641	31	1.9
CT 7102.00	**14,055**	**232**	**1.7**
BG 2	4,633	202	4.4
BG 3	4,542	13	0.3
BG 5	26,70	0	-

Source: U.S. Census Bureau, 2006-2010 American Community Survey
ACS data are estimates; they are not counts

3.2.1.3 Community Cohesion

Using FHWA definitions as guidelines, community cohesion is defined as patterns of behavior that individuals or groups of individuals hold in common. Residential subdivisions may develop a sense of community cohesion through social interaction or participation in neighborhood organizations. For instance, if a local church or school provides a location where residents of the neighborhood or community can assemble and associate with one another, or a neighborhood association or neighborhood watch program is in place to serve the community and satisfy the residents' economic and social needs, then some sense of cohesion likely exists. Cohesion may also be based on common characteristics of interest shared by the members of the community, such a religion, ethnicity, or income level (FHWA 1996).

The northern portion of the study area contains developing communities, such as Roman Forest, Kings Colony, and Woodbranch. Roman Forest and Woodbranch are established communities that are experiencing new development. Kings Colony has been platted but is still in the early development stage. Some of these communities are densely populated, while others are in the early stages of development with only street infrastructure in place. Some large areas have been cleared in preparation of development. Other scattered areas consist of low-lying floodplain areas. Along US 59 (N)/I-69, the study area appears mostly developed with residential areas and commercial strip centers. Some undeveloped forested areas are present north of FM 1485, as well as floodplains and wetlands in and around Caney Creek and Peach Creek in the vicinity of Patton Village. Residences and businesses become increasingly sparse along FM 1485 as you travel further from US 59 (N)/I-69. The Lake Houston Wilderness Park is along the south side and adjacent to FM 1485; however, there is no entrance to the park along FM 1485. The entrance to Lake Houston Wilderness Park is off Baptist Encampment Road on the west side of the park, south of FM 1485.

The Baptist Encampment subdivision consists of a group of individuals on a large lot subdivision west of the park that are commonly associated with the Peach Creek Baptist Church. The central portion of the study area east of the Lake Houston Wilderness Park and south along FM 2100 is also forested; however, there is evidence of future development including subdivision construction and commercial strip development.

A majority of the central portion of the study area consists of wide open spaces that are maintained as farms and pastures. The topography is very level through most of the center of the study area with the exception of a salt dome near FM 686. Crops include rice, sorghum, soybeans, and hay. Railroad lines exist along FM 1960 and US 90 and are utilized daily in and out of Houston. The City of Dayton is within this area along the eastern edge of the study area and contains many old homes and buildings and a central business area. Several rail lines converge within the City of Dayton near the central area, and an old rice industrial complex is present. An area of oil and gas activity is also present in the vicinity of the Dayton landfill. Located on the western edge of the central portion of the study area is the unincorporated community of Huffman. Huffman is a small established community with a large agricultural community.

The southern portion of the study area is characterized by heavy oil and gas industrial activities immediately north of the City of Mont Belvieu. The City of Mont Belvieu is positioned on a salt dome which can be seen as a raised landform. Surrounding the salt dome is a concentration of wells and supporting industrial facilities. Oil and gas wells, storage facilities, emission stacks, and processing plants are dense in Mont Belvieu. The residential communities of Cherry Point and Country Creek are located in the area as well as churches, businesses, and schools. The new location of the City of Mont Belvieu is physically separated from the industrial area (old Mont Belvieu) by a canal. Residents and visitors in the Mont Belvieu area view roadways that are at-grade rural facilities with limited traffic. Traffic does, however, consist of a high percentage of trucks due to the industry in the area.

Community Linkages and Interaction

Although each of the individual communities within the study area form their own unique cohesive units, a number of social, economic, educational, institutional, and cultural linkages exist among these communities. In most cases, these linkages are based on the location of community facilities and the areas they serve in relation to other surrounding communities.

Education

The study area is served by 10 school districts. Barbers Hill Independent School District (ISD) (serving the Mont Belvieu area), Cleveland ISD, Crosby ISD, Dayton ISD, Goose Creek Consolidated ISD, Huffman ISD, Humble ISD, New Caney ISD, Splendora ISD, and Tarkington ISD. New Caney ISD serves the urbanized portion of the study area between US 59 (N)/I-69 and FM 2100. Schools in the Huffman ISD are located on the western edge of the study area. Schools in the Dayton ISD and Barbers Hill ISD are located on the eastern edge of the study area. The remaining school districts' boundaries enter into the Segments H and I-1 study area and include Cleveland ISD, Crosby ISD, Goose Creek Consolidated ISD, Humble ISD, Splendora ISD, and Tarkington ISD. Refer to **Exhibit 3-3** for locations of school districts within the study area.

Activities associated with the study area ISDs schools, such as athletics, school clubs, fine arts, and other school-sponsored organizations and activities involve students from all over the Gulf Coast Region and often require students to travel to various locations within and outside the study area from many University Interscholastic League activities.

Commerce

Linkages between the study area and surrounding areas are apparent with regard to shopping opportunities for study area residents. Although there are several small local grocery options within the study area communities, to access larger grocery stores, such as Wal-Mart Super Center, Kroger, or HEB, residents must travel outside the study area to the surrounding communities. Additionally, the study area does not contain a large general merchandise store within its boundaries. For this type of shopping, residents from the study area would need to travel outside the study area.

Healthcare and Public Facilities

The closest full service hospital to the study area is Liberty Dayton Regional Medical Center, located just east of the study area in Liberty, Texas. Smaller public and private clinics serve the basic healthcare needs of the study area residents. Additionally, there are several urgent care facilities and full service hospitals located in surrounding areas of Kingwood and Conroe. The Harris County, Montgomery County, and Liberty County Health Department clinics are the only publicly-funded facilities devoted to healthcare in the study area that nearby communities can use for services. Services provided by the these facilities include,

but are not limited to, indigent healthcare services, as well as immunizations and services to children with special health care needs.

Other public facilities within the study area include, but are not limited to: local public libraries; County Tax Assessor Offices; County Rural Transportation Offices; County Courthouses; local Fire Departments; and Police Departments. These facilities serve both the study area and the surrounding areas and contribute to interaction between each of the communities within the study area. However, it should be noted that many of these public service offices have multiple locations (i.e. public libraries, public healthcare clinics, courthouses, etc.) outside the study area, so residents living outside the study area are not strictly bound to traveling to the study area to benefit from these resources.

3.2.1.4 Economic Conditions

The Houston MSA's economic assets are linked to petrochemical industries, area universities and colleges, and medical complexes. The study area is a very small portion of the Houston region in terms of population and economy. Its economic growth depends on economic activity at a broader regional scale. As the area grows and develops, the study area, which is primarily rural in character, would continue to diversify with an assortment of commercial and industrial enterprises. The data provided throughout the following sections is the best available data and reflects economic conditions at a regional or county level as smaller geographic areas of economic data are currently not available. General economic impacts of the proposed project are not discussed in **Chapter 4** (**Environmental Consequences**), but are discussed in **Chapter 5** (**Indirect Impacts**). The economic impact of tolling is discussed in **Chapter 4**.

Employment Characteristics

Education, health, professional management, and manufacturing services comprise the major sectors of the Houston MSA economy. The *2010 Census* indicated that 35.6 percent of the non-agricultural employees in the Houston MSA worked in management, business, science, and arts occupations. Sales and office occupations was the second largest category of occupations, employing 24.3 percent of the Houston MSA population in 2010, with the service occupations ranking third at 16.3 percent.

Residents within the four counties associated with the study area are predominantly employed by the management, business, science, arts, service, sales and office occupations. The agricultural industry, represented by farming/fishing/forestry occupations, employs a minimal percentage of the area population.

The importance of the four-county industry contributions to the Houston MSA economy is illustrated in **Table 3-5**.

Table 3-5: Number of Persons Employed by Occupation – 2010

Occupational Category	Chambers County		Harris County		Liberty County		Montgomery County		Statewide	
	#	%	#	%	#	%	#	%	#	%
Agriculture, forestry, fishing and hunting, and mining	613	4.1	51,017	2.7	1,441	4.9	8,571	4.2	325,101	2.9
Management, business, science, and arts occupations	4,633	31.2	62,648	33.2	6,839	23.4	74,390	36.8	3,751,544	33.7
Service occupations	1,868	21.6	313,520	16.6	4,793	16.4	28,695	14.2	1,877,988	16.9
Sales and office occupations	3,092	20.8	469,587	24.90	6,817	23.3	52,542	26.0	2,8541,95	25.7
Natural resources, construction, and maintenance occupations	2,782	18.7	231,686	12.3	5,611	19.2	23,306	11.5	1,291,496	11.6
Production, transportation, and material moving occupations	2,467	16.6	247,770	13.10	5,141	17.6	23,357	11.5	1,350,393	12.1

Source: U.S. Census Bureau, 2006-2010 American Community Survey
ACS data are estimates; they are not counts

The major employers located within the study area are listed in **Table 3-6**. The Texas Workforce Commission (TWC) provides regional labor market analysis data through the SOCRATES web-based application. Major employers provide services ranging from education to retail, with a fair amount dedicated to manufacturing and distribution.

Table 3-6: Major Employers in the Study Area - 2012

Employer	Location	No. of Local Employees
Montgomery County		
East Montgomery County Fair	New Caney	100-499
Gerlands 92 Food and Drug	New Caney	100-499
Harris County		
Huffman Lodge	Huffman	100-499
Triple B Construction Service	Huffman	100-499
Liberty County		
Criminal Justice Department	Dayton	100-499
Dayton High School	Dayton	100-499
Insteel Wire Products Co.	Dayton	100-499
Sam's Distribution Center	Dayton	100-499
Tanner Construction Co.	Dayton	100-499
Chambers County		
Enterprise Products	Mont Belvieu	100-499
Pol-Tex International	Mont Belvieu	100-499

Source: SOCRATES, TWC, 2012 http://socrates.cdr.state.tx.us/index.asp

The Career Development Resources (CDR) Unit of the TWC utilizes the CDR economic diversification index which measures the degree to which a county economy is diversified relative to the Texas economy. Concentrating employment in only one or two industrial sectors makes an area less diversified and more susceptible to widespread decline should a key sector suffer a substantial loss. A statistically diverse economy does not necessarily correlate with higher growth. The study area has an economic base which is of average diversity. The H-GAC lists the existing 2011 and projected 2035 total employment estimate shown in **Table 3-7**.

Table 3-7: 2011 - County Employment

Area	Employment		
	2011	2035	% Increase
Chambers County	9,000	13,000	44
Harris County	2,296,000	3,136,000	37
Liberty County	24,000	36,000	50
Montgomery County	133,000	239,000	80
Employment Total	**2,462,000**	**3,424,000**	**39**

Source: H-GAC, 2035 Forecast Data, 2012, http://www.h-gac.com/HGAC/home/Default.htm

Median Household Income

The 2013 (most recent data available) HHS poverty guidelines for a family of four persons is $23,550. A comparison of median household income and poverty status for the study area is shown in **Table 3-8**. Median household income of BGs comprising the study area ranged from $24,038 to $166,979 in 2011.

Table 3-8: Median Household Income and Poverty Status – 2011

Census 2010 Geography	Total Households	Median Household Income ($)	Persons Below Poverty Level*	
			#	%
CT 2509.00	**3,172**	**131,563**	**14**	**0.2**
BG 3	369	166,979	-	-
CT 2515.01	**1,410**	**118,235**	**278**	**5.5**
BG 1	1,410	118,235	-	-
CT 2516.00	**1,764**	**74,821**	**324**	**5.9**
BG 1	494	52,625	-	-
BG 2	1,270	87,045	-	-
CT 2517.00	**2,858**	**59,766**	**959**	**11.9**
BG 1	615	105,903	-	-
BG 2	1,105	54,276	-	-
BG 3	450	45,909	-	-
BG 4	688	78,269	-	-
CT 2518.00	**615**	**77,936**	**55**	**3.3**
BG 1	615	77,936	-	-
CT 2519.01	**2,973**	**62,286**	**636**	**7.4**
BG 2	186	55,214	-	-
BG 4	1,037	55,017	-	-
CT 2527.00	**1,440**	**56,884**	**781**	**18.4**
BG 1	438	35,789	-	-
BG 2	593	60,375	-	-
BG 3	409	90,063	-	-
CT 2528.00	**1,766**	**40,703**	**719**	**15.1**
BG 2	640	48,232	-	-
CT 2531.00	**2,408**	**78,040**	**329**	**4.1**
BG 1	1,366	79,779	-	-
CT 2532.00	**3,034**	**57,885**	**1,736**	**20.8**
BG 2	777	27,476	-	-
BG 3	536	67,722	-	-
CT 6923.00	**4,842**	**63,261**	**1,506**	**10.2**
BG 5	1,836	74,773	-	-
CT 6924.00	**3,567**	**45,177**	**1,204**	**15.5**
BG 1	705	46,051	-	-
BG 2	428	46,731	-	-
CT 6925.00	**2,754**	**42,683**	**1,177**	**14.8**
BG 1	448	41,667	-	-
BG 2	540	63,381	-	-

Table 3-8: Median Household Income and Poverty Status – 2011

Census 2010 Geography	Total Households	Median Household Income ($)	Persons Below Poverty Level*	
			#	%
BG 3	437	30,163	-	-
BG 4	1,329	50,625	-	-
CT 6926.02	**2,992**	**38,635**	**2,157**	**23.7**
BG 2	1,742	47,321	-	-
BG 3	490	29,531	-	-
CT 6927.00	**2,520**	**58,080**	**1,157**	**16.2**
BG 2	756	61,000	-	-
BG 3	812	58,553	-	-
CT 6928.01	**2,823**	**53,890**	**1,087**	**12.8**
BG 1	811	64,375	-	-
BG 2	941	43,843	-	-
BG 4	468	54,303	-	-
CT 6928.02	**1,176**	**60,878**	**335**	**9.9**
BG 1	604	53,056	-	-
BG 2	294	65,263	-	-
BG 3	278	88,269	-	-
CT 7003.00	**3,256**	**39,912**	**1,877**	**20.0**
BG 4	300	106,917	-	-
BG 5	599	51,023	-	-
CT 7004.00	**2,142**	**53,571**	**691**	**11.4**
BG 2	736	52,121	-	-
CT 7008.00	**3,134**	**50,476**	**1,199**	**13.1**
BG 1	560	80,769	-	-
BG 2	732	24,038	-	-
BG 3	235	56,488	-	-
BG 4	637	57,188	-	-
BG 5	970	43,200	-	-
CT 7009.00	**567**	**66,250**	**227**	**13.3**
BG 1	224	67,283	-	-
BG 2	335	63,304	-	-
BG 3	8	n/a	-	-
CT 7010.00	**1,877**	**51,473**	**1,359**	**22.7**
BG 1	951	68,072	-	-
BG 2	252	40,227	-	-
BG 3	674	35,395	-	-
CT 7011.00	**2,229**	**55,792**	**444**	**7.1**

Table 3-8: Median Household Income and Poverty Status – 2011

Census 2010 Geography	Total Households	Median Household Income ($)	Persons Below Poverty Level*	
			#	%
BG 2	984	54,375	-	-
BG 3	240	80,349	-	-
CT 7101.00	**2,279**	**75,120**	**780**	**11.2**
BG 1	794	76,229	-	-
BG 2	683	84,426	-	-
CT 7102.00	**5,127**	**86,674**	**1,131**	**7.0**
BG 2	1,518	71,848	-	-
BG 3	1,657	94,718	-	-
BG 5	1,019	88,083	-	-

Source: U.S. Census Bureau, 2007-2011 American Community Survey
*Population for whom poverty status has been determined
ACS data are estimates; they are not counts. Income data is provided in 2011 inflation adjusted dollars

All BGs in the study area exhibit median household incomes greater than the poverty threshold. The percentage of the total study area population with incomes below the poverty level is 12.1 percent. Availability of poverty data for the number of households below the poverty level is limited to the CT level, and is therefore only reported to that level in **Table 3-8**. As shown in the table, the percentage of study area persons living below poverty level per CT ranges from 0.2 to 23.7 percent.

3.2.2 Pedestrian and Bicyclists

Segments H and I-1 of the Grand Parkway would accommodate access to "Proposed Shared-Use Paths/Trails" as identified in H-GAC's Regional Bikeway Plan. These include a shared-use path/trail along FM 2100. All of the existing and proposed paths and trails within the project limits were used to define the study area boundary.

3.2.3 Visual and Aesthetic Qualities

Title 23 United States Code (U.S.C.), Section 109 (h) requires that visual effects be considered as a part of the EIS process. The visual character of an area includes landforms and topography, water features, parks, vegetation and man-made features such as statues, historic features and buildings, roadways, bridges, industries, businesses, and residences. Existing visual resources in the study area may be viewed both from the driver's perspective traveling through the study area as well as from the residents, workers and visitors whose view is of the roadway. The study area overall is heavily disturbed due to previous

development, farming, ranching, and industrial use. Existing roadways are unobtrusive because they are at-grade, and there are no existing elevated structures, with the exception of bridges slightly elevated over waterways and termini at interchanges with US 59 (N)/I-69 and I-10 (E). Most of the existing roadways are two-lane rural facilities within narrow rights-of-way (ROW). The following discussion characterizes the visual resources within the study area.

The study area near US 59 (N)/I-69 and FM 1485 is mostly developed with residential and commercial areas. Traveling east along FM 1485 from US 59 (N)/I-69 also lends a view of a forested area adjacent to a narrow rural roadway. Residences and businesses become increasingly sparse along FM 1485 as you travel further east from US 59 (N)/I-69. The Lake Houston Wilderness Park is located south and adjacent to FM 1485. FM 1485 crosses Caney Creek and Peach Creek, and the view from the roadway bridges overlooks well defined creek channels at both locations.

The central portion of the study area east of the Lake Houston Wilderness Park and south along FM 2100 is also forested; however, there is evidence of anticipated development including subdivision construction and commercial strip development. The FM 2100 roadway is narrow and the view is contained primarily to the roadway ROW and adjacent development in this area. The view along FM 1960 and US 90 traveling east-west consists of expansive vistas of open rural areas. Several rail lines converge within the City of Dayton near the central area and an old rice industrial complex is prominently seen. Traveling south from Dayton a large rail yard is visible to the west near SH 146. An area of oil and gas activity is also present in the vicinity of the Dayton landfill.

The southern portion of the study area is characterized by heavy oil and gas industrial activities. Immediately north of the City of Mont Belvieu the view is open across farms and pastures. The City of Mont Belvieu is positioned on a salt dome which can be seen as a raised landform. An extensive network of pipelines and industrial plants can be seen throughout the area from the roadway. A few residential communities are located in the area as well as churches, businesses, and schools. The new location of the City of Mont Belvieu is physically separated from the industrial area (old Mont Belvieu) by a canal. Residents and visitors in the Mont Belvieu area view roadways that are at-grade, rural facilities with limited traffic.

3.3 SOILS AND FARMLANDS

The study area for these resources includes the geology, soils, and farmlands mapped as outlined in **Exhibit 3-5** and **Exhibit 3-6**.

3.3.1 Physiographic Setting

There are seven physiographic provinces in Texas. Each physiographic province has characteristic geologic structure, rock and soil types, vegetation, and climate. The study area is located in the southeast part of Texas in the Coastal Prairies of Texas as shown in **Exhibit 3-4.** This consists of a nearly level topographic setting, bisected by many rivers, creeks, bayous, and floodplains. A portion of this region to the north is part of the Big Thicket National Preserve, a forested area with a wide variety of trees including pine, oak, ash, hickory, cypress, and walnut trees. The southern section contains Gulf prairies and marshes.

3.3.2 Geology

The study area from northwest to southeast is geologically characterized as the Lissie (Ql) and Beaumont (Qb) Formations, respectively, which were deposited during the Quaternary Period, less than two million years ago. Refer to **Exhibit 3-5** for the geological formations within the study area. Over 200 million years ago, dry climatic conditions resulted in evaporation of the sea, and salt was subsequently deposited over the area. Two salt domes, the Esperson Dome northwest of Dayton and the Barbers Hill Dome near Mont Belvieu, are prominent in the study area. Several oil fields are located throughout the study area, including the areas of Splendora, Dayton, and Mont Belvieu.

Caney Creek, Peach Creek, the East Fork of the San Jacinto River and the lower portion of the Lake Houston Wilderness Park are characterized on the Beaumont Sheet of the Geologic Atlas of Texas as the Deweyville Formation (Qd) and Alluvium (Qal). The Deweyville Formation consists of sand, silt, and clay with some gravel, and includes point bars, natural levees, stream channels, and backswamps slightly above the current floodplain. The Alluvium includes clay, silt, and sand with organic matter.

The northern portion of the Lake Houston Wilderness Park and the northern part of the study area are characterized as the Lissie Formation which consists of clay, silt, sand with gravel, pebbles, and calcareous and iron manganese concretions. The remainder of the study area to the east and south is made up of the Beaumont Formation. The portion of the study area south of US 90 is found on the Geologic Site Atlas, Houston Sheet. The Beaumont Formation is characterized by mostly clay, silt and sand, and includes

mainly stream channels, point bars, natural levees, backswamps, and some coastal marsh and mud-flat deposits.

3.3.3 Soils

The soil surveys of Montgomery County, Harris County, Liberty County, and Chambers County provide data applicable to the engineering principles as they pertain to the construction of a roadway (Natural Resources Conservation Service [NRCS] (NRCS, 1972; NRCS, 1976; NRCS, 1996; NRCS, 1976)).

The characteristics mentioned include the shrink-swell capacity of soils. The shrink-swell capacity is an indication of the volume change to be expected in the soil material as the moisture content changes. Shrinkage and swelling of soils causes damage to building foundations, roads, and other structures. All of the soils in the study area have a high shrink-swell potential and poor traffic supporting capacity, which poses engineering constraints.

3.3.3.1 Soil Associations in the Grand Parkway Segments H and I-1 Study Area

Dominant soil associations included in the study area are shown in **Exhibit 3-6**. Soil associations within Montgomery County include the Splendora-Boy-Segno association and the Sorter association. The Splendora-Boy-Segno association consists of deep, nearly level to gently sloping, somewhat poorly drained to well drained, loamy and sandy soils that have loamy lower layers. The Sorter association consists of deep, level, poorly drained soils that are loamy throughout.

Dominant soil associations included in the study area within Harris County include the Lake Charles-Bernard association, the Midland-Beaumont association, the Wockley-Gessner association, the Aldine-Ozan association, and the Segno-Hockley association. The Lake Charles-Bernard association consists of somewhat poorly drained, very slowly permeable, clayey and loamy soils. The Midland-Beaumont association consists of poorly drained, very slowly permeable, loamy and clayey soils. The Wockley-Gessner association consists of somewhat poorly drained and poorly drained, very slowly permeable soils. The Aldine-Ozan association consists of somewhat poorly drained and poorly drained, very slowly permeable and slowly permeable soils. The Segno-Hockley association consists of moderate well drained, moderately slowly permeable soils.

Dominant soil associations included in the study area within Liberty County include the Beaumont-Lake Charles association, Vamont-Woodville-Aldine association, and the Kirby-Waller-Sorter association. The Beaumont-Lake Charles association consists of nearly level to gently sloping, somewhat poorly drained and poorly drained, very slowly permeable, clayey soils. The Vamont-Woodville-Aldine association consists of nearly level to moderately sloping, somewhat poorly drained, very slowly permeable, clayey and loamy soils. The Kirby-Waller-Sorter association consists of nearly level, somewhat poorly drained and poorly drained, moderately permeable and slowly permeable, loamy soils.

Dominant soil associations included in the study area within Chambers County include the Beaumont-Morey-Lake Charles association, the Anahuac-Morey-Frost association, and the Vaiden-Acadia-Calhoun association. The study area is immediately adjacent to the Wallisville Reservoir, but not within the reservoir boundary. The Beaumont-Morey-Lake Charles association is level or nearly level, consists of acid to neutral, clayey and loamy soils, and contains standing water for long periods. The Anahuac-Morey-Frost association consists of acid loamy soils in nearly level areas with few natural drainageways. The Vaiden-Acadia-Calhoun association is in nearly level or depressional areas and contains acid, clayey and loamy soils. Water stands for long periods of time after heavy rains on Vaiden-Acadia-Calhoun association soils.

3.3.3.2 Mapped Soil Series

Eighty-six different soil types are found within the Grand Parkway Segments H and I-1 study area. **Exhibit 3-6** is a map of the soil types found in the study area, shown by mapping unit. **Tables 3-9** through **3-12** list the different soil types and corresponding county hydric soil status in the study area. Hydric soils are those that are saturated, flooded, or ponded long enough during the growing season to develop anaerobic conditions that favor the growth and regeneration of hydrophytic vegetation. Hydric soils that occur in areas having positive indicators of hydrophytic vegetation and wetland hydrology are wetland soils.

Table 3-9: Soil Types Located Within the Study Area: Montgomery County

Soil Type	Description	Hydric Status (NRCS, NTCHS)
Albany fine sand (Ab)	Occupies slightly convex ridges on stream terraces. Slopes are dominantly 0-3% but range up to 6%.	Non-hydric
Angie fine sand (An)	Occupies slightly convex ridges on stream terraces. Slopes are from 0- 2%.	Non-hydric
Bibb soils, frequently flooded (Bb)	Have slopes of less than 1% and occupy the floodplain of streams draining sandy and loamy soils.	Hydric
Blanton fine sand, 0 to 5% slopes (BIC)	This soil occupies convex slopes on ridge crests.	Non-hydric
Boy fine sand (Bo)	This level to gently sloping soil occupies convex areas. Slopes are dominantly 0-5% but in places range up to 7%.	Non-hydric
Bruno loamy fine sand (Br)	Occupies the natural levees next to the channel in the floodplain of streams. It has a plane to slightly convex slope of less than 1%.	Non-hydric
Crowley fine sandy loam (Cw)	Occupies terraces and broad upland interstream divides. Slopes are generally less than 1%, but range up to 2% and are plane to slightly concave.	Hydric
Eustics loamy fine sand (Eu)	Occupies both ridge crests and foot slopes. Slopes are mainly 0-5%, but range up to 7%, and are convex on ridge crests and concave foot slopes.	Non-hydric
Fuquay loamy fine sand, terrace (Ft)	This nearly level to slightly convex soil occupies low stream terraces and has slopes less than 1%.	Non-hydric
Fuquay loamy fine sand (Fs)	This soil has mainly slightly convex slopes of 0-3%, but some slopes range to 5%.	Non-hydric
Garner clay (Ga)	This soil level is slightly convex. Slopes are dominantly between 0.5 and 1.5% but range up to 3%.	Non-hydric
Lucy loamy fine sand (Lu)	This nearly level to gently sloping soil has convex slopes that are mainly 0.5-3%, but some slopes range up to 8% on the narrow breaks to the bottom lands.	Non-hydric
Segno fine sandy loam (Se)	Occupies broad, low, convex ridges. Slopes are dominantly 0.5-2% but range up to 5% in a few places.	Non-hydric
Sorter silt loam (So)	This nearly level to slightly depressional soil has a slope of less than 1%.	Non-hydric
Splendora fine sandy loam (Sp)	This soil has a plane slope of less than 1%.	Non-hydric
Susquehanna fine sandy loam, 1-5% (SuC)	Occupies broad interstream divides. Soil areas are irregular and have slightly convex surfaces.	Non-hydric
Tuckerman loam, heavy substratum (Tk)	Occupies slightly depressional areas on low stream terraces and has a slope of less than 0.3%.	Hydric
Waller loam (Wa)	This level to slightly depressional soil has a slope of less than 0.3%. Water is removed from the surface of this soil very slowly.	Hydric
Wicksburg loamy fine sand, 5-12% slopes (WkD)	This soil has strong; convex slopes.	Non-hydric

Note: Soil series shown as having hydric inclusions are not included on the hydric soils list. However, they may contain small, unmapped soils with hydric conditions
Sources: Soil Survey of Montgomery County, NRCS 1972; NTCHS

Table 3-10: Soil Types Located Within the Study Area: Harris County

Soil Type	Description	Hydric Status (NRCS, NTCHS)
Addicks loam (Ad)	A nearly level soil in broad areas on the upland prairies. The surface is plane to slightly convex. The slope ranges from 0-1% but averages about 0.3%.	Hydric
Addicks-Urban land complex (Ak)	A nearly level complex in rural areas. The surface is plane to slightly convex. The slope ranges from 0-1% and averages about 0.3%.	Hydric
Aldine very fine sandy loam (Am)	A nearly level soil in broad, oblong and oval wooded areas. The surface is plain to slightly convex. The slope is 0 to 1%, but averages about 0.6%.	Non-hydric
Aldine-Urban land complex (An)	A nearly level to gently sloping complex in metropolitan areas and in rural areas where the population is increasing. The slope is mainly 0-2% but ranges to 3%.	Non-hydric
Atasco find sandy loam, 1-4% slopes. (AtB)	A gently sloping soil in oblong and oval areas along ridges and natural drainageways. The surface is plane to convex. The slope averages about 2.5%.	Non-hydric
Beaumont clay (Ba)	A nearly level soil on the coastal prairie. The slope ranges from 0-1% but average 0.3%.	Hydric
Bernard clay loam (Bd)	A nearly level soil in broad, irregularly shaped areas. The slope ranges from 0 to 1% but averages less than 0.5%.	Hydric
Bernard-Edna complex (Be)	This complex is in broad areas on the costal prairie. The surface is convex and is characterized by many distinctive knolls and pimple mounds. The slopes average 0.8%.	Hydric
Beaumont-Urban land complex (Bc)	A nearly level complex in broad metropolitan areas and surrounding rural areas. The slope ranges from 0-1% but averages about 0.3%.	Non-hydric
Bernard-Urban land complex (Bg)	A nearly level complex in broad metropolitan areas and rural areas where the population is increasing. The slope is 0-1% but averages 0.5%.	Non-hydric
Clodine loam- (Cd)	Nearly level soils that are generally low on the landscape. Slopes are 0-1% but average 0.5%.	Hydric
Clodine-Urban land complex (Ce)	A nearly level complex in broad, irregular areas. The slope ranges from 0-1% but averages 0.6%.	Hydric
Edna fine sandy loam (Ed)	A nearly level soil on the prairie. The slope is mainly 0-2% but average 0.8%.	Hydric
Gessner loam (Ge)	A nearly level soil in broad irregular areas in small, round depressions. It is lower than the adjacent soils. Slopes are mainly less that 0.5%, but range 0-1%. The surface is plane to slightly concave.	Hydric
Hockley fine sandy loam, 1-4% slopes. (HoB)	This is a gently sloping soil in forest areas and pastures. Slopes are slightly convex and average 2%.	Non-hydric
Lake Charles clay, 0-1% slopes (LcA)	Soils are nearly level and are in broad, irregular areas. Slopes average 0.2%. A mulch of fine, discrete, very hard aggregates is on the surface of undisturbed areas.	Non-hydric
Lake Charles-Urban land complex (Lu)	Soils are nearly level and are in broad, irregular areas. Slopes range mainly from 0-1%, but range from 0-3% in some areas leading to drainage ways.	Non-hydric
Midland silty clay loam (Md)	Soils are nearly level and are in broad, irregular areas. Slopes range from 0-1%.	Hydric
Midland-Urban land complex (Mu)	Soils are nearly level and are in broad, irregular areas. Slopes range from 0-1%. Most areas are open prairie but some are covered with native hardwood.	Non-hydric
Ozan loam (Oa)	Nearly level soil in broad areas and on the floor of enclosed depressions. Slopes are plane to slightly concave and average 0.2%.	Hydric
Ozan-Urban land complex (On)	The nearly level soils on this complex are in built up rural and urban areas. The boundaries of this complex generally coincide with those of built-up subdivisions.	Hydric
Vamont clay, 0-1% slopes (VaA)	Nearly level soil in areas with slopes that average 0.5%. The surface is undisturbed and is characterized by gilgai micro relief.	Non-hydric
Wockley fine sandy loam (Wo)	Nearly level soils in areas of prairie and woodlands. Areas are irregularly shaped. The surface is plane to slightly concave. Slopes average 0.3%.	Hydric
Wockley-Urban land complex (Wy)	Nearly level soils in areas of prairie and woodlands.	Non-hydric

Note: Soil series shown as having hydric inclusions are not included on the hydric soils list. However, they may contain small, unmapped soils with hydric conditions
Source: Soil Survey of Harris County, NRCS 1976; NTCHS

Table 3-11: Soil Types Located Within the Study Area: Liberty County

Soil Type	Description	Hydric Status (NRCS, NTCHS)
Aldine-Aris complex (Ae)	Nearly level soils are in mounded areas of the coastal prairie and flatwoods. Most areas are broad, slopes are 0-1%.	Hydric
Anahuac-Aris complex (An)	Nearly level soils are in mounded areas of the coastal prairie. Areas are irregular in shape; slopes are 0-1%.	Hydric
Aris silt loam (Ar)	Nearly level soil on broad flats along drainage ways. Areas are long and narrow or irregular in shape; slopes are 0-1%.	Hydric
Beaumont Clay (Ba)	Nearly level soils are in broad areas of the coastal prairie; slopes are 0-1%.	Hydric
Bernard clay loam (Be)	Nearly level soils are in areas of the coastal prairie. Areas are elongated or irregular in shape; slopes are 0-1%.	Hydric
Bienville loamy fine sand, 0-2% slope (BnB)	Nearly level and gently sloping soil on stream terraces. Areas are oval or elongated.	Hydric
Bienville-Kenefick complex, 1-3% slopes (BvB)	Gently undulating soils on stream terraces. Areas are oval or elongated.	Hydric
Dylan Clay, 3-6% slopes (DyC)	Gently sloping and moderately sloping soil on side slopes along major drainage ways. Areas are elongated or irregular in shape.	Non-hydric
Estes Clay, frequently flooded (Es)	Nearly level soil on the floodplain of rivers and streams. Areas are long and narrow; slopes are 0-1%.	Hydric
Guyton-Aldine Complex (Gy)	Nearly level soils are in mounded areas of the coastal prairie. Areas are broad and irregular in shape.	Hydric
Hatliff clay loam, occasionally flooded (Ha)	Nearly level soil on the floodplain of rivers and major creeks. Areas are long and narrow; slopes are 0-1%.	Hydric
Kaman clay, frequently flooded (Kf)	Nearly level soil along the floodplain of the Trinity River and other large streams. Areas are long and broad; slopes are 0-1%.	Hydric
Kemah silt loam (Kh)	Nearly level soil in broad areas on uplands of coastal prairie. Areas are elongated or irregular in shape; slopes 0-1%.	Hydric
Kemah-Aris complex (Km)	Nearly level soils are in mounded areas of the coastal prairie. Most areas are broad, slopes are 0-1%.	Hydric
Kenefick fine sandy loam (Kn)	Nearly level soil in stream terraces. Areas are irregular in shape; slopes are 0-1%.	Hydric
Kirbyville fine sandy loam (Kr)	Nearly level soil on broad upland areas, irregular in shape. Slopes are 0-1%.	Hydric
Lake Charles clay, 0-1% slopes (LaA)	Nearly level soil on broad upland areas, irregular in shape.	Hydric
Mantachie loam, frequently flooded (Ma)	Nearly level soil on the floodplain of rivers and streams. Areas are long and narrow; slopes are 0-1%.	Hydric
Mocarey-Yeaton complex (My)	Nearly level soils on broad mounded areas of the coastal prairie. Areas are generally oblong in shape; slopes are 0-1%.	Hydric
Otanya fine sandy loam, 1-3% slopes (OyB)	Gently sloping soils on broad ridges and mounds of flatwoods. Areas are irregular in shape.	Hydric
Pits (Pt)	This map unit is mainly on stream terraces along the Trinity River. Areas are rectangular or oblong.	Non-hydric
Sorter loam (Sb)	Nearly level soil in slightly depressed areas of the flatwoods. Areas are broad and irregular in shape. Slopes are plane or convex, and less than 1%.	Hydric
Sorter-Dallardsville complex (Sd)	Nearly level soil on mounds of the flatwoods. Areas are broad and irregular in shape. Slopes are 0-1%.	Hydric
Sorter-Kirbyville complex (Sk)	Nearly level soil on mounds of the flatwoods. Areas are broad and irregular in shape. Slopes are 0-1%.	Hydric
Spurger fine sandy loam, 0-2% slopes (SrB)	This map unit is nearly level and gently sloping soil on low ridges of stream terraces along the floodplains of the Trinity River and large local streams.	Hydric
Spurger-Waller complex, 0-2% slopes (SwB)	Nearly level and gently sloping soil in stream terraces. Areas are broad and irregular in shape.	Hydric
Vamont silty clay, depressional (Vd)	Nearly level soils in broad areas of the coastal prairie. Areas are irregular in shape; slopes are 0-1%.	Hydric
Verland clay loam (Ve)	Nearly level soils in plane to slightly concave areas of the coastal prairie. Areas are irregular in shape; slopes are 0-1%.	Hydric
Voss fine sand, occasionally flooded (Vo)	This map unit is nearly level soil along the floodplains of the Trinity River and large streams. Areas are generally long and narrow. Slopes are 0-1%.	Hydric
Voss fine sand, frequently flooded (Vs)	This map unit is nearly level soil along the floodplains of the Trinity River and major streams. Areas are generally long and narrow. Slopes are 0-1%.	Hydric
Waller loam (Wa)	Nearly level soils in broad areas of the flatwoods. Areas are irregular in shape; slopes are 0-1%.	Hydric

Table 3-11: Soil Types Located Within the Study Area: Liberty County

Soil Type	Description	Hydric Status (NRCS, NTCHS)
Waller loam, depressional (Wc)	Nearly level soils in depressional areas of the flatwoods. Areas are round or elongated in shape; slopes are 0-1%	Hydric
Waller-Dallardsville complex (Wd)	Nearly level soils on broad mounded areas of stream terraces and flatwoods. Areas are irregular in shape. Slopes are 0-1%.	Hydric
Waller-Kirbyville complex (Wk)	Nearly level soils on broad mounded areas of flatwoods. Areas are irregular in shape. Slopes are 0-1%.	Hydric
Waller-Splendora complex (Wn)	Nearly level soils on mounds of the flatwoods. Areas are irregular in shape. Slopes are 0-1%.	Hydric
Wockley fine sandy loam (Wo)	Nearly level soils in broad, plane to slightly concave areas of the flatwoods. Areas are irregular in shape. Slopes are 0-1%.	Hydric
Woodville fine sandy loam, 1-3% slopes (WvB)	Very gently sloping soil on broad uplands. Areas are irregular in shape.	Non-hydric
Woodville fine sandy loam, 5-8% slopes (WvD)	Moderately sloping soil on uplands along drainage ways. Areas are generally long and narrow.	Non-hydric

Note: Soil series shown as having hydric inclusions are not included on the hydric soils list. However, they may contain small, unmapped parcels of soils exhibiting hydric characteristics within the larger map unit
Source: Soil Survey of Liberty County, NRCS 1996; NTCHS

Table 3-12: Soil Types Located Within the Study Area: Chambers County

Soil Type	Description	Hydric Status (NRCS, NTCHS)
Anahuac silt loam (An)	This soil is in long, narrow, slightly elevated areas. It is deep, nearly level, loamy soils.	Hydric
Beaumont clay (Be)	Deep nearly level, clayey soils on broad flats. Where this soil is in native range or improved pasture, the upper 4 in. has granular structure. Where it is used for rice, the surface layer is massive or has coarse platy structure.	Hydric
Frost silt loam (Fo)	Deep, acid, loamy soils that are nearly level or depressional. Slopes are less than 0.5% and are convex.	Hydric
Frost-Anahuac complex, undulating (FrB)	Deep, acid, loamy soils that are nearly level or depressional. It is 50-70% Frost silt loam, 25-45% Anahuac silt Loam and 5-25% other soils.	Hydric
Frost-Morey complex, leveled (Fs)	Deep, acid, loamy soils that are nearly level or depressional. It is 45-65% Frost silt loam, 25-55% Morey silt loam, and 5-50% other soils. Water stands on the surface of these soils for long periods after rains.	Hydric
Lake Charles clay, 0-1% slopes (LaA)	Deep, nearly level or gently sloping, clayey soils. In most places, it is not affected by floodwaters from Gulf storms. Slopes are less than 1%.	Hydric
Morey silt loam, leveled (Mo)	Deep, nearly level, loam soils. Slopes are less than 1%.	Hydric
Vaiden clay, 0-1% slopes (VaA)	Deep, nearly level or gently sloping clayey soils. Slopes are less than 1%.	Hydric
Vaiden clay, 1-5% slopes (VaB)	Deep, nearly level or gently sloping clayey soils. This soil is on narrow side slopes that lead to low terraces and floodplains of natural drainage ways. Slopes are 1-5%.	Hydric

Source: Soil Survey of Chambers County, NRCS 1976; NTCHS
Note: Soil series shown as having hydric inclusions are not included on the hydric soils list. However, they may contain small, unmapped soils with hydric characteristics within the larger map unit

3.3.3.3 Prime and Statewide or Local Important Farmland Soils

The U.S. Department of Agriculture (USDA) is the agency primarily responsible for the implementation of federal policy concerning farmland. Guiding farmland policy is the Farmland Protection Policy Act of 1981 (FPPA), U.S.C., Title 7, Chapter 73, Section 4201. The general provisions of Section 4201 state that "the Nation's farmland is a unique natural resource that provides food and fiber necessary for the continued welfare of the people of the United States." Section 4201 also states that "the Department of Agriculture and other federal agencies should take steps to assure that the actions of the Federal Government do not

cause United States farmland to be irreversibly converted to nonagricultural uses in cases in which other national interests do not override the importance of the protection of farmland nor otherwise outweigh the benefits of maintaining farmland resources". Each year a large amount of the nation's farmland is irrevocably converted from actual or potential agricultural use to nonagricultural use.

Section 4201 defines prime farmland as "land that has the best combination of physical and chemical characteristics for producing food, feed, fiber, forage, oilseed, and other agricultural crops with minimum inputs of fuel, fertilizer, pesticides, and labor, and without intolerable soil erosion." Prime farmland may include land that is currently being used to produce livestock or timber. Farmlands of statewide importance are generally considered to be those lands that are nearly prime farmland and that produce high yields of crops in an economic manner when treated and managed according to acceptable farming methods. Farmlands of statewide importance may also include tracts of land that have been designated for agriculture by state law. Farmlands of local importance are additional lands used for farming that are identified by local agencies. Farmlands of local importance may also include tracts of land designated for agriculture by local ordinance.

According to the NRCS, much of the region associated with the study area contains prime and statewide or locally important farmland soils. The Segments H and I-1 study area contains 113,401 ac of prime farmland and an additional 161,139 ac that would be considered prime farmland if the soil was drained. Refer to **Table 3-13** for a list of the prime farmland soils within the study area.

Table 3-13: Prime Farmland Soil Types Located Within the Study Area

County	Soil Map Units
Montgomery County	Angie fine sand (An) and Waller loam (Wa).
Harris County	Bernard clay loam (Bd), Bernard-Edna complex (Be), Hockley fine sandy loam, 1-4% slopes (HoB), Lake Charles clay, 0-1% slopes (LcA), Vamont clay, 0-1% slopes (VaA), and Wockley fine sandy loam (Wo). If drained: Beaumont Clay (Ba), Clodine loam (Cd), Gessner loam (Ge), Verland silty clay loam (Md), and Ozan loam (Oa).
Liberty County	Bernard clay loam (Be), Bienville-Kenefick complex, Kenefick fine sandy loam (Kn), Kirbyville fine sandy loam (Kr), Lake Charles clay, 0-1% slopes (LaA), Otanya fine sandy loam, 1-3% slopes (OyB), Spurger fine sandy loam, 0-2% slopes (SrB), Vamont silty clay, 0-1% slopes (VaA), and Wockley fine sandy loam (Wo). If drained: Aldine-Aris complex (Ae), Anahuac-Aris complex (An), Mocarey-Yeaton complex (My), Sorter loam (Sb), Sorter-Dallardsville complex (Sd), Sorter-Kirbyville complex (Sk), Spurger-Waller complex, 0-2% slopes (SwB), Vamont silty clay, depressional (Vd), Waller loam (Wa), Waller-Dallardsville complex (Wd), Waller-Kirbyville complex (Wk), and Waller-Splendora complex (Wn).
Chambers County	Anahuac silt loam (An), Lake Charles clay, 0-1% slopes (LaA), and Vaiden clay, 0-1% slopes (VaA). If drained: Beaumont clay (Be), Frost silt loam (Fo), Frost-Anahuac complex, undulating (FrB), Frost-Morey complex, leveled (Fs), Morey silt loam, leveled (Mo).

Source: NRCS, 1976,1972,1976,1996

3.4 AIR QUALITY

Air pollution may contribute to adverse human health effects and ecosystem degradation. Motor vehicles, industries, construction equipment, and some commercial operations are among the sources of air pollution in the Houston area. The main air pollutants emitted from motor vehicles are volatile organic compounds (VOCs), nitrogen oxides (NO_X), carbon monoxide (CO), particulate matter (PM) and a class of compounds called mobile source air toxics (MSAT).

3.4.1 Criteria Pollutants

As reported by the Environmental Protection Agency (EPA) in 2012, the National Ambient Air Quality Standards (NAAQS) pollutants include ozone, lead, carbon monoxide, sulfur dioxide, nitrogen dioxide, and particulate matter. These pollutants are discussed below.

3.4.1.1 Ozone (O_3)

Ozone is not emitted directly into the air, but is formed through chemical reactions between precursor emissions of volatile organic compounds and nitrogen oxides in the presence of sunlight. Both volatile organic compounds and nitrogen oxides are emitted by transportation and industrial sources. Volatile organic compounds are emitted from sources such as automobiles, chemical manufacturing, dry cleaners, paint shops, and other sources using solvents.

3.4.1.2 Lead (Pb)

Historically, the main sources of lead emissions were lead gasoline additives. Emissions of lead from on-road vehicles decreased 99 percent between 1970 and 1995 due primarily to the use of unleaded gasoline. Additional reductions of lead emissions are anticipated as a result of the EPA's Multimedia Lead Strategy issued in February 1991.

3.4.1.3 Carbon Monoxide (CO)

The largest source of carbon monoxide emissions comes from motor vehicle exhaust. In some cities as much as 95 percent of all carbon monoxide emissions emanate from automobile exhaust.

3.4.1.4 Sulfur Dioxide (SO_2)

Sources of sulfur dioxide result largely from stationary sources such as coal and oil combustion, steel mills, refineries, pulp and paper mills and from non-ferrous smelters.

3.4.1.5 Nitrogen Dioxide (NO_2)

The two major emission sources of nitrogen dioxide are transportation and stationary fuel combustion sources such as electric utility and industrial boilers.

3.4.1.6 Particulate Matter (10 and 2.5 Microns)

Particulate matter (i.e., dust, dirt, soot, smoke, and liquid droplets) are directly emitted into the air by sources such as factories, power plants, cars, construction activities, fires, and natural windblown dust.

3.4.2 Regional Compliance

The EPA designates the status of an area's ambient air with respect to compliance to the NAAQS. The designations are as follows:

Designation	Definition
Attainment	Meets or is better than requirements
Nonattainment	Did not meet requirements
Unclassifiable	Cannot be classified

EPA has determined that Harris County and the seven other counties (including Montgomery, Liberty, and Chambers Counties) that comprise the Houston-Galveston–Brazoria area are in attainment for all of the NAAQS pollutants except ozone, for which it is in marginal nonattainment for the 2008 ozone NAAQS. EPA regulations require that a nonattainment area demonstrate that its Regional Transportation Plan (RTP) and Transportation Improvement Program (TIP) conform to the intent of the State Implementation Plan (SIP) by showing that the emissions under the plan are less than the emission budget set in the SIP. Under the regulations, added capacity projects, such as the Grand Parkway, may advance to construction only if they are part of the RTP and TIP that have been determined to conform to the SIP by the Metropolitan Planning Organization (MPO) and USDOT. The proposed project is included in the area's financially constrained 2035 RTP Update, as revised, and the 2013-2016 TIP, which were found to conform to the SIP by FHWA/Federal Transit Administration (FTA) on January 25, 2011 and November 1, 2012, respectively.

3.4.3 Mobile Source Air Toxics (MSAT)

Controlling air toxic emissions became a national priority with the passage of the Clean Air Act Amendments (CAAA) of 1990, whereby Congress mandated that the EPA regulate 188 air toxics, also known as hazardous air pollutants. The EPA has assessed this expansive list in their latest rule on the Control of Hazardous Air Pollutants from Mobile Sources (Federal Register, Vol. 72, No. 37, page 8430,

February 26, 2007) and identified a group of 93 compounds emitted from mobile sources that are listed in their Integrated Risk Information System (IRIS) (http://www.epa.gov/ncea/iris/index.html). In addition, EPA identified seven compounds with significant contributions from mobile sources that are among the national and regional-scale cancer risk drivers from their 1999 National Air Toxics Assessment (NATA) (http://www.epa.gov/ttn/atw/nata1999/). These are acrolein, benzene, 1,3-butadiene, diesel particulate matter plus diesel exhaust organic gases (diesel PM), formaldehyde, naphthalene, and polycyclic organic matter. While FHWA considers these the priority mobile source air toxics, the list is subject to change and may be adjusted in consideration of future EPA rules.

3.5 TRAFFIC NOISE

This analysis was accomplished in accordance with TxDOT's (FHWA approved) 2011 *Guidelines for Analysis and Abatement of Roadway Traffic Noise*. This guidance describes TxDOT's implementation of requirements of FHWA Noise Standard at 23 Code of Federal Regulations (CFR) Part 772. This guidance was developed by TxDOT and reviewed and concurred with by FHWA.

The following discussion provides a brief overview of the noise concept, describes the existing land uses that are most sensitive to noise (noise sensitive areas), and presents the existing noise levels within the study area. It also identifies the major sources contributing to existing noise and the methodology for determining existing noise levels within the study area.

Sound is defined as mechanical energy produced by the movement of compressed air waves radiating spherically from a source that can be sensed by the human ear. Although sounds are perceived differently from one person to another, they can be precisely measured. The strength of sound is commonly measured on a relative scale of sound pressure levels expressed in decibels or "dB." Noise is commonly defined as "unwanted" sound. Loudness is a term used to describe the manner in which people perceive the intensity of sound, and is considered to be subjective, as it varies from person to person. In general, sound becomes unwanted when it either interferes with normal activities such as sleeping or conversation, or when it disrupts or diminishes a person's quality of life.

Sound occurs over a wide range of frequencies. However, not all frequencies are detectable by the human ear; therefore, an adjustment is made to the high and low frequencies to approximate how the average human hears traffic sounds. These average levels are known as "A-weighted noise levels," and are expressed as "dB(A)."

Existing sources of noise in the study area include area roadways and railroads as well as residential, commercial and industrial developments. The predominant noise sources in the study area are currently vehicular traffic along the existing roadways (US 59 (N)/I-69, FM 1485, FM 1960, US 90, and I-10 (E)) and railroads.

Sound from highway traffic is generated primarily from a vehicle's tires, engine, and exhaust. It is commonly measured in decibels and is expressed as "dB." Sound occurs over a wide range of frequencies; however, not all frequencies are detectable by the human ear. Because traffic sound levels are never constant due to the changing number, type and speed of vehicles, a single value is used to represent the average or equivalent sound level and is expressed as "Leq."

The traffic noise analysis typically includes the following elements:

- Identification of land use activity areas that might be impacted by traffic noise;
- Determination of existing noise levels;
- Prediction of future noise levels;
- Identification of possible noise impacts; and
- Consideration and evaluation of measures to reduce noise impacts.

FHWA has established the Noise Abatement Criteria (NAC), shown in **Table 3-14**, for various land use activity areas that are used as one of two means to determine when a traffic noise impact would occur.

Table 3-14: Noise Abatement Criteria

Activity Category	FHWA dB(A) L_{eq}	Description of Land Use Activity Areas
A	57 (exterior)	Lands on which serenity and quiet are of extra-ordinary significance and serve an important public need and where the preservation of those qualities is essential if the area is to continue to serve its intended purpose.
B	67 (exterior)	Residential.
C	67 (exterior)	Active sport areas, amphitheaters, auditoriums, campgrounds, cemeteries, day care centers, hospitals, libraries, medical facilities, parks, picnic areas, places of worship, playgrounds, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, recreation areas, Section 4(f) sites, schools, television studios, trails, and trail crossings.
D	52 (interior)	Auditoriums, day care centers, hospitals, libraries, medical facilities, places of worship, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, schools, and television studios.
E	72 (exterior)	Hotels, motels, offices, restaurants/bars and other developed lands, properties, or activities not included in A–D or F.
F	------	Agriculture, airports, bus yards, emergency services, industrial, logging, maintenance facilities, manufacturing, mining, rail yards, retail facilities, shipyards, utilities (water resources, water treatment, electrical), and warehousing.
G	------	Undeveloped lands that are not permitted.

Source: *TxDOT's Guidelines for Analysis and Abatement of Roadway Traffic Noise* (2011)

A noise impact occurs when either the absolute or relative criterion is met. These criteria are defined as follows:

Absolute criterion: the predicted noise level at a receiver approaches, equals, or exceeds the NAC. "Approach" is defined as 1 dBA below the FHWA NAC. For example: a noise impact would occur at a Category B residence if the noise level is predicted to be 66 dBA or above.

Relative criterion: the predicted noise level substantially exceeds the existing noise level at a receiver even though the predicted noise level does not approach, equal, or exceed the FHWA NAC. "Substantially exceeds" is defined as more than 10 dBA. For example: a noise impact would occur at a Category B residence if the existing level is 54 dBA and the predicted level is 65 dBA (11 dBA increase).

When a traffic noise impact occurs, traffic noise abatement measures must be considered and evaluated for feasibility and reasonableness. A traffic noise abatement measure is any positive action taken to reduce the impact of traffic noise on an activity area.

To assess the ambient noise (existing conditions) within the Segments H and I-1 study area, noise monitoring was conducted in accordance with the TxDOT 2011 guidelines. Short-term noise measurements of 30-minute durations each were conducted at the selected monitoring sites using a Quest Technologies Sound Pro DL Integrating/Logging Sound Level Meter. The approximate location of these sites is shown in **Exhibit 3-7**. These ambient noise monitoring sites were chosen to represent the land use activity areas and to determine the existing background noise levels within the study area outlined in **Exhibit 3-1**. Simultaneous traffic counts were also recorded for nearby roadways as applicable. **Table 3-15** lists the existing noise level samples within the Segments H and I-1 study area.

Table 3-15: Representative Ambient Noise Levels in the Study Area

Site Location	Noise Level (dBA Leq)	Representative Receiver
SH 494	62.2	N/A
Roman Forest	51.7	R1A-R27
FM 1485*	57.4, 57.2	R28-R48A, R57, R58
FM 2100	59.1	R49-R56
FM 686	54.0	N/A
FM 1960	59.4	N/A
US 90	56.4	R59A, R59B

Source: Study Team, 2013
Notes: *Two noise reading were taken along FM 1485.
N/A: Non-applicable. No representative receivers were included in the noise model.

Existing background noise levels measured in the field at the various monitoring sites for the representative receivers ranged from 51 to 59 dBA Leq. The highest measured noise levels occurred south of FM 1960 in the eastern part of the study area. The lowest noise levels were measured at a site near a row of residences in the Roman Forest subdivision in the study area. These measured ambient sound levels characterize the existing noise conditions within the Segments H and I-1 study area.

3.6 WATER QUALITY

There are five regional watersheds found within the study area: Buffalo-San Jacinto, East Fork San Jacinto, Lower Trinity, North Galveston Bay, and West Fork San Jacinto. Many minor tributaries feed all major streams in the study area. The study area for water quality was determined by examining those areas of each watershed that fall within the study area outlined in **Exhibit 1-2**.

3.6.1 Watersheds

Five regional watersheds are found within the study area and smaller, or local, watersheds are within the regional watersheds. The Buffalo-San Jacinto and West Fork San Jacinto watersheds are found in the western limits of the H and I-1 study area and do not contain any smaller watersheds or major waterbodies. The majority of the study area and all major water features are inside the East Fork San Jacinto, North Galveston Bay, and Lower Trinity watersheds. The following is a description of each of the watersheds.

East Fork San Jacinto Watershed

The primary water bodies in the East Fork San Jacinto watershed are the East Fork San Jacinto River, Peach Creek, Caney Creek, and Luce Bayou. A smaller watershed is associated with each of these features and combined they form the portion of the East Fork San Jacinto watershed within the study area.

The East Fork San Jacinto River enters the study area from Liberty County and traverses southwest approximately 2 mi where it crosses the Montgomery County line. In the northwest portion of the study area, and beyond, the river watershed contains approximately 404 mi^2 at the confluence with Caney Creek. There are approximately 129 mi^2 of the watershed within the study area. The watershed is primarily Pineywoods and Blackland Prairie. The river extends upstream 75 mi to US 190 in Walker County. There is approximately 9.5 mi of the river's reach within the study area.

The East Fork San Jacinto River channel was analyzed by FEMA with specific roughness factors (Manning's "n") that indicate a channel with a moderate degree of irregularity, occasionally alternates,

medium density of vegetation and a moderate amount of meandering. The river contains some sluggish reaches, a substantial amount of weeds and deep pools. Over bank roughness values indicate floodplains with medium to dense brush and dense forests, in parts, with flood stage reaching branches. The large drainage area of the river, coupled with flat topography, results in slow runoff and longer duration floods.

The base flood elevation (BFE) at the river intersection within the northern study area is approximately 95 ft., which is equivalent to a 1 mi wide floodplain. The 100-yr peak discharge is approximately 57,000 cfs. Maximum water depth at flood stage is approximately 25 ft with a velocity of 2.5 fps. This location is within the limits of the City of Plum Grove. Approximately 2.75 mi downstream and near the intersection of the Montgomery, Harris, and Liberty county lines the 100-yr floodplain widens to over 6,500 ft. The BFE is 81.0 ft at this location with the depth at the center of the channel near 26 ft. The 100-yr flow is approximately 56,000 cfs with a corresponding velocity of 3.0 fps.

As the river traverses the east side of the Lake Houston Wilderness Park, the 100-year floodplain narrows to 1,500 ft. At the junction of the river and Caney Creek in the southern portion of the park the BFE is 57 ft. and the floodplain is approximately 1 mi wide. The river continues south for approximately 2.5 mi to the Luce Bayou junction. The floodplain in this location expands to 6,000 ft at a BFE of 50.5 ft. Approximately 4,500 ft downstream, the East Fork San Jacinto River discharges into Lake Houston just outside the study area, where the floodplain is 3,000 ft wide. The watershed at this point represents 2,900 mi^2. Normal pool elevation of the lake is approximately 44 ft. The BFE of Lake Houston is approximately 50 ft and the peak discharge of the river entering the lake is 252,000 cfs.

The Peach Creek watershed is primarily undeveloped. The geography of the watershed has similar characteristics to that of the East Fork San Jacinto River watershed with the major land use category being forest. The Peach Creek watershed area is 151 mi^2, encompassing land from its confluence with Caney Creek in Montgomery County north for 57 mi to SH 150 in Walker County. The creek enters the study area 2,500 ft north of US 59 (N)/I-69 at the southern limits of the City of Splendora and flows south over 6 mi to the confluence with Caney Creek. The Peach Creek floodplain at the City of Splendora is 2,200 ft wide with a BFE of 100 ft and a channel centerline water depth of approximately 15 ft. The 100-year peak discharge is approximately 39,000 cubic feet per second (cfs) with a velocity of 2.0 feet per second (fps). As the creek traverses south, it passes through the small towns of Patton Village, Woodbranch, and the City of Roman Forest, and crosses FM 1485 immediately west of the Lake Houston Wilderness Park.

Floodplain widths vary from 1,800 ft at US 59 (N)/I-69 and the UPRR to over 5,000 ft at the Caney Creek junction, which is approximately 4,000 ft north of the Harris County line. At the Caney Creek confluence, the Peach Creek BFE is 71 ft; the 100-year flow is approximately 44,000 cfs with a velocity slightly exceeding 2.0 fps. The flood stage water depth is approximately 25 ft.

The Caney Creek watershed is also largely undeveloped and the major land use category is forest. From its confluence with the East Fork San Jacinto River in Harris County, north through Montgomery County to SH 150 in Walker County, the watershed encompasses 222 mi^2. The reach length is also 57 mi long, of which approximately 7 mi lies within the study area. The creek enters the study area approximately 2,500 ft northwest of US 59 (N)/I-69 where the floodplain is approximately 1,500 ft wide. The BFE is 84 ft with a 100-year peak flow of approximately 27,000 cfs, and a velocity of slightly over 3.0 fps. The centerline floodwater depth would be approximately 24 ft. Caney Creek crosses FM 1485 approximately 2 mi downstream from its confluence with US 59 (N)/I-69 and establishes its confluence with Peach Creek approximately 3 mi further. The 100-year floodplain varies from approximately 3,000 ft wide near FM 1485 to approximately 1 mi wide at the Peach Creek junction.

At the junction, the BFE is approximately 71 ft; the 100-year peak discharge is 66,000 cfs with a velocity of approximately 2.5 fps. The main channel flood stage would be approximately 23 ft deep. The confluence of Caney Creek and White Oak Creek is approximately 1.5 mi south of the Harris County line. During a 100-year flood event this junction would experience backwater effects from the East Fork San Jacinto River, which has confluence with Caney Creek 4,400 ft downstream. At the White Oak Creek confluence, the BFE is 58.0 ft. This floodplain is 2,800 ft wide with a 100-year peak discharge of approximately 66,000 cfs. The corresponding velocity would be near 3.0 fps. At the confluence of Caney Creek and the East Fork San Jacinto River, the BFE is approximately 57.0 ft and the floodplain is approximately 1 mi wide.

Although White Oak Creek drains a sub-watershed within the Caney Creek watershed, it deserves mention here because its drainage area is 29.5 mi^2 and it contributes a 100-year peak discharge of over 4,000 cfs to the flow of Caney Creek, and subsequently the East Fork San Jacinto River. White Oak Creek has nearly 7 mi of stream reach within the study area. The floodplain is 2,000 ft wide at US 59 (N)/I-69 and narrows to 900 ft wide approximately 2 mi downstream. At the Harris County line, the floodplain is 4,000 ft wide and is indistinguishable from that of Caney Creek. Although the entire watersheds of the East Fork San Jacinto

River, as well as those of Peach and Caney Creeks are mostly undeveloped, there is substantial subdivision development within the study area.

The Luce Bayou watershed is located 3 mi north of Dayton in west central Liberty County, and flows from the northeast to the southwest as it transects the northeastern portion of the study area. The watershed is largely non-urbanized with an area of approximately 227 mi^2. Approximately 14 mi of the bayou's reach is within the study area. The watershed is primarily flat terrain with local escarpments and surface sandy loam soil, in places, that supports heavy forests and agriculture. Roughness values indicate the bayou channel is irregular, with the cross-section alternating frequently and displaying heavy vegetation. The floodplain is most often heavily wooded and exhibits tall grasses. Storm water runoff is slow and there are long duration flood concentrations. Flow is intermittent in the upper reaches and very sluggish elsewhere.

Luce Bayou enters the study area 1,000 ft upstream of SH 321 where the BFE is 97.5 ft and the floodplain is 7,500 ft wide. The 100-year peak discharge is approximately 4,000 cfs with a velocity of 0.5 fps. The centerline water depth, relative to the BFE, is approximately 13 ft. The Luce Bayou confluence with Tarkington Bayou is 4 mi downstream. At this juncture, the floodplain is approximately 3,000 ft wide. The 100-year flow is 16,900 cfs with a velocity of less than 2.0 fps. Backwater effects from Tarkington Bayou extend nearly 3 mi up Luce Bayou, which is indicative of the flat channel, floodplain, and watershed. The floodplain narrows to 1,000 ft wide in places downstream. Nine miles beyond Tarkington Bayou where Luce Bayou enters Harris County, the floodplain is 2,200 ft wide. Three miles farther the floodplain narrows to 1,700 ft at FM 2100. Approximately 7.3 mi downstream of the county line, Luce Bayou meets the East Fork San Jacinto River within a subdivision development. The 100-year peak discharge at this point is approximately 16,100 cfs, and the BFE is 50.5 ft with a floodplain width of 6,000 ft. The 100-year flood stage is 34.0 ft with a velocity of 1.0 fps.

North Galveston Bay Watershed

Cedar Bayou is the primary water body in the North Galveston Bay watershed. The 247 mi^2 Cedar Bayou watershed is characterized by level terrain that slopes gently to the south. There are approximately 144 mi^2 of the watershed in the study area. Headwaters of the bayou are found in Liberty County 7.5 mi northeast of the FM 1960 intersection with the Liberty County/Harris County line. The channel forms most of the boundary between Harris, Liberty, and Chambers counties, with approximately half of the watershed in Harris County. Much of the watershed is undeveloped with the exception of Mont Belvieu and the City of

Baytown. Flooding is frequent with extended periods of storm water concentrations. Based on the surface roughness or texture values, the bayou channel has a fairly high degree of irregularity, with the cross-section alternating frequently and often covered with heavy vegetation. Floodplain widths vary dramatically from 1,000 ft to 14,000 ft. The Harris County Flood Control District (HCFCD) maintains at least 14 channels within the study area that discharge into Cedar Bayou.

At the upstream end of Cedar Bayou the 100-year flow is approximately 900 cfs. Downstream 5.2 mi at the Liberty County/Harris County line the 100-year peak discharge is 4,400 cfs with an average velocity of less than 2.0 fps. The floodplain is 2,000 ft wide with a BFE of 71 ft and a centerline floodwater depth of 16 ft. Cedar Bayou intersects FM 1960 approximately 2,000 ft downstream where the floodplain widens to 14,000 ft, primarily on the west side of the channel. The channel grade line and associated floodplain flatten near FM 1960 with flood stage channel velocities generally less than 2.0 fps downstream. At the US 90 intersection 7.8 mi downstream the BFE is 57 ft; the 100-year flow is approximately 7,200 cfs and the floodplain is 4,500 ft wide. The flood stage water depth is 17 ft. At the confluence with Adlong Ditch 4.5 mi downstream, Cedar Bayou has a peak flow over 8,000 cfs with a floodplain width of approximately 10,000 ft. Harris, Liberty, and Chambers counties intersect approximately 2.3 mi downstream where the floodplain is 6,000 ft wide and the BFE is 36 ft. One mile south is the junction with Hickory Island Gully, a stream with a 6-mi reach which contributes a peak discharge of 1,600 cfs to Cedar Bayou. Approximately 3.2 mi downstream, Cedar Bayou passes FM 1942 where the floodplain narrows to 1,500 ft wide. The bayou exits the study area 3.6 mi downstream, approximately 1,500 ft south of I-10 (E). Flood stage water depth is over 30 ft at the channel centerline. The 100-year peak flow is 17,000 cfs and the floodplain is 3,000 ft wide.

The City of Mont Belvieu, in Chambers County, occupies a topographic high elevation in the southeast corner of the study area. Phase I of the Grand Parkway Segment I-2 has completed construction south of I-10 (E) to FM 1405 and intersects the interstate 2,300 ft south of the Mont Belvieu city limits. Smith Gully traverses the center of town as it drains 4.3 mi^2. It converges with Cedar Bayou north of I-10 (E) and west of Loop 207. The 100-year peak discharge is 2,400 cfs and the floodplain is approximately 700 ft wide, with out-of-bank flooding and shallow ponding common. The BFE north of Mont Belvieu is 54 ft and the BFE is 24 ft at SH 146 near Cedar Bayou.

Lower Trinity Watershed

The proposed intersection of I-10 (E) and Segment I-1 represents the western limits of the Lower Trinity River watershed. There are approximately 71 mi^2 of the watershed in the study area. The BFE is 32 ft with a 100-year peak flow of 2,000 cfs, where Hackberry Gully bisects the proposed I-10 (E) and Segment I-1 intersection. Approximately 2,000 ft south where Hackberry Gully exits the study area the BFE is 27 ft and the floodplain width is approximately 300 ft.

The remainder of the study area lies within the Lower Trinity River watershed, and the storm water runoff direction is generally from west to east. The terrain slopes gently and has low relief. Ground cover is typical for the Coastal Province. Roughness values indicate heavy brush with forests in the floodplains. The soils are principally dark clays and sandy loams. The City of Dayton in Liberty County is found at the east-central boundary of the study area. The western edge of the Trinity River 100-year floodplain is approximately 1 mi east of the intersection of US 90 and SH 146 where the BFE is 28.5 ft. The surrounding natural ground elevation is approximately 80 ft. Two branches of Linney Creek, a minor tributary of the Trinity River, are located approximately 2 mi north of Dayton. Linney Creek has yet to be studied by the Federal Emergency Management Agency (FEMA), but does not appear to be a major source of flooding. The East and West Dayton Ditches that intersect FM 1960 are located approximately 4 mi west of Dayton. Each ditch has a peak discharge of approximately 550 cfs. The floodplain is approximately 1 mi wide and has a BFE at FM 1960 of approximately 77.5 ft. The East Prong Old River crosses SH 146 approximately 3.8 mi south of Dayton, and the West Prong crossing is approximately 2 mi downstream. Neither of the watersheds have been studied in great detail by FEMA. Therefore, an additional hydrologic study would be required in the future.

Buffalo-San Jacinto and West Fork San Jacinto Watersheds

The Buffalo-San Jacinto and West Fork San Jacinto watersheds are mapped within the western portion of the proposed Segments H and I-1 study area. There is approximately 1 mi^2 of the West Fork San Jacinto watershed and 5 mi^2 of the Buffalo-San Jacinto watershed in the study area. Although drainage ditches and small tributaries are present, no significant watershed features are located within either the Buffalo-San Jacinto or West Fork San Jacinto watersheds within the study area. Within the Buffalo-San Jacinto watershed there are minor tributaries that flow to Lake Houston and Gum Gully.

3.6.2 Surface Water

The Texas Surface Water Quality Standards (TSWQS) apply to all surface water features in the state. These standards are enumerated in Title 30, Chapter 307 of the Texas Administrative Code. The standards were approved by the EPA in accordance with Section 303 of the Clean Water Act (CWA) and, as required by the statute, are updated every 3 years. The standards are typically designed to protect the most sensitive beneficial use within a water body. The Texas Commission on Environmental Quality (TCEQ) distributes the information provided by the TSWQS and administers compliance with the standards. Five general categories for water use are defined in the TSWQS: aquatic life use, contact recreation, general use, public water supply, and fish consumption.

The TCEQ carries out a regular program of monitoring and assessment to compare conditions in Texas surface waters to established standards and to determine which water bodies are meeting the standards. The results of the assessment are published periodically in the Texas Water Quality Inventory and 303(d) list, as required by Sections 305(b) and 303(d) of the CWA. The Texas Water Quality Inventory and 303(d) list is an overview of the status of surface waters of the state, including concerns for public health, fitness for use by aquatic species and other wildlife, and specific pollutants and their possible sources.

As a result of this assessment, the State of Texas must develop action plans to remediate those water bodies that are impaired through the development of a total maximum daily load (TMDL) which determines the maximum amount of pollutants that a water body can receive and still both attain and maintain its water quality standards and which allocates this allowable amount (load to point and non-point sources in the watershed). The TCEQ monitoring program divides the state's surface water into river basin data, and further divides this data into specific segments which are each allocated a segment identification number.

According to the 2010 Texas 303(d) list, two listed segments are within the study area. Cedar Bayou Above Tidal (Segment ID: 0902) is listed as impaired from a point 1.4 mi upstream of I-10 (E) in Chambers/Harris County to a point 4.6 mi upstream of FM 1960 in Liberty County, where it is listed as a Category 5c, Rank D because of low dissolved oxygen. Category 5 waters are those which do not meet applicable water quality standards or are threatened for one or more designated uses by one or more pollutants. Category 5c waters are those where additional information would be collected before a TMDL is scheduled. A rank of "D" indicates that additional data would be collected before a TMDL is scheduled. Cedar Bayou Tidal (Segment ID: 0901) is listed along its entire length as impaired due to dioxin in catfish

and crab tissue (Category 5a, Rank U). The Category 5a designation means that a TMDL is scheduled, underway or would be scheduled for the waterway in question. The Rank of "U" indicates that a TMDL study is underway.

3.6.3 Groundwater

The major aquifer underlying the study area is the Gulf Coast aquifer. This aquifer contains large quantities of fresh water that extend to a depth of 1800 ft below sea level (Anders, 1968). The Gulf Coast aquifer has been divided into five hydrostratigraphic units: Catahoula confining system, Jasper aquifer, Burkeville confining system, Evangeline aquifer, and Chicot aquifer (TWDB, 2006). These units dip from land surface southeastward at slight angles toward the Gulf of Mexico (United States Geological Survey [USGS], 2002). Recharge to the Gulf Coast aquifer mainly occurs from rainfall that falls on the outcrop areas (TWDB, 2006). Most of the rainfall is taken up by evapotranspiration (water loss from the surface of soils and plants) before reaching the zone of saturation. Water also drains into the aquifer from some reaches of the numerous streams that cross the Gulf Coast. Areas with extensive groundwater pumping, such as water and irrigation wells, can form large cones of depression and may capture recharged water that was naturally discharging to local streams. This could result in an increase of downdip recharge. Recharge through the unconfined, permeable, sandy portions of the aquifer may be relatively fast, while recharge to the confined portions of the aquifer may be considerably slow.

Throughout the early to mid-1900's, numerous studies in the region linked groundwater withdrawal to subsidence (HGSD, 2009). In 1961 when Hurricane Carla resulted in much more flooding than was expected, local governments began to look at what could be done about the impact of subsidence on the economy and quality of life in the area. As a result, in 1975 the Texas Legislature created the Harris-Galveston Subsidence District (HGSD), the first of its kind in the United States. The Lone Star Groundwater Conservation District (GCD) was created for Montgomery County in 2001 by the Texas Legislature. Authorized as regulatory agencies, the HGSD and Lone Star GCD were given authority to restrict groundwater withdrawals within their jurisdictions.

3.6.4 Water Well Review

Public well records from the TCEQ, private water well records, and driller's reports from the Texas Water Development Board (TWDB) were reviewed for the study area. Both agencies maintain a listing of existing water wells in the area. However, the databases only include wells that have been reported to the TCEQ or

the TWDB and may not include all water wells in the study area. The results of the water well review indicate that there are a total of 314 water wells within the study area (TCEQ, 2007 and TWDB, 2006). Of this total, 80 are public water supply wells. The remaining 234 are private which are not presently afforded protection by any regulations.

The state's Source Water Protection (SWP) program is a community based, voluntary pollution prevention program that was created by the 1996 Safe Drinking Water Act Amendments and the expansion of the Wellhead Protection Program. All public water supply systems are eligible to participate in the state's SWP program. This program establishes procedures and criteria for identifying the boundaries of areas which constitute the sources of water used by public water systems. It also sets out procedures for identifying potential sources of contaminants within these areas and provides for the development and implementation of plans for managing the potential sources to prevent contamination.

3.7 WATERS OF THE U.S., INCLUDING WETLANDS AND VEGETATIVE COMMUNITIES

3.7.1 Regional Setting

The study area lies at the southern edge of the Pineywoods and the northern and eastern portion of the Gulf Coastal Prairies and Marshes natural ecological regions as designated by the TPWD (**Exhibit 3-8**). Within the study area, the Pineywoods natural region covers the northern and western half of the study area, approximately 103,426 ac or 46 percent of the study area, while the Gulf Coastal Prairies and Marshes covers approximately 121,413 ac or 54 percent of the study area. The study area encompasses those wetlands and vegetative communities that exist within the project limits defined in **Exhibit 3-9**.

The study area, located in the Austroriparian Biotic Province **(Exhibit 3-10)**, is characterized as an ecotonal region including the Gulf coastal plain from the Atlantic Ocean to Eastern Texas. The western boundary of this province is approximated by a north-south line from western Harris County to Red River County. The western boundary of the Austroriparian Biotic Province is the western extent of pine and hardwood forests of the eastern Gulf plain. The vegetation of this biotic province within the study area includes the longleaf pine and the pine-oak forests. In recent decades, the faunal distribution within the study area has been primarily impacted by development, both urban and the clearing of forested land for agricultural use. Consequently, the distribution of forest habitat specialty species has become more restricted due to loss of habitat; many species once associated with the gulf coastal prairies are no longer found in many areas due to conversion of habitat to agricultural crop production.

3.7.2 Waters of the U.S.

The EPA and the United States Army Corps of Engineers (USACE) are charged with the protection of "Waters of the U.S." under the Federal Water Pollution Control Act of 1972, amended in 1977 to the CWA. The term "Waters of the U.S.," as defined in 33 CFR 328.3, denotes:

- All waters which are currently used, or were used in the past, or may be susceptible to use in interstate or foreign commerce, including all waters which are subject to the ebb and flow of the tide;
- All interstate waters including wetlands; and
- All other waters such as intrastate lakes, rivers, streams (including intermittent streams), mudflats, sandflats, wetlands, sloughs, prairie potholes, wet meadows, playa lakes, or natural ponds, the use, degradation or destruction of which could affect interstate or foreign commerce.

To characterize surface drainage systems (streams), the designations perennial, intermittent, and ephemeral are used:

- Perennial streams flow year-round during a typical year. The water table is located above the stream bed for most of the year and groundwater is a primary source for stream flow. A perennial stream is typically capable of supporting aquatic life.
- Intermittent streams flow during certain parts of the year, typically seasonally, when groundwater provides water for stream flow. During dry periods, intermittent streams may not have flowing water. Rainfall is a supplemental source of flow. Biological constituents are adapted to wet and dry fluctuations.
- Ephemeral streams only flow for short durations after precipitation. Ephemeral streams are located above the water table year round. Runoff from rainfall is the primary source of flow. Aquatic life is extremely scarce or typically absent. Not all ephemeral streams are USACE regulated waters. In order to be considered jurisdictional, ephemeral streams must have a hydrological connection to jurisdictional waters.

All tidal waters, interstate waters and intrastate waters whose use, degradation, or destruction could affect interstate commerce are considered jurisdictional and subject to USACE regulation. In practical application, this includes all perennial and intermittent streams and all ephemeral streams exhibiting an ordinary high water mark (OHWM). Also included are natural lakes and ponds with surface connections to navigable water or other ties to interstate commerce, all impounded lakes or ponds created from jurisdictional waters described above, and their adjacent wetlands.

Five regional watersheds are found within the study area: Buffalo-San Jacinto, East Fork San Jacinto, Lower Trinity, North Galveston Bay, and West Fork San Jacinto (**Exhibit 3-11**). Within these five

watersheds at least 52 named potential Waters of the U.S. were identified in the study area (**Exhibit 3-12** and **Exhibit 3-13**):

- Adlong Ditch
- Ash Gully
- Barbers Hill Canal
- Big Ditch
- Camp Branch
- Caney Creek
- Cary Bayou
- Casey Gully
- Casey Pond
- Cat Pond
- Cedar Bayou
- Cherry Point Gully
- Church House Gully
- Clawson Ditch
- Coastal Water Authority Canal
- Cotton Bayou
- Dayton Canal
- Dunks Ditch
- East Fork Cedar Bayou
- East Fork San Jacinto River
- East Prong Old River
- Ellis Branch
- Frost Reservoir
- Green Tree Ditch
- Gum Gully
- Hackberry Gully
- Harvard Ditch
- Hickory Island Gully
- Krenek Ditch
- Lakeland Lake
- Lick Branch
- Linney Creek
- Long John Creek
- Luce Bayou
- Lynchburg Canal
- Magee Gully
- Maple Branch
- Mare Branch
- Mexican Gully
- Orange Branch
- Orton Gully
- Patton Lake
- Peach Creek
- Peach Creek Lake
- Robinson Gully
- Rocky Branch
- Shadow Lake
- Shook Bayou
- Smith Gully
- Tarkington Bayou
- Taylor Gully
- West Prong Old River

Various other unnamed ponds, streams, and ditches were also identified in the study area.

3.7.3 Wetlands

Wetlands are zones of transition between terrestrial (upland) ecosystems and aquatic habitats. The wetlands in the study area are generally found near streams and rivers or as man-made or natural impoundments. Wetlands can also be found in depressional areas where the ground elevations result in the formation of ponds or areas that tend to remain wet longer than the surrounding landscape.

The term "wetlands" as applied in the CWA and by the USACE includes those areas that are "inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances typically do support, a prevalence of vegetation typically adapted for life in saturated soils." Inherent in this definition is the presence of three mandatory criteria: hydric soils, hydrophytic vegetation, and wetland hydrology.

The primary function of wetlands relates to their physical, chemical, and biological attributes. The CWA recognizes water quality benefits and the uniqueness of water habitat as the principle reasons for regulating wetlands and avoiding unnecessary impacts. Examples of wetland functions include flood flow alteration, wildlife habitat, filtering of contaminants, and groundwater recharge. The term "values" may be used to describe those functions that are generally regarded as beneficial to society. Recreation and uniqueness are examples of values. Values are typically associated and weighed by a combination of a wetland's inherent capabilities combined with the opportunity to perform those functions. Accordingly, a wetland might have the potential to remove contaminants from a waterway, but its value may be low because of the lack of opportunity to do so. All or part of society may not value some wetland functions. For example, nutrient removal and transformation may not be considered a value if that function leads to algal blooms and noxious odors.

Wetlands are especially valued because of their location on the landscape, the variety of functions they perform, and the uniqueness of their plant and animal communities. Individual landowners and members of the general public also value wetlands for their open space and aesthetic qualities, as locations of important historic and archeological sites and as locations for conveying floodwaters.

The United States Fish and Wildlife Service (USFWS), for the purpose of their designation and inventory of wetlands, defines "wetlands" as "lands transitional between the terrestrial and aquatic system where the water table is usually at or near the surface or the land is covered by shallow water." Many National

Wetland Inventory (NWI) wetlands are not jurisdictional wetlands regulated by the USACE. This fact is emphasized in the USACE 1987 Wetland Delineation Manual, which specifies that USFWS Cowardin NWI definition of wetlands only requires a positive indicator for one of the three parameters (hydric soils, hydrophytic vegetation, and wetland hydrology) required for consideration as a regulated wetland pursuant to Section 404 of the CWA.

The USFWS Wetland Designation System designates wetlands hierarchically by system, subsystem, class, and subclass. Additional modifiers (such as regime) and dominance type (dominant species present) may also be assigned. Hence, riverine wetlands are subsequently assigned to a subsystem based on flow (e.g., tidal, perennial, or intermittent), to a class based on general appearance of the environment (e.g., substrate or shoreline), to a subclass (e.g., finer distinction of substrate or shoreline), and to a regime (e.g., permanently or intermittently flooded). A dominance type may be assigned based on the species or species complex dominating the substrate or the upper level of emergent vegetation.

Wetland types identified within the study area include palustrine, riverine, and lacustrine. Refer to **Exhibit 3-12** for NWI wetlands within the study area which were utilized due to the lack of right of entry granted in the study area.

Palustrine System

The palustrine system includes all nontidal wetlands dominated by trees, shrubs, persistent emergents, emergent lichens, or mosses, and all such wetlands that occur in tidal areas where salinity due to ocean-derived salts is below 0.5 percent. Palustrine systems are bounded by uplands or any of the other Cowardin systems. The palustrine system typically includes those areas called marshes, swamps, and bogs.

There are approximately 2,242 ac of palustrine wetlands within the study area. This acreage includes approximately 453 ac of forested wetlands, 78 ac of shrub-scrub wetlands, 296 ac of emergent herbaceous wetlands, 1,188 ac of farmed emergents (likely to be non-jurisdictional rice fields), 210 ac of unconsolidated bottom, 11 ac of aquatic bed, and 6 ac of unconsolidated shoreline. Unconsolidated bottom consists of all wetland and deepwater habitats that are characterized by less than 30 percent vegetative cover and a lack of large stable surfaces for plant and animal attachment. Aquatic bed consists of wetlands dominated by plants that grow on or beneath the surface of the water for most of the growing season. Unconsolidated

shoreline consists of wetlands having less than 75 percent rock cover, less than 30 percent vegetation cover, and flooded conditions.

It is likely that the 453 ac of forested wetlands, 296 ac of emergent herbaceous wetlands, and 78 ac of shrub-scrub wetlands would be jurisdictional provided they demonstrate a hydrologic connection to a navigable water. The jurisdictional status of the unconsolidated bed and shoreline areas and aquatic bed areas depends upon the hydrology and connection to navigable waters and would be determined during the USACE verification process.

Riverine System

Riverine systems include all wetland and deepwater habitats (greater than 6 ft deep) contained within a channel except for:

- wetlands dominated by trees, shrubs, persistent emergents, emergent mosses or lichens; and
- habitats with water containing ocean-derived salts in excess of 0.5 percent.

Riverine systems are bounded on the landward side by upland, by the channel bank, or by wetlands dominated by trees, shrubs, persistent emergents, or emergent mosses or lichens. Approximately 218 ac of riverine wetlands are within the study area. These wetlands include areas in Caney Creek, Peach Creek, the East Fork of the San Jacinto River, Luce Bayou, Cedar Bayou, and the Dayton Canal. Riverine systems including wetlands are almost exclusively lower perennial systems and are likely to be jurisdictional. This determination would be made during the USACE verification process.

Lacustrine System

Lacustrine wetlands include wetlands with all of the following characteristics:

- situated in a topographic depression or dammed river channel;
- lacking trees, shrubs, persistent emergents, emergent mosses, or lichens with greater than 30 percent areal coverage; and
- total area exceeds 20 ac.

Similar habitats less than 20 ac can be classified as lacustrine if an active wave-formed or bedrock shoreline feature makes up part of the boundary or if water depth exceeds 6.5 ft at low water. Lacustrine wetlands may be tidal or nontidal, but must have an ocean-derived salinity of less than 0.5 percent.

There are approximately 250 ac of lacustrine wetlands within the study area. This includes open water areas greater than 6.5 ft deep (limnetic) and areas less than 6.5 ft deep, to the shoreward edge of the system. Dammed river channels and naturalized depressional areas with surface connections to navigable waters are potentially jurisdictional. Man-made depressions excavated from upland and/or isolated features may also be jurisdictional areas, and this determination would be made during the USACE verification process.

3.7.4 Vegetative Communities

The major ecological regions within the study area are the Pineywoods and the Gulf Coastal Prairies and Marshes (Gould, 1960). The designated TPWD vegetation types within the study area are dominated by the pine-hardwood forests in the north and crops found in the southern portion as shown on **Exhibit 3-9** (TPWD, 1984).

As depicted on the TPWD *Vegetation Types of Texas* (TPWD, 1984) map, there are four vegetation types mapped within the study area. A majority of the northern one-third of the study area is mapped as pine-hardwood forests. This area is interspersed with native pine-hardwood vegetation, farmlands, and pastures. A small area designated as young forest/grasslands is located in the northwest corner of the study area. This area exhibits various combinations and age classes of pine and re-growth of southern red oak (*Quercus falcata*), sweetgum (*Liquidambar styraciflua*), and other oaks resulting from recent harvesting of pine or pine-hardwood forests and the establishment of pine plantations or young pine-hardwood forests. A small area designated as other native or introduced grasses is located in the northeast portion of the study area. This area is a mixture of native and introduced grasses and forbs on grassland sites or mixed herbaceous communities resulting from the clearing of woody vegetation. The southern two-thirds of the study area is designated as crops with the exception of the land adjacent to Cedar Bayou which is designated as pine-hardwood forests. Of the 224,840 ac contained within the study area, approximately 122,650 ac (54.6 percent) are designated as crops, approximately 91,700 ac (40.8 percent) are designated as pine-hardwood forest, approximately 9,930 ac (4.4 percent) are designated as young forest/grasslands, and approximately 560 ac (0.2 percent) are designated as other native or introduced grasses. Generally, vegetation in the study area is consistent with the TPWD designations.

The typical vegetation species associated with the pine-hardwood forest vegetation type include shortleaf pine (*Pinus echinata*), water oak (*Quercus nigra)*, white oak (*Quercus alba),* southern red oak (*Quercus*

falcata), winged elm (*Ulmus alata)*, beech (*Fagus grandifolia)*, blackgum (*Nyssa sylvatica*), magnolia (*Magnolia grandiflora)*, American beautyberry (*Callicarpa americana*), American hornbeam (*Carpinus caroliniana*), flowering dogwood (*Cornus florida*), yaupon (*Ilex vomitoria*), hawthorn (*Crataegus sp.*), supplejack (*Berchemia scandens*), Virginia creeper (*Parthenocissus quinquefolia*), wax myrtle (*Myrica cerifera*), red bay (*Persea borbonia* var. *borbonia*), sassafras (*Sassafras albidum*), southern arrowwood (*Viburnum dentatum*), poison ivy (*Toxicodendron radicans*), greenbriar (*Smilax sp.*) and blackberry (*Rubus sp.*). The following species may be found within the study area along deep sand ridges: black hickory (*Carya texana*), sandjack oak (*Quercus incana*), common persimmon (*Diospyros virginiana*), sweetgum, beaked panicum (*Panicum anceps*), Indiangrass (*Sorghastrum nutans*), switchgrass (*Panicum virgatum*), three-awn (*Aristida sp.*), and bushclover (*Lespedeza sp.*).

TPWD maps indicate that the southern portion of the study area is designated as the crops vegetation type. This vegetation type includes either cover crops or row crops including rice fields. Crops may also include grasslands associated with crop rotations.

In addition, 2010 infrared aerials were obtained from the Texas Natural Resource Information System (TNRIS) and used to further identify the vegetative communities. Based off of this review, agricultural land, agricultural wetlands, forested land, forested wetlands, and riparian zones were identified within the study area.

Agricultural land within the study area closely matches the definition given by TPWD. Agricultural wetlands identified via infrared aerial interpretation would more than likely contain wetland plant species that are often associated with areas disturbed from recent agricultural activity. These species may consist of: green flat sedge (*Cyperus virens*), Dombey's spike-rush (*Eleocharis montana*), falling beakrush (*Rhynchospora caduca*), and broad leaf cattail (*Typha latifolia*). In general, the quality of this type of wetland is typically low especially in areas where agricultural activity is active and the land is routinely disturbed.

Forested land also closely fits the description provided by TPWD for pine-hardwood forest, as described above. Wetlands within these forested areas are considered important habitats for wildlife and are of value for the conservation of biological diversity (TPWD, 1984). Plant species composition within these areas generally consist of bald cypress (*Taxodium distichum*), water oak, willow oak (*Quercus phellos*), water hickory (*Carya aquatica*), green ash (*Fraxinus pennsylvanica*), buttonbush (*Cephalanthus occidentalis*),

swamp privet (*Forestiera acuminata*), swamp smartweed (*Polygonum hydropiperoides*), arrow head (*Sagittaria latifolia*), raven-foot sedge (*Carex crus-corvi*), Cherokee sedge (*Carex cherokeensis*), woodoats (*Chasmanthium sessiliflorum*), cutgrass (*Leersia hexandra*), lizard tail (*Saururus cernuus*), and spider lily (*Hymenocallis liriosme*).

Riparian zones are defined by areas that fall within a 100-year floodplain of a stream, or if a floodplain is absent, a zone hydrologically influenced by a stream or river (Hunt, 1988). Riparian ecosystems are maintained by high water tables and periodic flooding (Committee on Mitigating Wetland Losses, et. al, 2001, p152). Riparian zones are significant in ecology, environmental management, and civil engineering because of their role in soil conservation, biodiversity, and the influence they have on aquatic ecosystems. Vegetation within riparian zones can vary greatly depending on location. Within the study area vegetation would generally consist of water oak, willow oak, bald cypress, water hickory, raven-foot sedge, Cherokee sedge, switchgrass, Indian sea-oats (*Chasmanthium latifolium*), and various species of fern.

3.7.4.1 TxDOT-TPWD MOU

Of the special habitat features listed in the Memorandum of Understanding (MOU) between TxDOT and TPWD, bottomland hardwoods and water bodies have been identified in the study area. In accordance with Provision (4)(A)(ii) of the TxDOT-TPWD MOU, and at the TxDOT Houston District's discretion, habitats given consideration for non-regulatory mitigation during project planning include the following:

- habitat for federal candidate species (impacted by the project) if mitigation would assist in the preservation of the listing of the species;
- rare vegetation series (S1, S2, or S3) that also locally provide habitat for a state-listed species;
- all vegetation communities listed as S1 or S2, regardless of whether or not the series in question provide habitat for state-listed species;
- bottomland hardwoods, native prairies and riparian sites; and
- any other habitat feature considered locally important that the TxDOT District chooses to consider.

According to the TPWD Texas Natural Diversity Database (TxNDD), a water oak-willow oak rare vegetation series, which is a bottomland hardwood plant community with a state rank S3, and is located in the study area just north of Lake Houston (2013). These areas are accounted for within the 91,700 ac of pine-hardwood forest. Additionally, a loblolly pine-white oak-southern red oak series (Pinus taeda-Quercus

alba-Quercus falcata) occurs within the study area. Riparian sites are also present within the study area. No known habitat for federal candidate species or S1 or S2 vegetation communities within the study area.

3.7.4.2 Beneficial Landscape Practices

In accordance with the Executive Memorandum on Beneficial Landscape Practices of August 10, 1995, all agencies shall comply with the National Environmental Policy Act (NEPA) as it relates to vegetation management and landscape practices for all federally-assisted projects. The Executive Memorandum directs that where cost-effective and to the extent practicable, agencies would (1) use regionally native plants for landscaping; (2) design, use, or promote construction practices that minimize adverse effects on the natural habitat; (3) seed to prevent pollution by, among other things, reducing fertilizer and pesticide use; (4) implement water-efficient and run-off reduction practices; and (5) create demonstration projects employing these practices. Landscaping included with this project would be in compliance with the Executive Memorandum and the guidelines for environmentally and economically beneficial landscape practices.

3.7.4.3 Invasive Species

On February 3, 1999, the President issued EO 13112 to prevent the introduction of invasive species and provide for their control, and to minimize their economic, ecological, and human health impacts. In accordance with EO 13112 on Invasive Species and the Executive Memorandum on Beneficial Landscaping, landscaping would be limited to seeding or planting with native species of grasses or other vegetation, as appropriate.

3.8 WILDLIFE

This section provides an overview of the wildlife resources within the study area. The wildlife species having a potential to occur within the study area are described based upon vegetation types established for Texas by the TPWD, as shown on **Exhibit 1-2**.

Agriculture has substantially impacted most of the study area. Cultivated fields dominate the landscape in the southern portion of the study area. With the removal or decline of native vegetation and human encroachment into habitats, the wildlife species composition and diversity also show a decline from the abundant communities that probably once existed throughout the Pineywoods and Gulf Coastal Prairies and Marshes regions of East Texas.

Agricultural fields that may seem to have very little wildlife may support multiple species within the ecotonal areas along fence rows and in the isolated pockets or fields that still exhibit native or fallow vegetation. Species may also utilize crop and fallow fields for feeding and temporary shelter. Rodent species like the fulvous harvest mouse (*Reithrodontomys fulvescens*), can be found in crop fields and fence rows within the study area. Some species, such as the northern pygmy mouse (*Baiomys taylori*), may have expanded their ranges using fence rows as travel corridors. Larger wildlife species, like the hispid cotton rat (*Sigmodon hispidus*), the eastern cottontail (*Sylvilagus floridanus*), striped skunk (*Mephitis mephitis*), bobcat (*Lynx rufus*), gray fox (*Urocyon cinereoargenteus*), and coyote (*Canus latrans*) may occasionally utilize ecotonal areas around agricultural fields. Many of these species, including the white-tailed deer (*Odocoileus virginianus*), are still present in parts of the study area. Avian species such as the chipping sparrow (*Spizella passerine*) and the lark sparrow (*Chondestes grammacus*) may utilize these farmland areas as permanent breeding residents and/or as wintering residents. The eastern meadowlark (*Sturnella magna*) is a permanent resident that may nest in hayfields or disturbed grasslands. Other avian species such as the broad-winged hawk (*Buteo platypterus*), red-shouldered hawk (*Buteo lineatus*), red-tailed hawk (*Buteo jamaicensis*), American kestrel (*Falco sparverius*), loggerhead shrike (*Lanius ludovicianus*), and the barn owl (*Tyto alba*) can be found locally.

Some of the avian species that may be found in the Pineywoods natural region located in the northern and western portion of the study area include Bachman's sparrow (*Aimophila aestivalis*), swallow-tailed kite (*Elanoides forficatus*), red-cockaded woodpecker (*Picoides borealis*), and barred owl (*Strix varia*). Mammals that can be found in the Pineywoods natural region (forested) of East Texas include river otter (*Lutra canadensis*), swamp rabbit (*Sylvilagus aquaticus*), Rafinesque's big-eared bat (*Corynorhinus rafinesquii*), southeastern myotis bat (*Myotis austroriparius*), and eastern spotted skunk (*Spilogale putorius*). Reptiles associated with the Pineywoods natural region of East Texas include timber rattlesnake (*Crotalus horridus*), Louisiana pine snake (*Pituophis ruthveni*), alligator snapping turtle (*Macrochelys temminckii*), and a variety of salamanders.

3.8.1 Migratory Bird Treaty Act

The Migratory Bird Treaty Act (MBTA) of 1918 states it is unlawful to kill, capture, collect, possess, buy, sell, trade, or transport any migratory bird, nest, or egg in part or in whole, without a federal permit issued in accordance with the Act's policies and regulations. Trees observed throughout the study area may provide migratory bird habitat.

3.9 THREATENED AND ENDANGERED SPECIES

The Endangered Species Act (ESA) of 1973 assigns the responsibility of enforcing the ESA to the Secretary of the Interior and the USFWS. Chapters 68 and 88 of the TPWD Code address the TPWD's responsibilities regarding state-listed threatened and endangered species. The study area was evaluated against the USFWS and TPWD's lists of federal- and state-listed threatened and endangered species for each county within the project limits. In addition, a check of the TPWD's "mimic" version of the TxNDD was requested on February 19, 2013 and obtained on February 24, 2013 for known locations of federal-listed threatened and endangered species.

3.9.1 U.S. Fish and Wildlife Service

The purpose of the ESA is to protect threatened and endangered species and their critical habitat. Endangered means a species is in danger of extinction throughout all or a substantial portion of its range. Threatened means that a species is likely to become endangered in the future throughout all or a substantial portion of its range. In addition, the USFWS maintains a list of "candidate" species. According to USFWS, candidate species are plants and animals for which the USFWS has sufficient information on their biological status and threats to propose them as endangered or threatened under the ESA, but for which development of a proposed listing regulation is precluded by other higher priority listing activities.

3.9.2 Texas Parks and Wildlife Department

In 1973, the Texas legislature authorized the TPWD to develop a list of threatened and endangered animal species. In 1988, the Texas legislature further authorized the TPWD to develop a list of threatened and endangered plants for the state. Chapter 68 of the TPWD Code requires the Department to manage and ensure the conservation and preservation of indigenous fish or wildlife that are threatened with extinction in the state. The protection of threatened and endangered plants is addressed in Chapter 88 of the TPWD Code.

The TPWD maintains a database, the TxNDD, which contains data on known locations of rare, threatened, and endangered species in the state. The TxNDD is comprised of data obtained from museum and herbarium collection records, peer reviewed publications, experts in the scientific community, organizations, qualified individuals, and on-site surveys conducted by the TPWD on public lands or private lands with written permission. However, because the majority of the state is in private ownership, substantial data gaps exist in the TxNDD data.

3.9.3 Listing and Monitoring Process

3.9.3.1 Federal-Listed Species

The ESA assigns the responsibility for determining whether to place a plant or animal on the endangered species list to the Secretary of the Interior. The Secretary of the Interior delegates the responsibility of approving petitions for listing species, the proposals for listing species, and the final listing determinations to the Director of the USFWS.

Section 4 of the ESA identifies five criteria for a species to be listed as threatened or endangered:

- the present or threatened destruction, modification, or curtailment of its habitat or range;
- overutilization for commercial, recreational, scientific, or educational purposes;
- disease or predation;
- the inadequacy of existing regulatory mechanisms; or
- other natural or manmade factors affecting its continued existence.

The proposed Segments H and I-1 of the Grand Parkway are located in Montgomery, Harris, Liberty, and Chambers counties. The federal-listed threatened and endangered species lists were obtained from the USFWS Region 2 office's website (USFWS, 2012) for these four counties and are presented in **Table 3-16**.

Table 3-16: Federal-Listed Threatened and Endangered Species Within the Study Area Counties

Common Name	Scientific Name	Listing Status	County	Habitat	Habitat Potential
Birds					
Bald eagle	*Haliaeetus leucocephalus*	DM[1]	Chambers, Harris, Liberty, Montgomery	Near water areas, in tall trees	Yes
Brown pelican	*Pelecanus occidentalis*	DM,E[2]	Chambers	Islands near coastal areas	No
Red-cockaded woodpecker	*Picoides borealis*	E	Liberty, Montgomery	Nests in 60+ year pines, forages in 30+ year pines	Yes
Piping plover	*Charadrius melodus*	E,T[2]	Chambers	beaches and bayside mud or salt flats	No
Reptiles					
Green sea turtle	*Chelonia mydas*	E,T[2]	Chambers	Gulf and bay system	No
Atlantic hawksbill sea turtle	*Eretmochelys imbricata*	E	Chambers	Gulf and bay system	No
Kemp's ridley sea turtle	*Lepidocheleys kempii*	E	Chambers	Gulf and bay system	No
Leatherback sea turtle	*Dermochelys coriacea*	E	Chambers	Gulf and bay system	No
Loggerhead sea turtle	*Caretta caretta*	T	Chambers	Gulf and bay system	No
Mammals					
West Indian manatee	*Trichechus manatus*	E	Chambers, Harris	Gulf and bay system	No
Plants					
Texas prairie dawn	*Hymenoxys texana*	E	Harris	Poorly drained areas in open grasslands; pimple mounds	Yes

AD – Proposed delisting; DM – Delisted taxon, recovered; E – Endangered; T – Threatened;
[1] The bald eagle is protected by the Bald and Golden Eagle Protection Act of 1940
[2] Multiple listing statuses are indicative of species with populations and/or subspecies that fall into more than one listing status category
Note: Species such as the Houston Toad and Whooping Crane are listed by the U.S. Wildlife Service; however, they are not listed to occur within these counties by the Clear Lake office of the U.S. Fish and Wildlife Service (2012)

On August 9, 2007, the bald eagle was removed from the USFWS threatened and endangered species list. Per the *Post-delisting Monitoring Plan for the Bald Eagle,* monitoring the status of the bald eagle is being done by collecting data on occupied nests over a 20 year period with sampling events held once every five years starting in early 2009 (USFWS, 2009). The USFWS could propose to relist the species if it appears that the bald eagle needs further protection under the ESA. Although the bald eagle is no longer protected under the ESA, it is currently protected under the Bald and Golden Eagle Protection Act and the MBTA. Bald eagles are known to occur in the vicinity of the proposed project. They have been known to feed along the riparian corridors of water ways that cross the proposed project area.

Potential habitat for the federal-listed endangered red-cockaded woodpecker and Texas prairie dawn exists within the study area. Red-cockaded woodpeckers prefer long-leaf pine forests; using 60-year and older pines for nesting and 30-year and older pines for foraging. Texas prairie dawn has relatively specific habitat requirements consisting of poorly drained areas in open grasslands. They are often on or at the base of pimple mounds.

The TxNDD data does not contain any known location records for the brown pelican, piping plover, or five sea turtle species in the study area. Although the TxNDD does not comprise a complete survey of all areas of the state, these species require coastal and pelagic (open sea) habitat not available within the study area. Therefore, these species are not expected to occur within the study area.

3.9.3.2 State-Listed Species

The county lists of state-listed threatened and endangered species, and species of concern, were obtained from the TPWD's Wildlife Diversity program for the four counties located within the study area. Known location data for state-listed threatened and endangered species was obtained from the TPWD's TxNDD on February 24, 2013. A list of state threatened and endangered species, and species of concern, is presented in **Table 3-17**.

Table 3-17: State-Listed Threatened and Endangered Species Within the Study Area Counties

Common Name	Specific Epithet	Listing Status[1]	County	Habitat	Habitat Potential
Amphibians					
Houston toad	*Anaxyrus houstonensis*	E	Harris, Liberty	Sandy soil, breeds in ephemeral pools	No
Birds					
American peregrine falcon	*Falco peregrinus anatum*	T	Chambers, Harris, Liberty, Montgomery	Potential migrant	Yes
Arctic peregrine falcon	*Falco peregrinus tundrius*	SOC	Chambers, Harris, Liberty, Montgomery	Potential migrant	Yes
Bachman's sparrow	*Aimophila aestivalis*	T	Liberty	Inhabits open pine forests with grassy understory or open habitats with dense ground cover of grasses and forbs	Yes
Bald eagle	*Haliaeetus leucocephalus*	T	Chambers, Harris, Liberty, Montgomery	Near water areas, in tall trees	Yes
Black Rail	*Laterallus jamaicensis*	SOC	Chambers, Harris	Salt, brackish, and freshwater marches, pond borders, wet meadows, and grassy swamps	Yes
Brown pelican	*Pelecanus occidentalis*	SOC	Chambers, Harris	Islands near coastal areas	No
Henslow's sparrow	*Ammodramus henslowii*	SOC	Chambers, Harris, Liberty, Montgomery	Weedy fields or cut-over areas	Yes
Mountain plover	*Charadrius montanus*	SOC	Harris	High plains or shortgrass prairie	No
Piping plover	*Charadrius melodus*	T	Chambers, Liberty, Montgomery	Beaches and bayside mud or salt flats	No
Red-cockaded woodpecker	*Picoides borealis*	E	Harris, Liberty, Montgomery	Nests in 60+ year pines, forages in 30+ year pines	Yes
Reddish egret	*Egretta rufescens*	T	Chambers	Brackish marshes, shallow salt ponds, and tidal flats; nests on dry coastal islands in brushy thickets	No
Snowy plover	*Charadrius alexandrinus*	SOC	Chambers, Harris	Potential migrant	Yes

Table 3-17: State-Listed Threatened and Endangered Species Within the Study Area Counties

Common Name	Specific Epithet	Listing Status[1]	County	Habitat	Habitat Potential
Southeastern snowy plover	*Charadrius alexandrinus tenuirostris*	SOC	Chambers, Harris	Beaches and bayside mud or salt flats	No
Western snowy plover	*Charadrius alexandrinus nivosus*	SOC	Chambers	Potential migrant	Yes
Sprague's Pipit	*Anthus spragueii*	SOC	Chambers, Montgomery, Harris, Liberty	Potential migrant. Strongly tied to native upland prairie, can be locally common in costal grasslands, uncommon to rare further west	No
Swallow-tailed kite	*Elanoides forficatus*	T	Chambers, Liberty	Lowland forests, especially swampy areas, ranging into open woodland; marshes, along rivers, lakes	Yes
White-faced ibis	*Plegadis chihi*	T	Chambers, Harris, Liberty, Montgomery	Freshwater, brackish, or salt marshes	Yes
White-tailed hawk	*Buteo albicaudatus*	T	Harris	Coastal Prairies	Yes
Whooping crane	*Grus americana*	E	Harris, Montgomery	Winters in Aransas NWR	No
Wood stork	*Mycteria americana*	T	Chambers, Harris, Liberty, Montgomery	Prairie ponds and flooded pastures	Yes
Fishes					
American eel	*Anguilla rostrata*	SOC	Chambers, Harris, Liberty	Coastal waterways below reservoirs to gulf	Yes
Creek chubsucker	*Erimyzon oblongus*	T	Harris, Liberty, Montgomery	Variety of small rivers and creeks, prefers headwaters	Yes
Paddlefish	*Polyodon spathula*	T	Liberty, Montgomery	Free-flowing rivers, shallow water over gravel bars; larvae may drift from reservoir to reservoir	Yes
Smalltooth sawfish	*Pristis pectinata*	E	Chambers, Harris	Sheltered bays, on shallow banks, and in estuaries or river mouths	No
Insects					
A mayfly	*Tricorythodes curvatus*	SOC	Montgomery	Bankside vegetation	Yes
A mayfly	*Plauditus gloveri*	SOC	Montgomery	Bankside vegetation	Yes
Gulf coast clubtail	*Gomphus modestus*	SOC	Liberty, Montgomery	Medium river, moderate gradient, and streams with silty sand or rocky bottoms	Yes
Texas emerald dragonfly	*Somatochlora margarita*	SOC	Montgomery	East Texas pineywoods; springfed creeks and bogs; small sandy forested streams with moderate current	Yes
Mammals					
Black bear	*Ursus americana*	T/SA	Liberty	Desert lowlands, high elevation forests and woodlands; rock piles, cliff overhangs, caves	Yes
Louisiana black bear	*Ursus americana luteolus*	T	Chambers, Harris, Liberty, Montgomery	Bottomland hardwoods; large, undisturbed forested areas	No
Rafinesque's big-eared bat	*Corynorhinus rafinesquii*	T	Harris, Liberty, Montgomery	Cavity trees in hardwood forest, concrete culverts, abandon buildings	Yes

Table 3-17: State-Listed Threatened and Endangered Species Within the Study Area Counties

Common Name	Specific Epithet	Listing Status[1]	County	Habitat	Habitat Potential
Red wolf	*Canis rufus*	E	Chambers, Harris, Liberty, Montgomery	Extirpated; Brushy, forested areas, coastal prairies	No
Plains spotted skunk	*Spilogale putorius interrupta*	SOC	Chambers, Harris, Liberty, Montgomery	Open fields, prairies, croplands, fence rows, farmyards, forest edges, and woodlands	Yes
Southeastern myotis bat	*Myotis austroriparius*	SOC	Chambers, Harris, Liberty, Montgomery	Cavity trees in bottomland hardwoods, concrete culverts, and abandoned man-made structures	Yes
Mollusks					
Creeper (squawfoot)	*Strophitus undulates*	SOC	Liberty, Montgomery	Small to large streams, prefers gravel or gravel and mud in flowing water	Yes
Fawnsfoot	*Truncilla donaciformis*	SOC	Liberty, Montgomery	Small and large rivers	Yes
Little spectaclecase	*Villosa lienosa*	SOC	Harris, Liberty, Montgomery	Creeks, rivers, and reservoirs	Yes
Louisiana pigtoe	*Pleurobema riddellii*	T	Chambers, Harris, Liberty, Montgomery	Streams and moderate-size rivers	Yes
Sandbank pocketbook	*Lampsilis satura*	T	Harris, Liberty, Montgomery	Small to large rivers on gravel, gravel-sand, and sand bottoms	Yes
Texas heelsplitter	*Potamilus amphichaenus*	T	Liberty	Quiet waters in mud or sand and also in reservoirs	Yes
Texas pigtoe	*Fusconaia askewi*	T	Harris, Liberty, Montgomery	Rivers with mixed mud, sand, and fine gravel	Yes
Wabash pigtoe	*Fusconaia flava*	SOC	Harris, Liberty, Montgomery	Creeks to large rivers on mud, sand, and gravel	Yes
Reptiles					
Alligator snapping turtle	*Macrochelys temminckii*	T	Chambers, Harris, Liberty, Montgomery	Deep water of rivers and canals	Yes
Atlantic hawksbill sea turtle	*Eretmochelys imbricata*	E	Chambers	Gulf and bay system	No
Green sea turtle	*Chelonia mydas*	T	Chambers, Harris	Gulf and bay system	No
Gulf saltmarsh snake	*Nerodia clarkia*	SOC	Chambers, Harris	Saline flats, coastal bays, and brackish river mouths	No
Kemp's ridley sea turtle	*Lepidochelys kempii*	E	Chambers, Harris	Gulf and bay system	No
Leatherback sea turtle	*Dermochelys coriacea*	E	Chambers, Harris	Gulf and bay system	No
Loggerhead sea turtle	*Caretta caretta*	T	Chambers, Harris	Gulf and bay system	No
Louisiana pine snake	*Pituophis ruthveni*	T	Liberty, Montgomery	Sandy, longleaf piney woods	Yes
Northern scarlet snake	*Cemophora coccinea copei*	T	Chambers, Liberty	Mixed hardwood scrub on sandy soils	Yes
Smooth green snake	*Liochlorophis vernalis*	T	Chambers, Harris	Gulf coastal prairies, prefers dense vegetation	Yes
Texas diamondback terrapin	*Malaclemys terrapin littoralis*	SOC	Chambers	Coastal marshes, tidal flats, coves, estuaries, and lagoons behind barrier beaches	No
Texas horned lizard	*Phrynosoma cornutum*	T	Chambers, Harris, Liberty, Montgomery	Open, semi-arid regions, with bunch grass	No
Timber/Canebrake rattlesnake	*Crotalus horridus*	T	Chambers, Harris, Liberty, Montgomery	Swamps/floodplains of hardwood and upland pine	Yes

Table 3-17: State-Listed Threatened and Endangered Species Within the Study Area Counties

Common Name	Specific Epithet	Listing Status[1]	County	Habitat	Habitat Potential
Plants					
Bristle nailwort	*Paronychia setacea*	SOC	Montgomery	Flowering vascular plant endemic to eastern southcentral Texas, occurring in sandy soils	No
Coastal gay-feather	*Liatris bracteata*	SOC	Harris	Black clay soils of prairie remnants	Yes
Correll's false dragon-head	*Physostegia correllii*	SOC	Montgomery	Wet soils including riverbanks, streamsides, creekbeds, roadside ditches, and irrigation channels	Yes
Florida ladies-tresses	*Spiranthes brevilabris* var. *floridana*	SOC	Harris	Moist to wet, relatively open sites of pine-dominated landscapes, meadows, pitcher plant and seepage bogs, wet prairies and savannahs, and flatwoods	No
Giant sharpstem umbrella-sedge	*Cyperus cephalanthus*	SOC	Harris	Remnant coastal prairies	No
Houston daisy	*Rayjacksonia aurea*	SOC	Harris	Seasonally wet, saline barren areas	No
Neglected coneflower	*Echinacea paradoxa var. neglecta*	SOC	Harris	Rocky prairies, glades, and crosstimber open woodlands	No
Panicled indigobush	*Amorpha paniculata*	SOC	Harris	Grows in acid seep forests, peat bogs, wet floodplain forests, and seasonal wetlands on the edge of Saline Prairies	No
Texas ladies'-tresses	*Spiranthes brevilabris* var. *brevilabris*	SOC	Harris	Sandy soils in moist prairies, incl. blackland/Fleming prairies, calcareous prairie pockets surrounded by pines, pine-hardwood forest, open pinelands, wetland pine savannahs/flatwoods	No
Texas meadow-rue	*Thalictrum texanum*	SOC	Harris	Mesic woodlands or forests	Yes
Texas prairie dawn	*Hymenoxys texana*	E	Harris	Poorly drained areas in open grasslands; pimple mounds	Yes
Texas windmill-grass	*Chloris texensis*	SOC	Chambers, Harris	Open to sometimes barren areas in prairies and grasslands	Yes
Threeflower broomweed	*Thurovia triflora*	SOC	Harris	Black clay soils of remnant grasslands, also tidal flats	Yes

[1] T-Threatened, E-Endangered, T/SA-Threatened by Similarity of Appearance, SOC – Species of Concern
Source: TPWD, 2012

There are 43 state-listed species that may have potential habitat within the study area. The American peregrine falcon, arctic peregrine falcon, snowy plover, and western snowy plover are all migrants and may utilize the study area for feeding or resting during their migration. The pine forests may provide suitable habitat for the Bachman's sparrow, red-cockaded woodpecker, and Louisiana pine snake.

Suitable habitat may be present in, or adjacent to, the streams within the study area for three state-listed fish species, four state-listed insects, eight state-listed mollusks, and the alligator snapping turtle. The streams and their riparian corridors may also provide suitable habitat for the bald eagle, black rail, wood stork, swallow-tailed kite, white-faced ibis, timber/canebrake rattlesnake, and Correll's false dragon-head.

Upland herbaceous areas may provide suitable habitat for Henslow's sparrow, plains spotted skunk, coastal gay feather, Texas prairie dawn, Texas windmill grass, and threeflower broomweed. Suitable habitat may be present in the coastal prairies for the white-tailed hawk and smooth green snake. Upland and bottomland hardwoods may provide suitable habitat for the black bear, Rafinesque's big-eared bat, Northern scarlet snake, southeastern myotis bat, and Texas meadow-rue.

Numerous colonial waterbird rookeries associated with riparian, bottomland, wetland, swamp, and marshland areas are known to occur throughout the study area. Rookeries are common in these areas as well as along the many impoundments and lakes within the study area, and along the nearby coastal areas of Trinity Bay, Burnet Bay, and Scott Bay. Anhinga (*Anhinga anhinga*), great blue herons (*Ardea herodias*), little blue herons (*Egretta caerulea*), cattle egrets (*Bubulcus ibis*), great egrets (*Casmerodius albus*), snowy egrets (*Egretta thula*), white ibis (*Eudocimus albus*), white-faced ibis, olivaceous cormorants (*Phalacrocorax olivaceus*), and roseate spoonbills (*Ajaia ajaja*) are known to congregate and nest in rookeries throughout the study area.

According to the TxNDD, two state-listed threatened species, three state-listed species of concern, and two rare plant communities have been documented within a 1.5-mi radius of the study area. There have been no other recorded sightings of any federal- or state-listed species within close proximity of the study area. However, it should be noted that an absence of data for a particular species does not mean an absence of occurrence for threatened, endangered, and rare species. The following provides a description of the element of occurrences, including the element of occurrence identification (EOID), within 1.5 mi of the study area.

Rafinesque's big-eared bat (*Corynorhinus rafinesquii*) – EOID 5412

This is a state-listed threatened species and TxNDD indicates an element of occurrence within the study area. Rafinesque's big-eared bat is a medium-sized bat with long rabbit-like ears (27-37 millimeters). The bat has large facial glands protruding from each side of its snout. Its fur is grayish brown above and

conspicuously bicolored underneath; it has a forearm length of 39-43 millimeters and weighs 7-13 grams. Rafinesque's big-eared bats roost in cave entrances, hollow trees, abandoned buildings, and under bridges in the forests of southeastern United States. Like others in the order Chiroptera, these bats are insectivores (eat only insects). They also hibernate during the winter. Rafinesque's big-eared bat has the potential, or a known presence, in multiple counties in eastern Texas, including Harris, Liberty, and Montgomery counties within the study area.

Bald eagle (*Haliaeetus leucocephalus*) – EOID 7972

This is a state-listed threatened species and TxNDD indicates an element of occurrence 0.29 mi from the study area. The bald eagle is a large raptor generally weighing seven to ten pounds with a wingspan sometimes reaching more than seven feet. Adult bald eagles are easily recognized with their stark white coloration on the head contrasting with a solid black or dark brown body. Bald eagles are opportunistic predators and commonly feed on water birds, bottom dwelling fish, and turtles in Texas. In Texas, bald eagles nest from October to July in nests measuring up to six feet in width and weighing hundreds of pounds (TPWD, 2013). In Texas, the winter and nesting range for the bald eagle is generally restricted to the eastern portion of the state.

Correll's false dragon-head (*Physostegia correllii*) – EOID 4512

This is a state-listed species of concern and TxNDD indicates an element of occurrence 0.11 mi from the study area. Correll's false dragon-head is a perennial herbaceous plant that flowers from May to September. Extent populations of Correll's false dragon-head are found in Texas, Louisiana, and Mexico. Habitat for this plant in Texas includes riverbanks, streamsides, creekbeds, roadside ditches, and irrigation canals.

Threeflower broomweed (*Thurovia triflora*) – EOID 7357

This is a state-listed species of concern and TxNDD indicates an element of occurrence within the study area. Threeflower broomweed is a herbaceous annual endemic to coastal Texas. Threeflower broomweed is found in black clay soils of remnant grasslands, tidal flats, and sparsely vegetated, saline areas in coastal prairie. Threeflower broomweed blooms from September to October.

Texas windmill-grass (*Chloris texensis*) – EOID 7812

This is a state-listed species of concern and TxNDD indicates element of occurrence 0.87 mi from the study area. Texas windmill-grass is a tufted perennial grass that flowers in October and November. Texas windmill grass occurs in open or barren areas within prairies along the Texas coast. Microhabitat for Texas windmill grass includes sandy openings on or at the base of pimple mounds.

Loblolly pine-white oak-southern red oak series (*Pinus taeda-Quercus alba-Quercus falcata* series) – EOID 1489 and EOID 5487

This is a state-listed special habitat (G4, S4) and TxNDD indicates an element of occurrence within the study area. This vegetation supports many animal species, such as the state threatened Rafinesque's big-eared bat, that depend on mature, bottomland hardwood habitats. Plant species commonly associated with this vegetation series include sweetgum, cherrybark oak (*Q. pagoda*), ash (*Fraxinus* spp.), and overcup oak (*Q. lyrata*). Ironwood, eastern hop-hornbeam (*Ostrya virginiana*), deciduous holly (*Ilex decidua*), and Florida maple (*Acer barbatum*) often compose the understory of this vegetation series.

Water oak-willow oak series (*Quercus nigra-Quercus phellos* series) – EOID 1910 and EOID 1092

This is a state-listed special habitat (G4, S3) and TxNDD indicates element of occurrence within the study area and 0.42 mi from the study area. The water oak/willow oak vegetation series is known to occur within the Lake Houston Wilderness Park and surrounding areas. The water oak/willow oak habitat is a deciduous bottomland hardwood forest located in often inundated floodplains of East Texas.

Those species listed in the TxNDD could potentially occur in areas of suitable habitat within the study area.

3.10 FLOODPLAINS

Floodplains (Zone A – 100 Year) in the study area are depicted on **Exhibit 3-13**. FEMA administers the National Flood Insurance Program (NFIP). All counties in the study area are participating members of the NFIP. The floodplains encountered are all Zone A. Zone A signifies a special flood hazard area that is inundated by 100-yr flood events.

FEMA has examined in detail the majority of the rivers, bayous and streams within the study area, and flood hazard areas have been established. They delineated Zones A, which are 100-yr floodplains with no BFE. They also delineated Zones AE, which are 100-yr floodplains that exhibit BFEs. Both zones are annotated on the Flood Insurance Rate Maps, also known as FIRM panels. Both zones were digitized by

FEMA as Quality Level 3 Digital FIRM (Q3). The Q3 flood data is controlled to the USGS mapping at 1:24,000 scale. The FEMA Flood Insurance Studies contain water surface profiles for the 10-, 50-, 100- and 500-yr floods.

Elevations of all types cited herein for Montgomery, Liberty, and Chambers counties are referenced to the National Geodetic Vertical Datum of 1929 (NGVD) with various updates. Harris County elevations are based on Tropical Storm Allison Recovery Project data (TSARP), which is year 2001 surface data with considerations for subsidence since 1973. TSARP technology resulted in 2-ft contour intervals for Harris County. The USGS mapping (Q3), used for the majority of the study area, is based on 5-ft contour intervals. According to the literature, a number of technical differences in the new TSARP approach make direct comparisons to the old studies or adjacent studies inappropriate. A direct relationship between TSARP in Harris County would only be established as other areas are mapped with the same technology.

There are three drainage basins that envelop the study area: the San Jacinto River Basin (5,600 mi^2), the transitional Trinity-San Jacinto Coastal Basin (247 mi^2) and the Lower Trinity River Basin (750 mi^2). The individual watersheds, water bodies, and floodplains within the study area are described in **Section 3.6**. Flooding commonly occurs along all reaches of the streams studied with 100-yr velocities typically slow, at less than 4.0 fps. In many cases, the peak discharges are attenuated downstream due to over bank storage. Many minor tributaries feed all major streams in the study area.

It should be noted that a floodway is considered the channel of a stream, including some adjacent floodplain area that must be kept free of encroachment. The 100-yr peak discharge conveyed within the floodway is not allowed to create substantial increase in the BFE. FEMA has instituted a 1 ft maximum increase provided high velocities are not created. The floodway fringe is the area between the floodway and the outer limits of the floodplain. For floodway computations, equal conveyance reduction from each side of the floodplain is normally used. Thus, it is possible to ascertain topographical change based on the floodway location relative to the entire 100-yr floodplain.

FEMA Q3 GIS data was used to approximate the acreages of floodway and 100-yr floodplain within the study area for each major river or stream. The approximated acreages of floodways and 100-yr floodplains are shown in **Table 3-18.**

Table 3-18: Study Area Floodways and 100-year Floodplains

Stream	Floodways within the Study area (acres)	100-year Floodplains within the Study area (acres)
Caney Creek	1,077.9	2,363.0
Cedar Bayou	3,577.4	11,817.0
East Fork Cedar Bayou	65.0	230.2
East Fork San Jacinto River	2,477.8	5,396.4
Luce Bayou	1,899.3	4,028.0
Peach Creek	893.4	2,508.3
Total	**9,990.8**	**26,342.9**

Source: FEMA Digital Q3 Data, 2010

3.11 WILD AND SCENIC RIVERS

The Wild and Scenic Rivers Act of October 2, 1968 was enacted to preserve outstandingly remarkable rivers in free-flowing condition, and to protect their immediate environments for the benefit and enjoyment of present and future generations. There are no rivers or river segments within the study area that are listed as part of, or under study for designation to, the National Inventory of the National Wild and Scenic River System.

3.12 COASTAL BARRIERS

The Coastal Barrier Resources Act of 1982 encourages conservation of coastal barriers by restricting federal expenditures that encourage development (USFWS, 1982). There are no coastal barriers located within the study area.

3.13 COASTAL ZONE MANAGEMENT

The Coastal Zone Management Act of 1972, administered by the National Oceanic and Atmospheric Administration (NOAA), provides for management of the nation's coastal resources and balances economic development with environmental conservation. The Texas Coastal Management Program was approved by NOAA in 1996 to improve the management of the state's coastal resources. The southern limit of the study area abuts I-10 (E), the northern Coastal Zone boundary in Chambers County. A portion of the study area at I-10 (E) is included in the coastal zone management program.

3.14 ESSENTIAL FISH HABITAT

In 1996, Congress revised the Magnuson-Stevens Act and emphasized the need to protect fish habitat. The Act requires that fishery management plans identify essential fish habitat (EFH), areas that are necessary to fish for their basic life functions. EFH areas were obtained from the NOAA Essential Fish Habitat Mapper (NOAA, 2009). According to NOAA, EFH for coastal migratory pelagic species, reef fish,

red drum, shrimp, and stone crab is located within the study area in the East Fork San Jacinto River, to approximately 3 mi upstream from Lake Houston. Additionally, Cedar Bayou is mapped as tidally influenced up to 1.4 mi north of I-10 (E) on the west side of Mont Belvieu and may potentially contain EFH.

3.15 CULTURAL RESOURCES

NEPA requires consideration of important historic, cultural and natural aspects of our national heritage. Important aspects of our national heritage that may be present have been considered under Section 106 of the National Historic Preservation Act (NHPA) of 1966, as amended. The Act requires federal agencies to take into account the effect that an undertaking will have on cultural resources. Cultural resources are structures, buildings, archeological sites, districts, (a collection of related structures, buildings and/or archeological sites), cemeteries, and objects of historical significance. Both federal and state laws require consideration of cultural resources during project planning. In addition, the project also falls under the purview of the Antiquities Code of Texas (ACT) because it involves lands owned or controlled by the State of Texas or any city, county, or local municipality.

In addition, compliance with NHPA requires federal agencies to take into account the effect that an undertaking will have on cultural resources. Compliance with these laws may require consultation with the Texas Historical Commission (THC)/Texas State Historic Preservation Officer (SHPO) and/or federally-recognized tribes to determine the project's effects on cultural resources. Review and coordination of this project would follow approved procedures for compliance with federal and state laws.

3.15.1 Archeological Resources

According to the Houston Potential Archeological Liability Map (PALM) GIS database compiled by TxDOT ENV, the study area traverses Map Units 1, 2, 2a, 3, 3a, and 4. For Map Unit 1, a surface survey is recommended, and deep reconnaissance is recommended if deep impacts are anticipated. For Map Unit 2, a surface survey is recommended, and deep reconnaissance is not recommended. For Map Unit 2a, a surface survey of mounds is recommended, and deep reconnaissance is not recommended. For Map Unit 3, a surface survey is not recommended; however, deep reconnaissance is recommended if deep impacts are anticipated. For Map Unit 3a, a surface survey is not recommended; however, deep reconnaissance is recommended only if severe deep impacts are anticipated. For Map Unit 4, no survey is recommended. PALM Map data is limited to only those portions of the study area which fall inside Harris

and Montgomery Counties (**Exhibit 3-14**). PALM Map data is not available for Liberty and Chambers Counties.

Known archeological site locations were researched using the THC's online Texas Archeological Sites Atlas. These records revealed a total of 1,882 previously recorded sites in the study area, including: Montgomery (215), Harris (1,149), Liberty (112), and Chambers (406) counties. Of these sites, 264 (Montgomery = 2, Harris = 252, Liberty = 5, and Chambers = 5) are listed on the National Register of Historic Places (NRHP), and 125 (Montgomery = 0, Harris = 95, Liberty = 14, and Chambers = 16) are identified as State Archeological Landmark (SAL) properties. Nine of these sites are present within the study area; four of these sites are in Liberty County and five in Harris County. No known archeological sites are known to exist within the study area for either Chambers or Montgomery counties. Attributes for the nine known archeological sites are summarized in **Table 3-19**. Each site is individually described below by county.

Table 3-19: Known Archeological Sites

County	Site Number	Historic or Prehistoric	Site Type	Cultural Affiliation	National Register Status	Further Work
Liberty	41LB44	Prehistoric	Occupation	Unknown	Unknown	Unknown
Liberty	41LB45*	Prehistoric	Occupation	Unknown	Unknown	Unknown
Liberty	41LB46*	Prehistoric	Occupation	Unknown	Unknown	No
Liberty	41LB50	Historic	Historic House	Unknown	Unknown	Unknown
Harris	41HR313	Prehistoric	Unknown	Unknown	Unknown	Unknown
Harris	41HR639	Prehistoric	Mound	Orcoquisac	Unknown	Yes
Harris	41HR641	Prehistoric	Occupation	Unknown	Unknown	Yes
Harris	41HR642	Prehistoric	Occupation	Unknown	Unknown	Yes
Harris	41HR684	Prehistoric	Occupation	Orcoquisac	Unknown	No

*Sites destroyed by previous activities
Source: THC, 2012

As shown in **Table 3-20**, the number of sites per square mile varies by county. These numbers do not necessarily reflect the actual occurrence of sites per county, but likely reflect the greater amount of surveys conducted in particular counties (i.e. Harris County).

Table 3-20: Number of Archeological Sites and County Acreage

County	# of Sites*	# of Surveys	County Square Mile**	Sites per Square Mile	Surveys per Square Mile
Chambers	402	208	606	0.7	0.3
Harris	1085	1048	1,778	0.6	0.6
Liberty	108	93	1,174	0.1	0.1
Montgomery	225	221	1,047	0.2	0.2
Average	**455**	**392**	**1,151**	**0.4**	**0.3**

* Data for archeological surveys obtained from the online Texas Archeological Sites Atlas, maintained by the THC. http://nueces.thc.state.tx.us/
** Data for county size obtained from the Texas State Historical Association, The Handbook of Texas Online http://www.tsha.utexas.edu/handbook/online/

The prehistory of Texas spans at least 13,000 years from at least 11,500 B.C. to the time of the European contact in the seventeenth century. The periods of Texas' prehistory are divided into three broad periods; Paleoindian, Archaic, and the Late Prehistoric.

3.15.1.1 Paleoindian (11,500 B.C. – 6,000 B.C.)

The Paleoindian period represents the earliest known occupation in East Central Texas. People during this period relied on mega fauna (predominantly mammoth and *Bison antiquus*) as well as broader-based hunting and gathering for their subsistence needs. Paleoindian artifacts included distinctive lanceolate projectile points, side scrapers, end scrapers, gravers, modified flake tools, and drills. These tools are sometimes found associated with the remains of extinct mega fauna species. Typically, Paleoindian sites are located near playa lakes and relict streambeds or along small rises and ridges. These sites are usually ephemeral and may be difficult to recognize. Differences in topographic settings and artifact and faunal assemblages have led archeologists to interpret Paleoindian sites in terms of function classes based on the activities inferred to have taken place there. Typical site types of this period include camp sites, kill sites, processing sites, and quarry sites. During the Paleoindian period, the climate was vastly different than it is today. It has been marked by continuous environmental change over several thousand years. During the earlier phases, the environment was wetter and cooler. Throughout the course of the Paleoindian period, the climate became increasingly arid with greater seasonal variation. These conditions resulted in shifting vegetation patterns and faunal extinctions, which in turn, affected Paleoindian subsistence strategies, settlement patterns, and lithic technologies (Aten 1983, Story 1990).

3.15.1.2 Archaic (6,000 B.C. – 700 A.D.)

The Archaic period, lasting some 5,000 to 6,000 years, is ascribed more longevity than other prehistoric cultural periods. Despite the fact that many sites in East Central Texas have been assigned to the Archaic period, relatively little is known about this time period. Subsistence adaptations during the Archaic period are thought to have generally changed from a reliance on big game hunting to a more broad-based hunting and foraging strategy. Archaic period occupations are distinguished from earlier and later occupations by side- and corner-notched projectile points, bifaces, flake scrapers, and drills. These sites typically consist of lithic and fire-cracked rock scatters that are often situated in areas that overlook drainages (Aten, 1983, Patterson 1979, Story 1990).

3.15.1.3 Late Prehistoric (700 A.D. to Historic Period)

Beginning sometime between A.D. 600 and 900 and continuing to as late as A.D. 1550, the archeological record of southeastern East Central Texas reflects increasing regional and interregional variability. Also during this period several technological developments occurred, namely the development of the bow and arrow, ceramics, and other distinctive types of stone tools. These developments marked a change of this period from the preceding Archaic. Cultural identifiers during the Late Historic Period include material culture, and hunting patterns. Settlement patterns included sedentary villages, and ceremonial centers. Social-cultural features included an established social hierarchy. One distinctive aspect of the Late Prehistoric was widespread, long-distance trade (Aten 1983).

3.15.2 Non-Archeological Historic Resources

Regulatory Requirements

In accordance with the Advisory Council on Historic Preservation (ACHP) regulations pertaining to the protection of historic properties (36 CFR 800.4), federal agencies are required to identify and evaluate historic-age non-archeological resources for NRHP eligibility and assess the effects that the undertaking would have on historic resources. A historic-age resource as defined in accordance with 36 CFR 60 is a building, structure, object, district or site that is within the area of potential effects (APE) and at least 50 years old at the time of project letting. The Programmatic Agreement for Transportation Undertakings (PA-TU) authorized among FHWA, the ACHP, the SHPO, and TxDOT outlines a streamlined approach for conducting Section 106 consultation and review with the SHPO. The document provides regulatory authority to TxDOT ENV to identify and evaluate cultural resources for NRHP eligibility and, when NRHP listed or eligible resources are present, assess potential project impacts and/or effects.

The proposed project also falls under the purview of the ACT. The ACT allows for all such resources to be considered as SAL, and requires that each be examined in terms of possible significance. Standards for the code are outlined under Chapter 26 of the THC Rules of Practice and Procedure for the ACT and closely follow those of the Secretary of the Interior's Standards and Guidelines.

If an effect is determined to be adverse, the agency must take steps to avoid, minimize, and/or mitigate the adverse effect. The consultation process of identification, evaluation, and assessment used to address the requirements of Section 106 of NHPA is codified in the PA-TU. If a transportation activity has the potential to adversely affect a historic resource and includes the proposed taking or use of the property for a

transportation activity, the special provision of Section 4(f) of the United States Department of Transportation (USDOT) Act of 1966 (now 23 CFR 774) must also be addressed. Considerations must include any feasible and prudent alternatives and planning to minimize harm.

3.15.2.1 Determination of the Proposed Area of Potential Effects, the Survey Study Area (SSA) and the Historic-Age Cut-off Date

An APE of 300 feet from the edge of the proposed ROW was approved by TxDOT ENV as part of the approved Research Design. The APE was justified because the majority of the proposed project is on new location. A survey study area (SSA) of 1300 feet beyond the proposed ROW was also approved as part of the Research Design to include resources that contribute to the development of historic contexts through a broader understanding of the project area.

The criterion of 50 years prior to the construction letting date to define historic-age is prescribed within the Secretary of the Interior's guidelines for NRHP eligibility and the current PA-TU among FHWA, ACHP, SHPO and TxDOT. However, a 45 year cut-off (45 years prior to the letting date) to allow for project changes and/or delays is suggested in the September 8, 2006, Draft Historic Resources Section 106 Review and NEPA Guide, published by ENV. The proposed letting date for the proposed project is 2016; therefore, resources dating to 1971 and earlier will be surveyed.

3.15.2.2 File Review Methodology

A file review of available records was completed to identify previously recorded historic resources within the APE and SSA. Repositories consulted included the Texas Historical Commission's Texas Historic Sites Atlas (Atlas). The historian specifically reviewed for listings in the NRHP, SAL, and Recorded Texas Historic Landmarks (RTHL). In addition, historians researched historic markers of all types including Official Texas Historic Markers (OTHM) and all cemeteries, including Historic Texas Cemeteries (HTC). Various published materials, including on-line resources were consulted in the development of the historic contexts for the APE. High resolution aerial photographs, current and historic topographic maps and highway maps, as well as other historic and non-historic maps were used to locate potential historic-age resources within the APE. A complete list of sources that were consulted is located in **Appendix F.**

3.15.2.2.1 Results of File Review

The review of available records resulted in the identification of no listed NRHP, SAL, or RTHL resources within the APE or SSA. No historic markers of any type, including OTHM, were identified within the APE or SSA. Two resources were identified within the APE that were previously determined NRHP-eligible. These resources are portions of the Dayton Canal rice irrigation system and include the Main Canal, and the Big Ditch drainage canal. A Draft Non-Archeological Historic-Age Resources Survey (HRSR) that was prepared for another project was identified during the records review entitled, 'Historic Resources Reconnaissance Survey SH 146: from US 90 in Dayton, Texas to the Chambers County Line, Liberty County, Texas, completed in April 2006 (TxDOT CSJ# 0389-01-036). In the report, an APE was surveyed in which the Dayton Canal was identified as a prominent feature and a historic-age resource. The report recommended an Intensive Survey to determine the NRHP eligibility of the Dayton Canal and the subsequent Intensive Survey entitled, 'Dayton Canal along SH 146 Liberty, County, Texas,' was completed in September 2006. The Dayton Main Canal and the Big Ditch (main drainage ditch) were determined eligible for the NRHP under Criterion A, at the local level of significance, in the area of Agriculture, and within the period of significance 1910-1927 and 1935-1964. The APE for both the previous reconnaissance and intensive surveys is west of and outside of the APE for Segments H and I-1. The APE determined in the previous reports does not overlap any portion of the APE for Segments H and I-1. However, because of the linear nature of canal systems, portions of both of the NRHP eligible features of the Dayton Canal are present within the APE for Segments H and I-1. One cemetery, the East River Baptist Church Cemetery in Montgomery County is listed in the Atlas as cemetery MQ-C024. The previously recorded historic resources within the APE and SSA are shown on **Exhibit 3-15.**

As a result of consultation with TxDOT ENV historians, a Non-Archeological Historic Resources Preliminary Survey was conducted in July 2007. The survey used an APE of 300 feet from the proposed ROW of each reasonable alternative being considered at that time. The projected letting date in 2007 was 2018, thus 1973 was the criteria used to determine the historic-age criteria cut-off date. The purpose of the survey was to identify previously designated NRHP, RTHL or SAL resources, as well as to identify historic-age resources considered to have NRHP eligibility potential, in an effort to avoid these resources to the maximum extent practicable during future alternatives analysis decision-making. Historic-age resources that were considered not to have NRHP eligibility potential, or were not visible or accessible from public

venues were intended to be fully documented during a future reconnaissance-level survey and subsequent HRSR.

3.15.2.3 Historic Resources Survey Report Methodology

A Draft Non-Archeological Historic-Age Resources Survey (HRSR) has been prepared and submitted to the TxDOT Houston District and to TxDOT ENV for their review. TxDOT ENV will make the final determinations of eligibility and effects to historic properties and will coordinate with SHPO per the First Amended Programmatic Agreement of Transportation Undertakings (PA-TU).

3.16 HAZARDOUS MATERIALS

Land uses within the study area are a mixture of industrial, commercial, residential, and agricultural. Major concentrations of developed areas are located at the northern and southern boundaries. Large rural tracts used for farming and other types of agricultural uses are located throughout the study area. The developed area in the northern section is primarily residential. The overall region is known for its petroleum-based industries, including numerous oil and gas refineries. These large petroleum-based facilities are located throughout the study area, with a heavy concentration in the southern portion.

There are also numerous oil and gas wells, including pipelines, within the study area. Two salt domes are located in the study area. One is located in Mont Belvieu at the southern end of the study area, and another is located northwest of Dayton in the northern portion of the study area. A salt dome can form pockets and reservoirs where petroleum and natural gas can collect. Oil from these pools can be extracted and is used as a major source of petroleum produced along the Gulf of Mexico.

Hazardous materials are generally defined as any material that has or would have, when combined with other materials, an adverse effect on humans or the natural environment. Characterized as reactive, toxic, infectious, flammable, explosive, corrosive, or radioactive, hazardous materials may be solid, sludge, liquid, or gas. Potential hazardous materials sites include service stations, landfills, salvage yards, and industrial sites, as well as aboveground and underground storage tanks (ASTs and USTs). The EPA and TCEQ maintain various databases of regulated sites, including landfills and facilities that transport, store, and treat hazardous materials.

A records search was conducted for hazardous materials sites and/or areas of potential concern and is provided as a GIS database. In addition, the Railroad Commission of Texas (RRC) was also contacted and

GIS spatial data layers were obtained, providing locations of oil and gas wells and pipelines for all four counties within the study area. Ortho-photography along with limited field visits was also used in locating and defining additional areas of concern.

3.16.1 Hazardous Materials Sites

There are 432 hazardous materials sites located within the study area. **Table 3-21** provides a summary of the potential hazardous materials sites identified during the initial search of the study area. **Exhibit 3-16** depicts the locations of the potential hazardous materials sites within the study area. Refer to **Appendix G** for individual in-depth site information.

Table 3-21: Federal Regulatory Database Search

Database Abbreviation	Database Description	Number of Sites
NPL	*National Priorities List* – Priority sites for cleanup under the federal Superfund program. EPA has determined that these sites pose a threat to human health and remediation is required.	0
CERCLIS	*Comprehensive Environmental Response, Compensation, and Liability Information System* – Listing of Superfund sites that the EPA has investigated or is currently investigating for a release or threatened release of hazardous substances. Contains sites which are either proposed or on the NPL and sites which are in the screening and assessment phase for possible inclusion on the NPL.	1
CERCLIS –NFRAP	*CERCLIS "No Further Remedial Action Planned"* –Contains information on sites that have been removed and archived from the inventory of Superfund sites. Archive status indicates that, to the best of EPA's knowledge, federal Superfund assessment of a site is complete and it has been determined that no further steps would be taken to list the site on the NPL.	6
CORRACTS	*Corrective Action Report* – Identifies Hazardous Waste Handlers with RCRA Corrective Action Activity.	6
RCRA	*Resource Conservation and Recovery Act Information* – Identifies sites that generate, transport, store, treat and/or dispose of hazardous waste.	103
ERNS	*Emergency Response Notification System* – Records and stores information on reported releases of oil and hazardous substances.	110
HMIRS	*Hazardous Material Incident Report System* – Contains hazardous material spill incidents reported to the DOT.	13
TRIS	*Toxic Chemical Release Inventory System* – Identifies facilities which release toxic chemicals to the air, water and land in reportable quantities under SARA Title III Section 313.	5
TSCA	*Toxic Substance Control Act* – Identifies manufacturers and importers of chemical substances included on the TSCA Chemical Substance Inventory list.	12
FTTS	*FIFRA (Federal Insecticide, Fungicide, & Rodenticide Act)/TSCA (Toxic Substances Control Act)* –Tracks administrative cases and pesticide enforcement actions.	5
PADS	*PCB Activity Database* – Identifies generators, transporters, commercial storers and/or brokers and disposers of PCB's who are required to notify the EPA.	1
MINES	*Mines Master Index File* – Contains all mine identification numbers issued for mines active or opened since 1971.	1
FINDS	*Facility Index System* – Contains both facility information and 'pointers' to other sources that contain more detail.	169
	Total	432

Source: Environmental Data Resources (EDR), 2012

3.16.1.1 State Superfund Site

There is one state Superfund site in the study area, the Cox Road Dump (also known as Liberty Waste Disposal Landfill), which is located 1 mi north of FM 1413 on the west side of County Road (CR) 491 (Cox Road), in Dayton (Liberty County) (Texas Secretary of State, 2006). This site was evaluated in August 2004 using the Hazard Ranking System (HRS) which is the principle screening guide used by TCEQ and was given a ranking of 13.14 (TCEQ, 2006). This ranking is used to determine if a site qualifies as a state funded or a federal funded site. In order for a location to be eligible as a federally-funded site, it must have an HRS score of at least 28.5. If the site has an HRS score between 5 and 28.5 it is eligible for designation as a state Superfund site. Therefore, the Cox Road Dump site meets the state Superfund site criteria. On February 10, 2006, a legal notice was published in the Texas Register (31 TexReg 907-908) proposing the site for listing on the state Superfund registry. The site falls within the TCEQ Region Houston-12.

The Cox Road Dump is an 83-ac landfill that was operated by the Joiner Oil Company from 1969 to 1983. The site is now owned by the Joiner Liquidating Trust. The TCEQ cited at a public meeting held March 16, 2006, that numerous parties had been identified as responsible for dumping at this location. Analytical results of soil and water as reported by TCEQ indicate the presence of arsenic, barium, boron, chromium, lead, mercury, Aroclor 1016, cadmium, cobalt, cyanide, phenol, toluene, xylene, and pesticide 4,4-DDE (dichlorodiphenyldichloroethylene) (TCEQ, 2006).

Aerial photography and site visits were used to determine the boundary for the Cox Road Dump site. The boundary around the Cox Road Dump site was set as a constraint for alternatives analysis and a 1-mi buffer was also created to provide adequate avoidance distances for preliminary alternatives and reducing the possibility of impacting potential contaminated areas. The size of the buffer was determined by the search criteria set by TxDOT for a state Superfund site as noted in TxDOT's *Hazardous Materials in Project Development Guidance Document* (TxDOT, 2006). In April 2006 and during the planning process, the Cox Road Dump site's regulatory status changed with its acceptance into the Voluntary Cleanup Program. This allowed the engineer to remove the avoidance buffer for later alignment revisions.

3.16.1.2 Oil Wells

The Railroad Commission of Texas (RRC) Information Service Division was contacted and the digital well location mapping, including the American Petroleum Institute database information, was acquired for the study area. The RRC regulates and issues permits for drilling of oil and gas wells within the State of Texas.

All permitted wells are maintained in a GIS database by the RRC. An estimated 6,644 oil and/or gas wells were identified within the study area for Segments H and I-1.

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CHAPTER 4
ENVIRONMENTAL CONSEQUENCES

Chapter 4 presents the potential environmental consequences for the Segments H and I-1 reasonable alternatives (**Exhibit 2-5**) and the Preferred Alternative (Reasonable Alternative 10R) (**Exhibit 2-6**). Technical and scientific information is presented with respect to the existing physical, biological, and human environments that may be affected by the construction and operation of Segments H and I-1 of the Grand Parkway. The DEIS published in June 2011 presented Reasonable Alternative 10 as the Recommended Preferred Alternative. Since publication of the DEIS, updated analyses and continual coordination with the public have led to modifications of the Recommended Preferred Alternative as detailed in Chapter 2. Therefore, the Preferred Alternative detailed in the FEIS differs from the Recommended Preferred Alternative presented in the DEIS. Studies presented in the FEIS utilized updated data. Additionally some issues such as traffic noise, cultural resources and hazardous materials have been analyzed beyond the level in the DEIS to fully disclose the potential impacts that would result from the Preferred Alternative.

Adverse and beneficial impacts were analyzed for a 400-foot (ft) right-of-way (ROW) for each of the 10 reasonable build alternatives, the Preferred Alternative, and the No-Build Alternative. For purposes of the environmental consequences discussions, the areas studied for all of the alternatives are collectively referred to as the "study area." For the Preferred Alternative, the area of potential impacts is referred to as the "project area."

4.1 LAND USE

Several factors were used to assess potential land use impacts for the reasonable alternatives including the Preferred Alternative and No-Build Alternative. These factors considered compatibility with local and regional plans and policies, direct conversion of land use, regional land use impacts, and toll road effects. The only land use plan in effect within a majority of the study area is the Houston-Galveston Area Council's (H-GAC) 2035 Regional Transportation Plan (RTP) Update. The 2035 RTP Update is not specific on land use goals for the region. In Texas, cities are allowed to develop comprehensive plans to guide development. Other plans consulted include the 2010 Mont Belvieu Comprehensive Plan and the City of Dayton's Thoroughfare Plan (2002). Meetings were held with city and county officials throughout the study area to obtain information on planning activities. The meetings with local agencies are documented in **Chapter 8 (Agency and Public Coordination)**. The bulk of the study area is unincorporated; therefore, no local planning has been done for most of the study area.

It is anticipated that construction of a new highway would increase accessibility to the area and make the area more attractive for growth and development. Impacts expected from the increase in growth will be addressed in **Chapter 5 (Indirect Impacts)** and **Chapter 6 (Cumulative Impacts)**.

A detailed land use analysis was conducted for the reasonable alternatives and Preferred Alternative. The analysis included reviews of recent aerial photography, site reconnaissance, and gathering readily available land use data from H-GAC, city and county comprehensive plans, and local agencies. All data gathered was then compiled using a geographic information system (GIS) to quantify land use designations within the ROW of the reasonable alternatives. The additional land use data was gathered through field visits and verification of the reasonable alternatives and resulted in the identification of more land use categories than what was identified for the study area in **Chapter 3 (Affected Environment)**. Refer to **Table 4-1** for land use acreages within the ROW of each alternative.

Table 4-1: Land Use Acreages for the Reasonable Alternatives

Land Use Type	Alt 1 (No-Build)	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6	Alt 7	Alt 8	Alt 9	Alt 10	Alt 10R*	Alt 11
	(acres)											
Agricultural	0	1,008	1,058	922	972	634	1,008	1,058	922	1,038	1,072	634
Commercial	0	0	0	0	0	0	6	6	6	6	7	6
Church Property	0	0	0	0	0	0	7	7	7	7	3	7
Industrial	0	31	34	31	34	32	35	38	35	29	22	36
Managed Lands	0	0	0	0	0	0	0	0	0	0	11	0
Preliminary Platted	0	22	22	22	22	37	0	0	0	0	0	16
Residential	0	56	56	41	41	53	152	152	138	138	13	150
Government Building/property	0	0	0	0	0	0	0	0	0	0	2	0
Other Undeveloped	0	603	608	568	574	827	717	727	681	595	687	944
Undeveloped Platted	0	132	132	132	132	132	0	0	0	0	0	0
Total Proposed ROW	0	1,852	1,910	1,716	1,775	1,715	1,925	1,988	1,789	1,813	1,933	1,793

*10R is the Preferred Alternative
Source: Study Team, 2013

The primary direct impact on land use from the Preferred Alternative is the conversion of land to highway ROW. The Preferred Alternative would require 1,933 acres (ac) of proposed ROW. As shown in **Table 4-1** the majority of the land use within the area consists of agricultural (1,072 ac) and other undeveloped (687 ac) land. A portion of the undeveloped land (20 acres) was already characterized as or land use types were not available (130 acres); therefore, this area was determined to be undeveloped by aerial review. The Preferred Alternative also consists of impacts to approximately 7 ac of commercial and 22 ac of

industrial land uses, 130 ac of residential, 11 ac of managed lands (Lake Houston Wilderness Park), 2 ac of a government building, and 3 ac of church property (Peach Creek Baptist Church and East River Baptist Church).

There are several residential areas within proximity to the Preferred Alternative (**Exhibit 4-1**) primarily located at the west end of Segment H in Montgomery County. A scattering of low-density residential development also exists in the vicinity of Farm-to-Market Road (FM) 1960.

A demographic update prepared for the Crosby Independent School District (ISD) (Harris County), which does not assume the development of the Grand Parkway Segments H and I-1, suggests that there would be 4,168 additional occupied housing units in the district between 2007 and 2016 (Population and Survey Analysts, 2006). More than 78 percent of these housing units would be located west of FM 2100, outside of the study area. The three primary factors supporting the growth projections are:

- The shorter travel times to work than in other districts on the eastern side of Houston (with large, easily developable parcels and with the recent improvements to United States Highway [US] 90);
- The incentives provided by the bankruptcy sale of 1,400 platted lots at discounted prices; and
- The increased demand for housing in Humble ISD, which cannot be easily accommodated without expanding past the San Jacinto River (Lake Houston) into Crosby ISD.

The proposed Segments H and I-1 would be a controlled-access toll facility. Property values may increase around proposed interchanges, as these types of areas are desirable for commercial and industrial development. However, depending upon the traffic volumes on Segments H and I-1, land adjacent to the highway between interchanges could offer advertising value for retail and industrial developments.

Industrial land use is concentrated in the southern portion of the study area, in and around the City of Mont Belvieu. The Preferred Alternative would provide a circumferential connection between US 59 (N)/Interstate Highway (I) 69 and I-10 (E) for these industrial complexes, as well as expand capacity through the area.

The Preferred Alternative intersects existing local roads. While it is evident that Segments H and I-1 would generally increase accessibility in the region, it is possible that during future project phases or coordination with local jurisdictions that there is a potential for the termination of local roads that could adversely affect local access. Current design has no such impacts as they are typically avoided through the use of

overpasses. If design or access changes occur that affect local access, TxDOT would coordinate with the local jurisdictions as well as the affected property owners. Access across Segments H and I-1 would be limited to those areas where interchanges are incorporated into the highway design.

4.1.1 Utilities

Utilities within the study area include water, sewer, gas and oil pipelines, telephone, and electrical transmission lines. Utilities were mapped using GIS and avoided to the fullest extent possible during the development of the reasonable alternatives. During the design phase of the project, the Texas Department of Transportation (TxDOT) would coordinate with utility companies regarding any potential displacements or relocations of utilities.

4.1.2 Summary of Land Use Impacts

The primary planning document for the Houston-Galveston-Brazoria area is the 2035 RTP Update. As a result of the predominance of agricultural land in the area, all of the reasonable alternatives (including the Preferred Alternative) would result in the reduction of agricultural and undeveloped land (both undeveloped platted and other undeveloped). Most of the land converted to highway ROW would be agricultural (ranging from 634 ac to 1,072 ac) or other undeveloped land and undeveloped platted (ranging from 0 ac to 959 ac). Reasonable Alternatives 7-11 would have the highest impacts to residential properties with acreages ranging from 138 ac to 152 ac and would impact up to 7 ac of church property (Peach Creek Baptist Church and East River Baptist Church). Reasonable Alternatives 2-6 would have no impacts to commercial properties, while Reasonable Alternatives 7-11 would impact up to 10 ac.

All of the reasonable build alternatives, including the Preferred Alternative, are consistent with the 2035 RTP Update. The Preferred Alternative would require 1,933 ac of proposed ROW. The majority of the land use within Preferred Alternative consists of agricultural (1,027 ac) and other undeveloped (687 ac) land. The Preferred Alternative proposed ROW also consists of impacts to approximately 10 ac of commercial, 130 ac of residential, 3 ac of church property, 11 ac of managed lands, and 22 ac of industrial land uses. Displacements on the various land use categories are discussed in **Section 4.2.1.7**. The No-Build Alternative for Segments H and I-1 would not be consistent with the 2035 RTP Update. The No-Build Alternative would not result in land use impacts associated with the construction or operation of the proposed project. Under the No-Build Alternative, suburban growth within the study area is expected to continue at a rate similar to historic trends.

Indirect Impacts

Based on the results of the indirect impacts analysis, it was determined that approximately 25,944 ac of induced development is anticipated as a result of the Preferred Alternative. This acreage accounts for approximately 52 percent of planned development within the indirect impacts area of influence (AOI) according to the results of an expert panel survey. It was determined that areas with the greatest potential for induced development are located at major intersections and adjacent to existing municipalities. There would be no indirect effects as a result of the No-Build Alternative. Refer to **Chapter 5** for a detailed indirect impacts analysis.

4.2 COMMUNITY IMPACTS ASSESSMENT

Transportation investments have major influences on society and have the potential to impose economic and social consequences. A community impacts assessment is a process to evaluate the effects of a transportation action on a community and its quality of life. The purpose of the assessment is to examine topics of importance to people, such as socio-economic impacts, environmental justice, proposed ROW and potential displacements, impacts to public facilities and services, and aesthetic considerations. The data presented below assessed the Preferred Alternative and originated from a variety of sources, from agency websites (such as the U.S. Census Bureau and H-GAC) to conversations with local government officials.

4.2.1 Social and Economic Impacts

4.2.1.1 Environmental Justice

Environmental justice addresses the fundamental human desires for fairness, equity, and social and economic justice. Environmental justice is defined as the fair treatment of all people in terms of the distribution of benefits and costs resulting from transportation projects, programs, and policies. Fair treatment means that a disproportionate share of adverse effects would not fall upon the low-income or minority populations.

In response to Executive Order (EO) 12898 signed by President Clinton on February 11, 1994, the United States Department of Transportation (USDOT) developed an environmental justice strategy that follows within the framework of the National Environmental Policy Act (NEPA) and Title VI of the Civil Rights Act of 1964, which was clarified in the Civil Rights Restoration Act of 1987.

The potential effects of the proposed action have been evaluated in accordance with the requirements of EO 12898. In Chapter 3, the environmental justice analysis presented an overview of the entire study area. The analysis presented in Chapter 4 would focus more closely on the area of the Preferred Alternative. The *2010 Census* data for census blocks (CB) and block groups (BG) were used in the following analyses. CB data provides information at the lowest scale available for race and ethnicity analysis; BG data provides information at the lowest scale available for household income, poverty, and limited English proficiency (LEP) population analyses (**Exhibit 4-2**).

Definition of Minority and Low-Income Population Study Areas

The study areas for the minority and low-income population analyses differ due to the availability of census data. Minority data is available at the CT, BG, and CB levels, however, low-income data is only available the CT and BG levels. A quarter-mile buffer for the Preferred Alternative was utilized to create a study area that identifies those populations who reside adjacent to the roadway. The CBs located within and intersecting the quarter-mile buffer comprise the "minority population study area." The area traversed by the Preferred Alternative lies within 16 BGs and comprises the direct impacts study area for household income and poverty populations, and would be referred to as the "low-income population study area."

Minority Characteristics

The Preferred Alternative has a 33 percent minority population at both the CB level and the BG level within the quarter mile buffer study area. As shown in **Table 4-2**, African-Americans and Hispanic or Latinos of any race represent the dominant minority populations at the CB, ranging from 0.2 percent to 50 percent of the total population for African-Americans and from 2.6 percent to 100 percent for Hispanic or Latinos of any race. These two groups are also the dominant minority populations at the BG level, ranging from 0.8 percent to 11.3 percent for African-Americans, and 9.9 percent to 50.8 percent for Hispanic or Latinos of any race. Refer to **Exhibit 4-2** for the locations of the individual CBs for the Preferred Alternative.

Thirteen CBs were identified as containing a significant minority population for the Preferred Alternative. A significant minority population is one in which the minority population exceeds 50 percent of the CB. The thirteen CBs with significant minority populations are highlighted in **Table 4-2.**

Table 4-2: Racial and Ethnic Composition for the Preferred Alternative

Census 2010 Geography	Total Population	Not Hispanic or Latino**														Hispanic or Latino of Any Race		Total Minority	
		White		Black*		Indian*		Asian		Islander*		Other*		Two*					
		#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
CT 2515.01	**4,807**	**3,652**	**76**	**128**	**2.7**	**19**	**0.4**	**351**	**7.3**	**4**	**0.1**	**5**	**0.1**	**88**	**1.8**	**560**	**11.6**	**1,155**	**24**
BG 1	4,807	3,652	76	128	2.7	19	0.4	351	7.3	4	0.1	5	0.1	88	1.8	560	11.6	1,155	24
CB 1000	14	10	71.4	0	-	0	-	0	-	0	-	0	-	0	-	4	28.6	4	28.6
CT 2516.00	**5,750**	**4,872**	**84.7**	**144**	**2.5**	**37**	**0.6**	**34**	**0.6**	**1**	**-**	**8**	**0.1**	**59**	**1**	**595**	**10.3**	**878**	**15.3**
BG 1	1,695	1,433	84.5	14	0.8	10	0.6	11	0.6	0	-	0	-	32	1.9	195	11.5	262	15.5
CB1000	90	67	74.4	0	-	1	1.1	1	1.1	0	-	0	-	2	2.2	19	21.1	23	25.6
CB 1001	0	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
CB 1002	77	75	97.4	0	-	0	-	1	1.3	0	-	0	-	1	1.3	0	-	2	2.6
CB 1026	0	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
CB 1027	4	4	100	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
BG 2	4,055	3,439	84.8	130	3.2	27	0.7	23	0.6	1	-	8	0.2	27	0.7	400	9.9	616	15.2
CB 2000	39	38	97.4	0	-	0	-	0	-	0	-	0	-	0	-	1	2.6	1	2.6
CB 2001	35	29	82.9	0	-	1	2.9	0	-	0	-	0	-	1	2.9	4	11.4	6	17.1
CB 2002	164	138	84.1	6	3.7	0	-	7	4.3	0	-	1	0.6	3	1.8	9	5.5	26	15.9
CT 6925.00	**8,331**	**6,017**	**72.2**	**192**	**2.3**	**38**	**0.5**	**29**	**0.3**	**4**	**-**	**5**	**0.1**	**95**	**1.1**	**1,951**	**23.4**	**2,314**	**27.8**
BG 1	1,195	986	82.5	39	3.3	7	0.6	2	0.2	1	0.1	0	-	12	1	148	12.4	209	17.5
CB 1000	0	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
CB 1001	0	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
CB 1002	**2**	**0**	**-**	**0**	**-**	**0**	**-**	**0**	**-**	**0**	**-**	**0**	**-**	**2**	**100**	**0**	**-**	**2**	**100**
CB 1003	24	22	91.7	0	-	2	8.3	0	-	0	-	0	-	0	-	0	-	2	8.3
CB1004	67	61	91	0	-	1	1.5	0	-	0	-	0	-	3	4.5	2	3	6	9.0
CB 1005	46	41	89.1	0	-	0	-	0	-	0	-	0	-	0	-	5	10.9	5	10.9
CB 1006	83	75	90.4	0	-	0	-	0	-	0	-	0	-	3	3.6	5	6	8	9.6
CB 1007	102	90	88.2	3	2.9	0	-	2	2	0	-	0	-	0	-	7	6.9	12	11.8
CB1008	22	22	100	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
CB 1009	84	69	82.1	0	-	0	-	0	-	0	-	0	-	0	-	15	17.9	15	17.9
CB 1010	32	32	100	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
CB 1011	248	183	73.8	29	11.7	0	-	0	-	1	0.4	0	-	1	0.4	34	13.7	65	26.2
CB 1012	418	333	79.7	6	1.4	4	1	0	-	0	-	0	-	3	0.7	72	17.2	85	20.3
BG 2	1,756	1,302	74.1	55	3.1	4	0.2	10	0.6	0	-	0	-	28	1.6	357	20.3	454	25.9

Table 4-2: Racial and Ethnic Composition for the Preferred Alternative

Census 2010 Geography	Total Population	Not Hispanic or Latino**														Hispanic or Latino of Any Race		Total Minority	
		White		Black*		Indian*		Asian		Islander*		Other*		Two*					
		#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
CB 2000	60	54	90	0	-	0	-	1	1.7	0	-	0	-	0	-	5	8.3	6	10
CB 2015	0	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
CB 2016	87	59	67.8	0	-	0	-	0	-	0	-	0	-	0	-	28	32.2	28	32.2
CB 2017	0	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
CB 2018	96	83	86.5	1	1	1	1	3	3.1	0	-	0	-	0	-	8	8.3	13	13.5
CB 2019	0	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
CB 2020	70	47	67.1	0	-	0	-	0	-	0	-	0	-	1	1.4	22	31.4	23	32.9
CB 2021	0	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
CB 2022	0	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
BG 3	1,794	1,271	70.8	24	1.3	10	0.6	2	0.1	1	0.1	0	-	15	0.8	471	26.3	523	29.2
CB 3000	1,027	707	68.8	11	1.1	3	0.3	2	0.2	1	0.1	0	-	14	1.4	289	28.1	320	31.2
CB 3001	117	85	72.6	5	4.3	0	-	0	-	0	-	0	-	1	0.9	26	22.2	32	27.4
CB 3003	81	59	72.8	0	-	1	1.2	0	-	0	-	0	-	0	-	21	25.9	22	27.2
CB 3008	0	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
BG 4	3,586	2,458	68.5	74	2.1	17	0.5	15	0.4	2	0.1	5	0.1	40	1.1	975	27.2	1,128	31.5
CB 4013	116	103	88.8	1	0.9	4	3.4	0	-	0	-	0	-	8	6.9	0	-	13	11.2
CB 4018	3	3	100	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
CB 4019	0	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
CT 6926.02	**10,150**	**6,389**	**62.9**	**216**	**2.1**	**35**	**0.3**	**68**	**0.7**	**1**	**-**	**5**	**-**	**129**	**1.3**	**3,307**	**32.6**	**3,761**	**37.1**
BG 2	5,107	3,345	65.5	143	2.8	11	0.2	55	1.1	0	-	5	0.1	72	1.4	1,476	28.9	1,762	34.5
CB 2016	2,107	1,309	62.1	89	4.2	7	0.3	33	1.6	0	-	2	0.1	29	1.4	638	30.3	798	37.9
CB 2036	0	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
BG 3	2,011	1,181	58.7	49	2.4	19	0.9	4	0.2	0	-	0	-	27	1.3	731	36.4	830	41.3
CB 3008	388	254	65.5	0	-	8	2.1	1	0.3	0	-	0	-	6	1.5	119	30.7	134	34.5
CB 3010	0	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
CB 3011	0	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
CB 3017	0	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
CB 3018	0	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
CB 3019	0	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
CT 6928.02	**3,745**	**2,618**	**69.9**	**84**	**2.2**	**33**	**0.9**	**14**	**0.4**	**0**	**-**	**4**	**0.1**	**31**	**0.8**	**961**	**25.7**	**1,127**	**30.1**

Table 4-2: Racial and Ethnic Composition for the Preferred Alternative

Census 2010 Geography	Total Population	Not Hispanic or Latino**														Hispanic or Latino of Any Race		Total Minority	
		White		Black*		Indian*		Asian		Islander*		Other*		Two*					
		#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
BG 1	1,508	954	63.3	47	3.1	13	0.9	6	0.4	0	-	1	0.1	21	1.4	466	30.9	554	36.7
CB 1000	243	182	74.9	16	6.6	1	0.4	4	1.6	0	-	0	-	5	2.1	35	14.4	61	25.1
CB 1006	32	26	81.2	0	-	0	-	1	3.1	0	-	0	-	2	6.2	3	9.4	6	18.8
CB 1014	8	8	100	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
CB 1015	236	133	56.4	9	3.8	1	0.4	0	-	0	-	1	0.4	3	1.3	89	37.7	103	43.6
CB 1017	40	34	85	0	-	0	-	0	-	0	-	0	-	0	-	6	15	6	15
CB 1019	22	14	63.6	0	-	0	-	0	-	0	-	0	-	2	9.1	6	27.3	8	36.4
CB 1024	59	43	72.9	0	-	0	-	0	-	0	-	0	-	0	-	16	27.1	16	27.1
CB 1028	1	1	100	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
CB 1042	65	55	84.6	0	-	1	1.5	1	1.5	0	-	0	-	1	1.5	7	10.8	10	15.4
BG 2	1,282	879	68.6	27	2.1	12	0.9	2	0.2	0	-	3	0.2	10	0.8	349	27.2	403	31.4
CB 2009	10	10	100	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
CB 2017	25	25	100	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
CB 2018	139	108	77.7	6	4.3	0	-	0	-	0	-	0	-	0	-	25	18	31	22.3
CB 2019	0	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
CB 2020	38	33	86.8	1	2.6	0	-	1	2.6	0	-	0	-	2	5.3	1	2.6	5	13.2
CB 2043	141	93	66	0	-	0	-	0	-	0	-	0	-	0	-	48	34	48	34
CB 2084	35	33	94.3	0	-	0	-	0	-	0	-	0	-	2	5.7	0	-	2	5.7
CT 7003.00	**9,514**	**6,390**	**67.2**	**478**	**5**	**40**	**0.4**	**37**	**0.4**	**1**	**-**	**13**	**0.1**	**97**	**1**	**2,458**	**25.8**	**3,124**	**32.8**
BG 5	2,257	1,342	59.5	18	0.8	9	0.4	0	-	0	-	3	0.1	15	0.7	870	38.5	915	40.5
CB 5016	581	471	81.1	1	0.2	2	0.3	0	-	0	-	2	0.3	4	0.7	101	17.4	110	18.9
CT 7009.00	6,059	2,948	48.7	1,534	25.3	13	0.2	19	0.3	0	-	17	0.3	45	0.7	1,483	24.5	3,111	51.3
BG 1	***765***	***509***	***66.5***	***49***	***6.4***	***2***	***0.3***	***0***	***0***	***0***	***-***	***2***	***0.3***	***20***	***2.6***	***183***	***23.9***	***256***	***33.5***
CB 1004	195	161	82.6	0	0	1	0.5	0	0	0	0	0	0	4	2.1	29	14.9	34	17.4
CB 1019	**15**	**6**	**40**	**1**	**6.7**	**0**	**-**	**0**	**-**	**0**	**-**	**0**	**-**	**1**	**6.7**	**7**	**46.7**	**9**	**60**
CB 1029	33	21	63.6	0	-	0	-	0	-	0	-	0	-	1	3	11	33.3	12	36.4
CB 1035	81	54	66.7	0	-	0	-	0	-	0	-	0	-	0	-	27	33.3	27	33.3
CB 1040	**8**	**2**	**25**	**0**	**-**	**0**	**-**	**0**	**-**	**0**	**-**	**0**	**-**	**0**	**-**	**6**	**75**	**6**	**75**
CB 1049	0	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
CB 1050	**32**	**10**	**31.2**	**1**	**3.1**	**0**	**-**	**0**	**-**	**0**	**-**	**0**	**-**	**0**	**-**	**21**	**65.6**	**22**	**68.8**

Table 4-2: Racial and Ethnic Composition for the Preferred Alternative

Census 2010 Geography	Total Population	Not Hispanic or Latino**														Hispanic or Latino of Any Race		Total Minority	
		White		Black*		Indian*		Asian		Islander*		Other*		Two*					
		#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
CB 1051	0	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
CB 1052	**6**	**0**	**-**	**2**	**33.3**	**0**	**-**	**0**	**-**	**0**	**-**	**0**	**-**	**0**	**-**	**4**	**66.7**	**6**	**100.0**
CB 1054	0	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
CB 1055	0	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
CB1056	0	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
CT 7010.00	**6,216**	**3,044**	**49**	**518**	**8.3**	**26**	**0.4**	**30**	**0.5**	**2**	**0**	**2**	**0**	**67**	**1.1**	**2,527**	**40.7**	**3,172**	**51.0**
BG 1	2,913	1,604	55.1	122	4.2	17	0.6	9	0.3	0	0	0	0	23	0.8	1,138	39.1	1,309	44.9
CB 1004	0	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
CB 1005	0	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
CB 1006	13	9	69.2	0	-	0	-	0	-	0	-	0	-	0	-	4	30.8	4	30.8
CB 1020	54	45	83.3	0	-	0	-	1	1.9	0	-	0	-	0	-	8	14.8	9	16.7
CB 1021	13	13	100	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
CB 1030	265	178	67.2	3	1.1	0	-	0	-	0	-	0	-	0	-	84	31.7	87	32.8
CB 1032	458	233	50.9	32	7	1	0.2	0	-	0	-	0	-	8	1.7	184	40.2	225	49.1
CB 1036	**76**	**13**	**17.1**	**7**	**9.2**	**0**	**-**	**0**	**-**	**0**	**-**	**0**	**-**	**0**	**-**	**56**	**73.7**	**63**	**82.9**
CB 1040	**124**	**47**	**37.9**	**19**	**15.3**	**0**	**-**	**0**	**-**	**0**	**-**	**0**	**-**	**0**	**-**	**58**	**46.8**	**77**	**62.1**
CB 1053	0	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
CB 1054	2	1	50	1	50	0	-	0	-	0	-	0	-	0	-	0	-	1	50
CB 1055	0	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
CB 1057	8	8	100	0	-	0	-	0	-	0	-	0	-	0	-	0	0	0	-
BG 3	2,493	1,072	43	116	4.7	7	0.3	6	0.2	2	0.1	1	0	23	0.9	1,266	50.8	1,421	57
CB 3010	10	10	100	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
CB 3015	16	12	75	0	-	0	-	0	-	0	-	0	-	0	-	4	25	4	25
CB 3016	0	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
CB 3018	**267**	**68**	**25.5**	**2**	**0.7**	**3**	**1.1**	**0**	**-**	**2**	**0.7**	**0**	**-**	**4**	**1.5**	**188**	**70.4**	**199**	**74.5**
CB 3022	**10**	**0**	**-**	**0**	**-**	**0**	**-**	**0**	**-**	**0**	**-**	**0**	**-**	**0**	**-**	**10**	**100**	**10**	**100**
CB 3023	0	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
CB 3024	**6**	**0**	**-**	**0**	**-**	**0**	**-**	**0**	**-**	**0**	**-**	**0**	**-**	**0**	**-**	**6**	**100**	**6**	**100**
CB 3037	**32**	**6**	**18.8**	**0**	**-**	**0**	**-**	**0**	**-**	**0**	**-**	**0**	**-**	**0**	**-**	**26**	**81.2**	**26**	**81.3**
CB 3053	**44**	**13**	**29.5**	**0**	**-**	**1**	**2.3**	**0**	**-**	**0**	**-**	**0**	**-**	**2**	**4.5**	**28**	**63.6**	**31**	**70.5**

Table 4-2: Racial and Ethnic Composition for the Preferred Alternative

Census 2010 Geography	Total Population	Not Hispanic or Latino**														Hispanic or Latino of Any Race		Total Minority	
		White		Black*		Indian*		Asian		Islander*		Other*		Two*					
		#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
CB 3055	0	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
CB 3056	0	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
CB 3070	0	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
CB 3071	0	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
CB 3072	0	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
CB 3073	0	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
CB 3074	0	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
CB 3075	0	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
CB 3082	0	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
CT 7101.00	**6,502**	**5,496**	**84.5**	**208**	**3.2**	**34**	**0.5**	**26**	**0.4**	**5**	**0.1**	**0**	**-**	**77**	**1.2**	**656**	**10.1**	**1,006**	**15.5**
BG 1	2,830	2,194	77.5	147	5.2	11	0.4	19	0.7	5	0.2	0	-	55	1.9	399	14.1	636	22.5
CB 1008	0	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
CB 1009	16	16	100	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
CB 1011	0	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
CB 1012	0	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
CB 1013	0	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
CB 1014	0	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
CB 1015	0	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
CB 1043	0	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
CB 1048	51	39	76.5	0	-	0	-	0	-	0	-	0	-	1	2	11	21.6	12	23.5
CB 1054	**3**	**1**	**33.3**	**0**	**-**	**0**	**-**	**0**	**-**	**0**	**-**	**0**	**-**	**2**	**66.7**	**0**	**-**	**2**	**66.7**
CB 1055	235	194	82.6	5	2.1	1	0.4	0	-	0	-	0	-	4	1.7	31	13.2	41	17.4
CB 1072	7	7	100	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
CB 1084	0	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
CB 1085	7	7	100	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
CB 1086	0	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
CB 1087	0	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
CB 1101	0	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
CB 1108	8	8	100	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
CB 1146	0	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-

Table 4-2: Racial and Ethnic Composition for the Preferred Alternative

Census 2010 Geography	Total Population	Not Hispanic or Latino**														Hispanic or Latino of Any Race		Total Minority	
		White		Black*		Indian*		Asian		Islander*		Other*		Two*					
		#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
CT 7102.00	**15,543**	**11,025**	**70.9**	**1,039**	**6.7**	**46**	**0.3**	**176**	**1.1**	**6**	**-**	**16**	**0.1**	**159**	**1**	**3,076**	**19.8**	**4,518**	**29.1**
BG 2	4,944	2,519	51	558	11.3	22	0.4	92	1.9	0	-	8	0.2	62	1.3	1,683	34	2,425	49
CB 2000	0	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
CB 2001	0	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
CB 2002	170	116	68.2	6	3.5	0	-	0	-	0	-	0	-	0	-	48	28.2	54	31.8
CB 2005	0	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
CB 2006	0	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
CB 2007	0	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
CB 2010	0	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
CB 2011	0	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
CB 2012	0	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
CB 2013	0	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
CB 2014	0	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
CB 2016	66	37	56.1	0	-	0	-	0	-	0	-	2	3	1	1.5	26	39.4	29	43.9
CB 2017	0	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
CB 2018	0	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
CB 2019	0	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
CB 2069	0	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-

Source: U.S. Census Bureau*: 2010 Census*
Note: CBs with significant minority populations have been highlighted
*Data based on census blocks within a quarter-mile of each alternative.
**The complete Census race descriptions are as follows: White alone; Black or African American alone; American Indian and Alaska Native alone; Asian alone; Native Hawaiian and Other Pacific Islander alone; Some Other Race alone; and Two or More Races

Income Characteristics

Federal Highway Administration (FHWA) Order 6640.23 includes definitions of low-income, minority, and disproportionately high and adverse effect. Low-income is defined as a household income at or below the U.S. Department of Health and Human Services (HHS) poverty guidelines. The HHS 2013 poverty guideline for a family of four is $23,550. The HHS poverty guidelines are an administrative version of the poverty measure and are used in determining financial eligibility for certain federal programs.

Poverty statistics presented in census publications use thresholds prescribed for federal agencies by Statistical Policy Directive 14, issued by the Office of Management and Budget. These data constitute a statistical version that measures the number of households with incomes below the threshold for that size household.

The 16 BGs comprising the "low-income population study area" have been used in the analysis. The availability of census data for median household income is limited to the BG level; therefore, "low-income population study area" is defined by the 16 BGs that are impacted by the Preferred Alternative.

Availability of poverty data is limited to the CT level, and is therefore only reported to that level in **Table 4-3**. The percentage of households with incomes considered to be below the poverty level range from 5.5 percent to a high of 23.7 percent. A comparison of median household income and poverty status per BG is shown in **Table 4-3**.

Table 4-3: Median Household Income and Poverty Status – 2011

Census 2010 Geography	Total Households	Median Household Income ($)	Persons Below Poverty Level*	
			#	%
CT 2515.01	**1,410**	**118,235**	**278**	**5.5**
BG 1	1410	118,235	-	-
CT 2516.00	**1,764**	**74,821**	**324**	**5.9**
BG 1	494	52,625	-	-
BG 2	1270	87,045	-	-
CT 6925.00	**2754**	**42,683**	**1177**	**14.8**
BG 1	448	41,667	-	-
BG 2	540	63,381	-	-
BG 3	437	30,163	-	-
BG 4	1,329	50,625	-	-
CT 6926.02	**2992**	**38,635**	**2157**	**23.7**
BG 2	1,742	47,321	-	-
BG 3	490	29,531	-	-
CT 6928.02	**1,176**	**60,878**	**335**	**9.9**
BG 1	604	53,056	-	-
BG 2	294	65,263	-	-
CT 7003.00	**3,256**	**39,912**	**1877**	**20.0**
BG 5	599	51,023	-	-
CT 7009.00	**567**	**66,250**	**227**	**13.3**
BG 1	224	67,283	-	-
CT 7010.00	**1877**	**51,473**	**1359**	**22.7**
BG 1	951	68,072	-	-
CT 7101.00	**2,279**	**75,120**	**780**	**11.2**
BG 1	794	76,229	-	-
CT 7102.00	**5,127**	**86,674**	**1131**	**7.0**
BG 2	1,518	71,848	-	-

Source: U.S. Census Bureau, 2007-2011 American Community Survey,
ACS data are estimates; they are not counts. Income data is provided in 2010 inflation adjusted dollars.
*Population for whom poverty status has been determined

Origin-Destination Analysis

Traffic Analysis Zones, Study Area, and Data Sources

The information associated with the origin and destination (O&D) analysis is organized by BGs, a geographical unit used by the U.S. Census Bureau, which is a subdivision of a Census Tract (CT). The O&D data presented in **Table 4-4** is normalized for BGs using Traffic Analysis Zones (TAZ). TAZs are small geographic units of area that are developed as a basis for estimate of travel. TAZs may vary in size, are determined by the roadway network and homogeneity of development, and directly reflect demographic data generated by the U.S. Census Bureau. Delineated by state and/or transportation officials for tabulating traffic-related data, TAZs usually consist of one or more CBs, BGs, or CTs.

BGs were selected to represent the study area based on their proximity to the Preferred Alternative. A total of 24 BGs which comprise the "census BG study area." These 24 BGs best represented the TAZs that were adjacent to the Preferred Alternative. In the H-GAC regional travel demand model, there were a total of 51 TAZs that corresponded to the 24 BGs. The 51 TAZs were, therefore, aggregated to the BG level.

A "select-link analysis" was conducted using the 2035 H-GAC regional travel demand model and 2039 demographics to generate O&D data associated with the proposed Grand Parkway Segments H and I-1 Preferred and No-Build Alternatives. Select-link analysis identifies where traffic is coming from (trip origin) and going to (trip destination) on any selected roadway section (**Exhibit 5-1**).

The O&D analysis was conducted using the EMME/2 software on which the H-GAC model was based. The O&D data was generated for the entire H-GAC region and consists of trips leaving or entering the TAZs. Select-link matrices were exported from EMME/2 to GIS and then correlated with BGs to provide a demographic profile of users anticipated to utilize the proposed Grand Parkway Segments H and I-1 in 2039.

Analysis Assumptions and Limitations

Select-link analysis does not attempt to identify specific users (low-income and minority populations) but instead compares the origins and intensity origins of trips based on collective socio-economic characteristics at the TAZ level. In other words, the O&D analysis predicts the potential users of the Grand Parkway Segments H and I-1 in 2039 based on 2010 U.S. Census Bureau demographic data. The travel demand model assigns vehicle trips based on user cost, trip distance, time of day, and other factors to

achieve system equilibrium in the network. Because no definitive data exists on the future users of the Grand Parkway Segments H and I-1, the O&D analysis cannot predict the specific race, ethnicity, or economic status associated with the predicted trips.

Analysis Results

Data analysis indicates that an average of 29 percent of the trips generated within the H-GAC region would travel the proposed Grand Parkway Segments H and I-1 and have origins or destinations within the Census BG study area. This represents approximately 16,963 daily trips (trips leaving + trips arriving) associated with the census BG study Preferred Alternative of the proposed Grand Parkway Segments H and I-1.

Table 4-4: Origin-Destination Data by Census Block Groups

County	CT	BG	No-Build	Build
			Daily Trips	Daily Trips
Chambers	7101.00	1	22,900	23,200
Harris	2515.01	1	8,500	8,500
Harris	2516.00	1	14,100	13,800
Harris	2516.00	2	13,300	13,200
Harris	2517.00	1	24,100	24,100
Harris	2517.00	4	20,900	20,900
Harris	2518.00	1	52,600	52,600
Harris	2527.00	3	38,400	38,400
Harris	2528.00	2	46,900	46,900
Harris	2531.00	1	49,800	49,800
Liberty	7003.00	5	4,500	4,500
Liberty	7009.00	1	400	400
Liberty	7009.00	2	5,800	5,800
Liberty	7009.00	3	4,900	4,800
Liberty	7010.00	1	3,200	3,100
Liberty	7010.00	2	7,500	7,600
Liberty	7010.00	3	6,800	6,800
Montgomery	6925.00	1	4,000	4,000
Montgomery	6925.00	2	9,600	9,600
Montgomery	6925.00	3	29,700	29,700
Montgomery	6928.01	1	14,600	14,700
Montgomery	6928.01	4	5,600	5,600
Montgomery	6928.02	1	3,700	3,700
Montgomery	6928.02	2	15,600	15,400
Census Block Group Study Area Total			**407,400**	**407,100**
Census Block Group Percent Share of H-GAC Region			***2%***	***2%***
H-GAC Region			**25,303,400**	**25,302,100**

Sources: Houston-Galveston Area Council EMME/2 Regional Travel Demand Model, 2012

Origin and destination data for the Census BG study area which is contained within the project 15-minute travel shed was used for further analysis of the impact of a toll facility on minority or low-income populations. The 15-minute travel shed is defined as the area encompassing all of the TAZs that would include people traveling through the corridor (**Exhibit 5-1**).

Identification of Environmental Justice TAZs

Analysis of the O&D trip data was concentrated on those TAZs with high proportions of low-income or minority populations within the Census BG study area that are anticipated to utilize the proposed Grand Parkway Segments H and I-1. The threshold for an environmental justice TAZ (EJ TAZ) was defined as a TAZ with an environmental justice population (specifically low-income or minority populations) equal to or greater than 50 percent of the total TAZ population. Ten EJ TAZs were identified using the threshold (**Table 4-5**). These EJ TAZs are concentrated in the far east and southwestern portions of the overall project study area.

Table 4-5: EJ TAZs

EJ TAZ	Census Geography	% EJ in TAZ
578	CT 2531.00 BG 1	62.8
580		
581		
582		
583		
584		
2658	CT 7009.00 BG 3	61.9
2650	CT 7010.00 BG 2	54.6
2653	CT 7010.00 BG 3	57
2657		

Sources: Houston-Galveston Area Council EMME/2 Regional Travel Demand Model, 2012
Note: The CT BGs represent EJ populations within the TAZ study area; Table 3-3 provides EJ data at the BG level.

Approximately 69,000 trips from the EJ TAZs would utilize Segments H or I-1, compared to an estimated 407,100 trips from the entire Census BG study area. Based on the analysis, approximately 16.9 percent of the trips into and out of the Census BG study area are from an area with high proportions of low-income or minority populations. The majority of trips (83.1 percent) originating or destined for Segments H and I-1 are

not from areas with identified high proportions of environmental justice populations. It is not anticipated that there would be any trip related disproportionate impacts to low-income or minority populations with implementation of the proposed project. This low distribution of trips is associated with the identified low-income or minority populations within the BG study area. The Grand Parkway Segments H and I-1 project would benefit users and adjacent populations as a result of the improved system linkage, improved mobility, and enhanced safety and infrastructure to support population growth within the study area and region.

Summary of Impacts to Minority or Low-Income Populations

Based on the analysis provided above, no significant direct environmental justice impacts would result from the proposed Grand Parkway Segments H and I-1 project. None of the displacements described in **Section 4.2.1.7** are located within a BG with a median household income below that of the HHS 2013 poverty level guidance. The Preferred Alternative is comprised of 142 CBs; 13 of the 142 CBs contain a significant minority population (i.e. minority populations exceed 50 percent of the CB). No specific environmental justice issues have been raised throughout the TxDOT or Grand Parkway Association's (GPA) communication with adjacent property owners, adjacent municipalities, and other public agencies with interests along the proposed project's corridor.

The proposed project's direct impacts associated with tolling would not be isolated within a limited number of BGs such as the potential displacement impacts, but would be distributed among all users of the proposed Grand Parkway Segments H and I-I facility (see **Section 4.2.1.2** for additional information regarding the economic impact of tolling). Low-income populations who elect or can occasionally afford to pay access tolls would be impacted by toll rates, toll collection, and other matters associated with user fees. In addition, the economic impact of tolling the mainlanes would be higher for low-income users because the cost of paying tolls would represent a higher percentage of household income than for non-low-income users. As indicated in the O&D analysis results, approximately 16.9 percent of the trips into and out of the BG study area are from an area with high proportions of low-income and/or minority populations.

The EO 12898 term "disproportionately high and adverse effect" considers the totality of significant individual or cumulative human health or environmental impacts. The benefits associated with the proposed Grand Parkway Segments H and I-1 project would improve system linkage, mobility, and enhance safety. It would also provide infrastructure to support population growth. Tolls on the proposed

Segments H and I-1 would be waived during emergency evacuations so that those that could not afford to pay the tolls would benefit. In the case of implementing tolling along the Grand Parkway Segments H and I-1 mainlanes, and considering the totality of effects of the project, there appears to be an overall benefit provided to minority and/or low-income populations, as well as the entire community.

The Preferred Alternative would have up to 98 potential displacements, with each building (i.e. barn, home, business, shed, etc.) being identified as a separate displacement. None of the displacements are located within any BGs with a median household income below that of the HHS 2013 poverty guideline. One residential displacement is anticipated within the CBs containing significant minority populations (CT 7009.00 BG 1 CB 1019). There do not appear to be any disproportionately high and adverse impacts on minority or low-income populations associated with the proposed project because: 1.) the majority of displacements would occur in non-environmental justice CBs or BGs; 2.) feedback from GPA or TxDOT-sponsored meetings have not indicated any environmental justice issues as a result of displacements or impacts to community cohesion; 3.) the O&D analysis indicated the majority of trips anticipated to utilize the Preferred Alternative would not originate from areas identified with high concentrations of environmental justice populations; and 4.) non-toll options exist for those who elect or can occasionally afford to pay access tolls.

4.2.1.2 Economic Impacts

The proposed project would result in economic implications for the study area counties in proximity to Grand Parkway Segments H and I-1. Economic impacts to those counties stem from changes in travel patterns and costs, and from expenditure-related activities for the facility. Such implications are quantifiably estimated (where possible) through an application of various modeling processes, including a travel demand model and an applied economic impact model.

Three economic components of the proposed project facility are assessed, and the region-specific and statewide results are presented, by component and in aggregate, for:

- Construction expenditures;
- Operations and Maintenance and Lifecycle expenditures; and,
- Changes in travel demand characteristics (i.e., travel efficiencies), and toll charges accruing to area businesses and households.

Modeling results indicate that the proposed project is anticipated to yield net positive aggregate economic impacts to the analyzed Houston Region and Texas over the cumulative analysis horizon spanning 2016 through 2039, as measured in terms of economic activity (or value added) and employment (in job-years [a full-time equivalent employment position over a one-year duration, or 2,080 labor-hours]).

Generally accepted methods for estimating the expenditures and travel efficiency based economic impacts of highway investments are the basis for the analysis. Economic impacts resulting from changes to transportation infrastructure or transportation policy are quantifiable with the assistance of various software tools, which widely range in complexity and capabilities from simplistic (e.g., static multiplier spreadsheets) to complex (e.g., dynamic econometric general-equilibrium models). In the economic impact analysis of the proposed project, the REMI®[1] model is employed with certain input variables calculated from travel demand modeling, engineering estimates, etc. REMI® is a generalized, dynamic economic impact model that can simulate a myriad of policy changes to a defined economic geography, including transportation projects. It produces standardized impact metrics as annualized results over a forecast analysis horizon. REMI® and the standardized economic impact metrics are further described below, followed by an outline of the impact analysis inputs and general modeling process. For more in-depth discussion of how the REMI® model works please refer to **Appendix H** for the full economic report.

Summary of Aggregate Total Economic Impacts

The net economic impact from implementing the proposed tolled facility is generally positive across the cumulative horizon years. However, some years immediately following the construction timeframe exhibit negative impacts across the aggregation of the impact components. A generally positive trend occurs because the initial facility construction produces relatively large-scale impacts (compared to the other evaluated economic impact components).

Constructing and implementing the proposed facility is estimated to result in cumulative total employment impacts measuring almost 21,100 job-years over the future horizon spanning 2016 through 2039 for the regional area, and 24,500 job-years within the entire State of Texas (see Exhibit 7 and Exhibit 8 in **Appendix H**).

[1] REMI® Policy Insight + v.1.3 was used as the modeling tool in this evaluation.

The pattern of total impacts is large and positive due to the initial construction expenditures between 2016 and 2019, then a sharp decline through about 2025, followed by a steady increase thanks to the strong and positive travel efficiency-related impacts for the rest of the future time horizon. Value-added impacts adhere to a similar trend, as do the impact to the State of Texas at large.

Corresponding to the employment impacts are value-added impacts amounting to $2.11 billion (in 2012 dollars) for the regional area and $2.44 billion for Texas over the 2016 through 2039 analysis horizon (see Exhibit 9 in **Appendix H**).

Expenditure-Based Component Impacts

According to the assumed expenditure schedule as shown in Exhibit 3 of **Appendix H**, the incremental spending between the Phase I and Phase II Build and the No-Build scenario (status quo) for the proposed project amounts to about $1.11 billion for the years 2012 through 2039, exclusive of the ROW costs[2].

The construction expenditure schedule is strongly "front-loaded" over the analysis period, with a vast majority of the total spending differential necessarily occurring in the first few years for the construction of the Preferred Alternative; that is, approximately $800 million from 2016 through 2018 for the Phase I construction. Once the Preferred Alternative Phase I is constructed and use commences in 2019, operations/maintenance and lifecycle infrastructure costs arise. Operations, maintenance, and lifecycle expenditures amount to approximately $310 million over the 2019 through 2039 analysis horizon.

Because the expenditure schedule and amounts are heavily "front-loaded," the pattern of economic impacts is consequently similar, with the largest and most pronounced impacts occurring during the first years of the Preferred Alternative construction. Spending on construction activities for the Grand Parkway facility translates into 7,920 job-years and $455 million in economic value-added for the regional study area across the analysis horizon; in Texas the impacts are 9,730 job-years and $636 million, respectively.

The economic impacts from construction expenditures are projected to be positive and relatively large during the years of Phase I construction (i.e., 2016 through 2018). As funding becomes available for Phase II, there will be another cycle of positive economic impact. After the Phase I and Phase II construction

[2] ROW purchases are considered asset transfers and are not translatable into economic output or employment impact metrics. As such, the ROW costs are of no relevance and dismissed herein.

periods, there will be a negative economic impact in the years immediately following. The reversal reflects the relative economic negative impact following the pronounced spending that is suddenly curtailed at the completion of the project construction. In the absence of similar construction spending patterns the labor, and capital dedicated for the construction activities leave the area for opportunities elsewhere.

Operations, maintenance, and lifecycle expenditures which begin immediately following the construction activity timeframe (i.e., in 2019, with the opening of Phase I of the facility, or in 2025, with the opening of Phase II of the facility) create positive economic impacts in each analysis year varying in relative proportion to the expenditure amounts. In aggregate and across the analysis horizon, the operations, maintenance, and lifecycle expenditure-related impacts are expected to yield employment impacts totaling 3,120 job-years for the regional study area, and 3,650 job-years for Texas. Associated value-added impacts total $219 million for the regional study area and $277 million for Texas overall.

Travel Efficiencies and Tolling Component Impacts

Changes in travel demand characteristics stemming from construction of the Preferred Alternative result in travel-time, vehicle-operation, and safety cost changes accruing to households and businesses within the defined study area, and thus results in economic impacts.

The proposed project is expected to increase vehicle-miles traveled (VMT) in the regional study area. The increase in VMT would increase vehicle-operating costs and thus negative economic impacts, as those direct costs are attributed to the sectors in the economic model (as appropriate, depending on the trip purpose) and run through the economic multipliers. Although network VMT are expected to increase with the implementation of the Preferred Alternative resulting in vehicle operation cost increases, the vehicle-hours travelled are expected to decline, leading to travel-time savings. Accidents as a function of VMT and the accident rates per mile are also expected to decline in aggregate across the analysis horizon as traffic shifts from the overall network to the Grand Parkway highway (with the highway configuration having notably reduced accident rates than the overall network). Consequently, the accident reduction leads to societal accident costs savings which are translated into positive economic impacts. Imposition of tolling on the local population is an out-of-pocket cost to households and businesses and generally by itself results in negative economic impacts.

Combining results of the various travel demand characteristic-related economic impacts yields net positive results across the entire analysis horizon. The impacts turn negative in a few years following the opening of the proposed project, but within a few years revert to net positive impacts that escalate rather quickly thereafter. The reasoning for the pattern of economic transitioning from negative to positive, then escalating thereafter is driven by the negative impacts attributable to the vehicle operating cost increases and tolling impositions that are not sufficiently offset initially by accident and travel time savings. Furthermore, because the travel time savings escalate at a higher rate than the annual changes in the other travel demand characteristic-related components, the aggregate savings turn positive together with the resulting total economic impacts around 2025.

Combining all the components, the economic impacts resulting from travel efficiencies and tolling implementation on the Preferred Alternative is estimated to amount to $1.44 billion in economic value-added and 10,030 job-years over the analysis horizon spanning from 2019 through 2039 for the regional study area, and $1.52 billion and 11,120 job-years, respectively, for the entire State of Texas.

Conclusion

The analysis examined two main sources of potential economic impacts arising from the Grand Parkway Segments H and I-1 investment: expenditures and travel efficiencies. The travel efficiency benefits arise as a result of savings accruing to users of the facility such as travel time savings, vehicle operating costs savings and accident savings, while the expenditures-based impacts are a function of the magnitude of the outlays on the facility and the input-output structure of the regional economy.

In summary, the proposed project is expected to bring employment and economic activity to the Houston regional and statewide economies. The combined (of the different impact categories) cumulative (over the entire 2016-2039 analysis horizon) total employment impact is projected to amount to almost 21,100 job-years in the Houston Region and 24,500 job-years Statewide. Corresponding economic activity (Gross Regional Product) impacts are projected to measure $2.1 billion and $2.4 billion in increased value-added for the Houston Region and Statewide, respectively. TxDOT will enter into one or more agreements with the counties in which the Grand Parkway is located. These agreements will provide for the assignment of responsibilities for the development and financing of the various segments of the Grand Parkway, including provisions relating to the use of the toll revenues from segments of the Grand Parkway to pay for the costs of the other segments. Under the existing agreements, TxDOT and the counties agreed that the Grand

Parkway will be developed under definitive project agreements in which toll revenues from each segment of the Grand Parkway will not be used for any purpose other than the development of Grand Parkway until the ultimate scope is completed.

Project Level Environmental Justice (EJ) Toll Analysis

A project-level toll analysis was conducted to determine the potential impact that tolling would have on the Environmental Justice community within the project area. To complete this study, H-GAC utilized a travel demand model to identify potential toll road users and to conduct a travel time analysis for persons residing in Environmental Justice traffic analysis zones (TAZs) and Non-Environmental Justice TAZs. In addition, an evaluation of toll policies, toll rates, and available non-toll facilities was conducted to fully evaluate the potential for disproportionate impacts to environmental justice communities.

Non-Toll Facilities

The new location 37-mile toll road with intermittent frontage roads would extend from US 59/I-69 to I-10 through Montgomery, Harris, Liberty, and Chamber counties. The main lanes are proposed to be tolled and there are no parallel arterials within the study area.

The non-tolled roadway network, which connects US 59/I-69 to I-10 within the study area, is primarily comprised of local two lane facilities and is circuitous. The approximate 37-mile route entails traveling along FM 1485 east to FM 2100 (Huffman-New Caney Road), FM 2100 (Crosby Huffman Road) to FM 1942, FM 1942 (Crosby Barbers Hill Road) east to SH 146, and SH 146 south to I-10 (**Exhibit 2-8)**.

There are no toll facilities within the study area. The Beltway 8/Sam Houston Parkway toll road connects to US 90 and lies 9 miles west of the study area. Although there is no transit service within the study area, three transit routes: 255, 259 and 236, terminate within 2 miles of the western boundary.

Toll Policies

Based on Senate Bill 792, TxDOT has agreed to be consistent with the Harris County Toll Road Authority (HCTRA) policies for all Grand Parkway projects; however, specific toll policies and rates will be set by order of the Texas Transportation Commission. These fees include reasonable fees for administering electronic toll collection customer accounts, toll tags, toll collection and toll transactions. For the purposes of this analysis, the HCRTA toll policies were used. Their toll policies have identified various circumstances for which non-tolled or free passage on area toll roads is allowed to certain individuals, certain types of

vehicles, and under special circumstances. The categories of free passage for toll roads are explained in **Table 4-6**.

Table 4-6: Categories of Free Passage on Toll Roads

Category	Description
Vehicles	1. Marked police vehicles, fire department vehicles, and ambulances.
	2. Authorized emergency vehicles identified in Texas Transportation Code §541.201.
	3. Vehicles designated by the Department of Public Safety as emergency vehicles during disasters declared by the governor of Texas (Texas Transportation Code §546.006).
	4. Individual military vehicles and convoys (considering the technological and personnel limitations of operating the toll project) (Texas Transportation Code §362.901). • Clearly identifiable military vehicles may use the electronic tolling lanes. • Military vehicles that are not clearly identifiable should use the collector lane and "sign through" on a log maintained by the collector. • Military vehicles that are not clearly identifiable will not be allowed free passage on toll roads where there are no collector lanes.
	5. Vehicles that are part of a funeral procession, provided that: • HCTRA is notified at least 24 hours in advance; • HCTRA's Director determines that it is in the interest of public safety that the procession be routed onto the toll road system; • the procession is escorted by certified peace officers; and • the procession enters and exits the toll road system outside of these hours: Monday through Friday – 6:00 AM to 9:00 AM. and 4:00 PM to 7:00 PM.
	6. Processions and motorcades for heads-of-state and dignitaries (if the procession/motorcade is escorted by the United States Secret Service, Texas Department of Public Safety, or other law enforcement agency responsible for safety and security).
	7. Harris County owned/leased vehicles while used in the performance of County business.
Individuals	1. Current federal and state military members with Military ID are permitted free passage through collector lanes. • Requires presenting valid military ID and signing a non-revenue sheet. • Free passage not available on Toll Roads with no collector lanes or through combination collector/electronic tolling lanes if vehicle is equipped with an EZ TAG device.
	2. HCTRA employees who must incur a toll to access or depart their duty stations at Hardy North Toll Plaza, Hardy South Toll Plaza, Sam Houston North Toll Plaza, and Sam Houston South Toll Plaza.
	3. HCTRA employees assigned to the Sam Houston Toll Bridge or Sam Houston East Plaza, whose route to work includes crossing the Toll Bridge are permitted sign through privileges for the Toll Bridge.
	4. HCTRA employees who must use the Toll Roads on HCTRA-related business (during working hours) in their private vehicles are permitted sign-through privileges upon presentation of proper authorization.
Circumstances	The Commissioners Court authorizes free passage on the Toll Roads when there is sufficient notice of an impending catastrophic event. When the emergency or event is unexpected or unforeseen, authority is delegated to persons in the best position to exercise informed judgment as outlined below: • **Large-scale emergency or calamity:** The County Judge is authorized to permit free passage on part or all of the Toll Roads when a large-scale emergency or calamity (natural or man-made) threatens public safety and necessitates the immediate evacuation or relocation of large numbers of people that may obstruct or impede rapid movement on the Toll Roads. • **Localized emergency or condition:** In the event of a localized emergency or condition (such as refinery explosions, gas leaks, hazardous material spills, flooding, traffic accidents, lane closures, etc.) that substantially threatens public safety and mobility, an on-site Incident Management certified peace officer may permit limited free passage for a period of no more than one hour. Approval of the County Judge, Executive Director of Harris County Public Infrastructure, or the Director of HCTRA must be obtained to extend free passage beyond the initial one-hour period.

Category	Description
	• **Lane and/or road closures:** When closures required for construction and maintenance of the Toll Roads are expected to substantially and adversely affect traffic flow and/or threaten public safety, free passage may be permitted by the Director of HCTRA, the Executive Director of Harris County Public Infrastructure, or their designee. • **Ramp tolls:** HCTRA may elect to not collect tolls at ramps on dates or during hours where the Director concludes that the amount of vehicle traffic at those ramps and the tolls likely to be collected do not justify the cost of assigning collectors during those times. • **Opening a new road project or segment:** HCTRA's Director may designate a time period where free passage may be permitted to allow for testing of the infrastructure supporting the toll collection process. If the test period needs to exceed 45 days, HCTRA's Director should obtain authorization from Commissioners Court to extend the test period.

Source: HCTRA (n.d.)

It should be noted that a specific tolling authority for the Grand Parkway Segments H and I-1 has not been determined at this time. Per Senate Bill 1420, TxDOT has the authority to select a tolling entity to govern tolling policies and rules specifically for Segments H and I-1. The selection of a toll entity is currently ongoing and has yet to be determined.

In addition, consistent with Texas Transportation Commission Minute Order No. 82325 signed October 25, 1984, the entire Grand Parkway would serve as an additional hurricane and emergency evacuation route for the Houston metroplex. In order to alleviate congestion during mass evacuations and create safer, more efficient evacuation conditions, tolls on the Grand Parkway would be suspended during hurricane evacuation.

Anticipated Toll Rate

The anticipated toll rate for the Grand Parkway project would be a schedule of rates that would not exceed the average per mile toll rates for electronic toll transactions in force and effect for the HCTRA operated toll road system. The current toll rates are identified in **Table 4-7**. The initial toll rate may be higher or lower, and may increase in later years of the project. Toll rate increases would require approval from the Commissioners Court.

Table 4-7: HCTRA Toll Rates

Vehicle Axles	Mainline Plaza
2 axle	$1.40 EZ Tag $1.75 Cash
3 axle	$3.50
4 axle	$5.25
5 axle	$7.00
6 axle	$8.75

Source: https://www.hctra.org/tollroads_rates

Methods of Toll Collection

Tolls would be collected using a completely electronic toll collection (ETC) system. No toll booths are proposed and therefore no cash payment would be accepted. The ETC system requires that users of the roadway have a toll tag that registers on the ETC system as the vehicles pass under the toll gantry. The ETC equipment would be placed on toll gantries positioned at specific locations along the mainlanes and at certain ramps.

The ETC allows participating motorists to prepay their tolls using a major credit/debit card or direct debit payment option. A small adhesive transponder (toll tag) that communicates electronically with a computer via radio frequencies is affixed to the inside of the windshield. As motorists use the facility, tolls are electronically deducted from their pre-paid account. When an account reaches the minimum balance level, it automatically charges (debits) the customer's credit card or bank account to bring it back to the original deposit amount. A cash payment option is currently not available. It has also yet to be determined what requirements would exist for account maintenance.

Motorists using the toll road without a toll tag would be charged via the video tolling system. The ETC video records a photograph of the vehicle's license plate and a (monthly) invoice would be mailed to the registered owner of the vehicle. The assessed toll fee for these motorists is higher than that for toll tag users, and an additional collection fee is included on the monthly invoices. This tolling program allows infrequent users without a transponder/toll tag to travel the toll road without having to stop and pay. The video tolling method is more expensive for users who do not have an active toll account because fees associated with billing and handling of the periodic billing statements are added to the costs.

Any EZ TAG account set up with a toll facility operator in Texas would be able to access toll roads or managed lanes in any of the toll authority areas while having the tolls charged to the user's home account. To achieve this objective, toll tags or transponders issued by a toll authority in one area of the state would be capable of registering toll transactions to the user's home toll account. Users from other states or international drivers would be billed similarly to users without toll tags.

The EZ TAG program requires an initial prepayment of $40 for credit/debit card payment and $80 for funds directly deducted from a bank, plus a $15 per-tag activation fee for the first three TAGs, and $10 per tag thereafter. Monthly statements for the previous eighteen months of an account usage are available at no

charge with an online account, or printed statements may be mailed. The associated fees for enrolling in the EZ TAG program are shown in **Table 4-8**.

Table 4-8: EZ TAG Fees

Number of Vehicle(s)	Pre-Paid Deposit	Balance at which Replenishment Required (¼ of Deposit)	Activation Fee (per EZ TAG)
1 - 3	$40	$10	$15
4 - 6	$80	$20	$10
7 - 9	$120	$30	$10
Etc.	Maximum $600 (or optional higher balance)	Maximum $150 (or ¼ of optional higher balance)	$10

Source: https//www.hctra.org/about_forms/.

The user would be required to set up a prepaid account that would automatically transfer funds from their credit card or bank account to the toll account. The minimum account balance is determined by the type of payment used for the account as well as the number of EZ TAGs on the account. The typical credit card-backed account with one to three EZ TAGs has a required replenishment amount of $40 and a low balance amount of $10. This means that as a motorist travels through the EZ TAG lanes and the account goes to $10 or below, the credit/debit card will automatically be charged $40 per the EZ Agreement.

The typical bank account EZ account with one to three EZ TAGs has a required replenishment amount of $80 and a low balance amount of $20. Similarly, if the balance falls below $20, the system will automatically replenish the EZ TAG account to the $80 minimum. Frequent toll road users would therefore see multiple replenishment charges on their bank account in a month. A $25.00 fee is applied to each rejected withdraw from the bank account. If a bank charge fails after three consecutive attempts or three times in a twelve month period, a credit card would be required as the primary form of payment. Currently, cash accounts are not accepted to maintain an EZ TAG. Toll accounts issued by other Texas transportation entities such as the TxTag and Texas Toll Tag would be accepted on the EZ TAG system.

Toll Booths Locations

Since the Grand Parkway is proposed as an all-electronic toll road with no cash payments, no toll booths are proposed. The mainlane toll gantries would span both directions of travel on a structure similar to a typical sign bridge. The gantry would support ETC reader units, video enforcement system cameras, illumination devices, automatic vehicle identification antennae, communications gear, and other necessary equipment. This equipment would be supported approximately 20 feet above the roadway surface and

would be used to collect electronic toll data. Similar, smaller gantries would be needed at some ramps as well, except these would only span the width of the particular entrance or exit ramp. The exact location of toll gantry locations (ramps and mainlane) would be determined during final design. Advantages of the ETC system include the following:

- The system minimizes the amount of ROW needed for the proposed toll collection facilities because additional lanes for cash toll booths and parking and other facilities for toll attendants would not be required.
- The gantry minimizes the acceleration and deceleration of traffic that usually accompanies toll booth collections because cash would not be accepted.
- Last-minute lane changes between toll and cash lanes would not occur, providing smoother traffic conditions at toll collection locations.
- Lighting impacts would be minimized because the gantries would not require any lighting beyond typical roadway-specific lighting for the video enforcement cameras.

Since the ETC system does not require the installation of toll booths, there would be no disproportionate impact to EJ communities regarding toll booth placement.

Environmental Justice

The H-GAC evaluation to determine the effects of the Grand Parkway Segments H & I-1 on Environmental Justice (EJ) populations utilized the travel demand model in conjunction with those 2000 Census block groups which contained 51 percent or more of minority and/or low income populations. Once the EJ block groups were identified, EJ Traffic Analysis Zones (TAZs) were identified if 50 percent or more of its area was identified as an EJ population.

Following the identification of the EJ TAZs, two regional roadway network scenarios were utilized, the 2035 RTP Build Scenario and the 2035 RTP No-Build Scenario, to conduct an analysis on travel time for persons within the EJ TAZs and non-EJ TAZs. The Build Scenario includes the new tolled lanes, managed lanes, and high occupancy tolled lanes (HOT) projects identified in the 2035 RTP. The No Build Scenario includes the current roadway network, the fiscally constrained 2035 RTP roadway network along with the existing plus the committed managed lane system (e.g. BW 8) but excludes the Grand Parkway Segments H & I-1 project.

Travel Demand Assumptions and Methodology

The region's travel demand model does not provide a means for tracking travel at an individual household level, but does provide a means for tracking travel at a zonal level. For purposes of the analyses, the zones are specified as either EJ zones or non-EJ zones based on the socioeconomic characteristics of the zonal populations. Some regional travel models employ a generalized cost assignment procedure for toll analyses. The H-GAC models perform toll analyses at the mode choice level. Hence, the H-GAC travel model uses a multi-class assignment procedure rather than a generalized cost procedure.

The mode choice models are applied by trip purpose. For the mode choice toll analyses, two travel time estimates are developed from each zone to all other zones: 1) the travel time using both toll and non-toll links (commonly referred to as "toll path" travel times), and 2) the travel time using only non-toll links (commonly referred to as the "free path" travel time). In the mode choice model, if the toll path does not offer a shorter travel time between two zones than the free path travel time, the trip is not considered a "candidate" for the toll facility. If a trip can save travel time using a toll path over a free path then it is considered a "candidate" trip. Of course, not all candidate trips will choose to use a tolled path. The probability of a candidate trip using a tolled path is a function of a number of variables such as the magnitude of the potential travel time savings, the toll costs and the income characteristics of the zones residents. Aspects of this approach are employed in the analyses presented.

In mode choice model applications, there is a single highway network which is used to estimate the travel times for toll paths and free paths. For the regional toll analyses, there are two networks: the "Build" network (i.e., the forecasted roadway network containing the subject toll facilities) and the "No-Build" network (i.e., the network containing all the forecasted roadways except the Grand Parkway Segments H & I-1). Existing and committed toll facilities are contained in both networks. In this analytical setting, simply comparing the toll path versus free path option will not identify the candidate trips for only the new toll facilities being studied. Indeed, such a grouping would include trips using both existing and proposed toll facilities.

To focus on candidate trips for the new toll facility, the travel time for toll paths in the Build network is compared to the toll path travel time in the No-Build network. Trips that have a shorter toll path travel time in the Build network than the toll path travel time in the No-Build network are defined as candidate trips for the new toll facilities. The trips for a given trip purpose are segmented into four groups:

- Trips produced by EJ zones that are classified as "Candidate" trips;
- The remaining trips produced by EJ zones are classified as non-"Candidate" trips;
- Trips produced by non-EJ zones that are classified as "Candidate" trips; and
- The remaining trips produced by non-EJ zones are classified as non-"Candidate" trips.

To determine the time analysis for the different types of trip scenarios, trips were divided into home based work trips (HBW) and home based non-work trips (HBNW) for both tolled and free facilities. The number of HBW trips and HBNW trips for the Grand Parkway Segments H & I-1 project is depicted in **Table 4-9**.

Table 4-9: Potential Person Trips in the EJ and Non-EJ Zones

	2035 HBW Person Trips			2035 HBNW Person Trips		
	Toll Candidate	Non-Candidate	Total	Toll Candidate	Non-Candidate	Total
EJ Zone	617,178	2,024,662	2,641,840	816,787	5,585,708	6,402,495
Percent of Total	23%	77%		13%	87%	
Non-EJ Zone	896,048	2,201,927	3,097,975	824,905	5,797,219	6,622,124
Percent of Total	29%	71%		12%	88%	

Source: H-GAC (2013).

Using toll path travel times and free path travel times from the Build and the No-Build networks, there are four travel times for each type of trip (e.g. HBW, HBNW) Build network-toll path option, 2) Build network-free path option, 3) No-Build network-toll path option, and 4) No-Build network – free path option). By computing the average trip lengths for each of the options, the impacts of the two networks on the choice options can be quantified, compared, and analyzed.

Results

As shown in Table 4-9, approximately 23 percent of the HBW trips identified within EJ zones were toll candidates. Additionally, nearly 29 percent of the HBW trips identified within non-EJ zones were toll candidates. Of the HBNW trips, approximately 13 percent of the EJ zone and 12 percent of the non-EJ zones trips were toll candidate trips.

Utilizing this data, further evaluation was conducted to determine the free path travel and tolled travel path for both the Build and No-Build Network Scenarios. The average trip length (ATL) in minutes was the measure used in this evaluation for both types of trips within the EJ and non-EJ zones.

The results of the HBW and HBNW trips analysis for the proposed Grand Parkway Segments H & I-1 are presented in **Table 4-10** and **Table 4-11**, respectively.

Table 4-10: AM Peak Home Base Work Trips

			AM Peak Average Trip Length (ATL) in minutes for Free and Tolled Facilities under the Build and No-Build Network Scenarios				Difference in AM Peak ATL in minutes	
			Build Network Scenario		No-Build Network Scenario			
Zones	2035 HBW Trip Scenarios	Number of 2035 HBW Person Trips (min.)	ATL Using Tolled Facility (min.)	ATL Using Free Facility (min.)	ATL Using Tolled Facility (min.)	ATL using Free Facility (min.)	Difference in ATL for the Tolled Facility (No-Build – Build) (min.)	Difference in ATL for Free Facility (No-Build – Build) (min.)
EJ Zone	Trips that save 0+ minutes using a new tolled facility	617,178	36.03	43.77	36.31	43.84	0.28	0.07
	Trips that cannot save 0+ minutes using a new tolled facility	2,024,662	22.17	24.45	22.18	24.47	0.01	0.02
Non-EJ Zone	Trips that save 0+ minutes using a new tolled facility	896,048	47.96	58.16	48.84	58.43	0.88	0.27
	Trips that cannot save 0+ minutes using a new tolled facility	2,201,927	26.71	29.86	26.73	29.91	0.02	0.05

Source: H-GAC (2013).

Table 4-11: AM Peak Home Base Non-Work Trips

			AM Peak Average Trip Length (ATL) in minutes for Free and Tolled Facilities under the Build and No-Build Network Scenarios				Difference in AM Peak ATL in minutes	
			Build Network Scenario		No-Build Network Scenario			
Zones	2035 HBNW Trip Scenarios	Number of 2035 HBNW Person Trips	ATL Using Tolled Facility (min.)	ATL Using Free Facility (min.)	ATL Using Tolled Facility (min.)	ATL using Free Facility (min.)	Difference in ATL for the Tolled Facility (No-Build – Build) (min.)	Difference in ATL for Free Facility (No-Build – Build) (min.)
EJ Zone	Trips that save 0+ minutes using a new tolled facility	816,787	30.82	35.07	30.99	35.16	0.17	0.09
	Trips that cannot save 0+ minutes using a new tolled facility	5,585,708	12.16	12.53	12.18	12.55	0.02	0.02
Non-EJ Zone	Trips that save 0+ minutes using a new tolled facility	824,905	30.18	35.54	31.55	36.23	1.37	0.69
	Trips that cannot save 0+ minutes using a new tolled facility	5,797,219	14.66	15.15	14.76	15.25	0.10	0.10

Source: H-GAC (2013).

The results for the HBW and HBNW trips analysis indicate:

- The addition of the Grand Parkway Segments H & I-1 project to the regional roadway network under the Build Scenario results in a minor reduction of travel time in the EJ and Non-EJ Zones (0.28 and 0.88 minutes respectively for HBW trips and 0.17 and 1.37 minutes for HBNW respectively).
- While the users of the toll facility in the Build Network Scenario within the EJ Zones would receive a greater time savings benefit than the users on the free network, there is no appreciable change in travel time on the free network in the EJ and Non-EJ Zones. As a result, there is no potential for a disproportionate negative effect to the EJ populations from the proposed Grand Parkway Segments H & I-1 project. In fact, the entire region, including the EJ

Zones would recognize a benefit in travel time savings because of the added capacity the of the entire toll roadway network facilities provide to the regional roadway network. (refer to **Section 6.4** for additional information)

Potential Economic Impact

Potential economic impacts to individuals using the proposed Grand Parkway Segments H & I-1 can be illustrated using the 2012 HCTRA toll rates and the median household income for the study area. Currently, the low, mid-range, and high toll rates are 12.3, 20.0, and 33.6 cents per mile. This analysis assumed a worst case scenario for the toll road user in that they would travel the entire 37-mile tollway from US 59/I-69 to I-10 250 times per year (500 total trips) As shown in **Table 4-12**, the annual cost for low, mid-range, and high toll rates would be approximately $2,276, $3,700 and $6,216, respectively. However, the actual cost should be less because the likelihood of a trip using only tolled facilities is diminutive.

A user with an annual household income that equals Harris County's 2011 median household income of $52,675 would spend 4.3, 7.0 and 11.8 percent of their household income on tolls. A user with an annual household income that equals Montgomery County's 2011 median household income of $66,657 would spend 3.4, 5.6, or 9.3 percent of their household income on tolls depending on the toll range. A user with an annual household income that equals Liberty County's 2011 median household income of $47,460 would spend 4.8, 7.8, or 13.1 percent of their household income on tolls depending on the toll range. A user with an annual household income that equals Chambers County's 2011 median household income of $72,850 would spend 3.1, 5.1, or 8.5 percent of their household income on tolls depending on the toll range. Users with an annual household income that falls within the HHS poverty level of $23,550 would spend 9.7, 15.7, or 26.4 percent of their household income on tolls depending on the toll range.

Table 4-12: Potential Economic Impact

					Harris	Montgomery	Liberty	Chambers	
Toll Range	Toll Rate Per Mile[1]	Percent of Median HH Income[2]	Miles Per Trip	Total Cost Per Year	Percent of Median HH Income[2]	Percent of Median HH Income[3]	Percent of Median HH Income[4]	Percent of Median HH Income[5]	Percent of Poverty Level Income[6]
Low	$0.123	500	37	$2,276	4.3	3.4	4.8	3.1	9.7
Mid-range	$0.20	500	37	$3,700	7.0	5.6	7.8	5.1	15.7
High	$0.336	500	37	$6,216	11.8	9.3	13.1	8.5	26.4

1. Per HCTRA 2012 toll rates
2. 2011 median household income for Harris County is $52,675 (http://quickfacts.census.gov/qfd/states/48/48201.html)
3. 20011 median household income for Montgomery County is $66,657 (http://quickfacts.census.gov/qfd/states/48/48339.html)
4. 2011 median household income for Liberty County is $47,460 (http://quickfacts.census.gov/qfd/states/48/48291.html)
5. 2011 median household income for Chambers County is $72,850 (http://quickfacts.census.gov/qfd/states/48/48071.html)
6. 2013 Health and Human Services poverty guideline level is $23,550 for a family of four

Assuming the same level of use, low-income populations would pay a larger percentage of their income in tolls when compared to the general population. If toll costs are beyond the affordability of low-income travelers, they have the alternative of using the existing non-tolled transportation network. As a result, potential users who are unable to afford the toll or maintain a toll tag would be denied the travel benefit (reduced travel time) associated with using the tolled facility.

Availability of Tolling Information

The HCTRA website provides information regarding the EZ TAG, toll road network, toll charges or violations, and safety on the toll roads. Currently, this website is only available in English; however, toll road users can also purchase toll tags and access information on Houston area toll roads (including the Grand Parkway) in Spanish on the TxTag website at www.txtag.org. The TxTag website also provides contact information for the deaf and hard of hearing ([TDD/TTY] 1-866-590-5155). The state-owned Grand Parkway system is covered by the provisions of Section 504 of the Americans with Disability Act (ADA) providing services and programs in the most integrated setting appropriate to the needs of qualified individuals with disabilities and make reasonable modifications in policies, practices and procedures to avoid discrimination on the basis of disability in accordance with department rules and regulations.

Growth of Toll Network

Grand Parkway minimum scope consists of constructing four tolled lanes or two tolled lanes and direct connectors, where financially feasible; when traffic demand increases, the ultimate design of Grand Parkway, according to Market Valuation Waiver Agreement (**Appendix I**), authorizes up to 6-lanes.

Assumptions and Limitations

The assumptions and limitations for the Segments H & I-1 project level toll analysis are as follows:

1. The model is based on the latest adopted H-GAC 2035 household and employment forecast as of November 2011 (Household and employment numbers are used for Trip Generation only, not population).
2. The model was validated to 2009 traffic counts within acceptable industry and H-GAC standards.
3. The model includes all system expansions as listed in the Houston 2035 RTP; the "No-Build" scenario removes only the segment being tested.
4. The model uses the same H-GAC 2035 household and employment forecast for all scenarios, both "Build" and No-build".
5. For this analysis, an EJ zone is any TAZ that meets the minimum criteria as defined under Title VI. The model does not use separate individual households. All travels in the model from households in an EJ zone are assumed to be EJ, regardless of their individual income levels or composition. The model's Trip Generation step does consider household's income level as a factor for trip generation. (The general assumption is that higher income households tend to make more trips.)

This modeling analysis includes only direct Home-Based Work and Home-Based Non-Work trips. Non-home-based trips, i.e. "trip chains", are not included in this analysis. (The H-GAC model includes Non-home-based trips for travel demand forecasting; however, for the project level EJ analysis, only HBW and HBNW trips are used).

4.2.1.3 Limited English Proficiency

EO 13166, "Improving Access to Services for Persons with LEP," calls for all agencies to ensure that their federally conducted programs and activities are meaningfully accessible to LEP individuals. BG data was obtained from the U.S. Census Bureau *2006-2010 ACS* database. As shown in **Table 4-13**, the presence of LEP populations adjacent to or within the Preferred Alternative is relatively low.

According to the LEP data provided in **Table 4-13**, a range of 0.2 percent (CT 7101.00 BG 1) to 8.0 percent (CT 7009.00 BG 1) of the population 5 years and older within the BGs adjacent to or within the Preferred Alternative speak English "less than well," "not well," or "not at all." Specific LEP languages and respective percentages represented in the LEP study area (comprised of 16 BGs) are the following: Spanish (3 percent), and Asian and Pacific Islander (0.001 percent). In a windshield survey along the proposed study

area both the Spanish and English languages were observed on billboards and signs. All of the Spanish billboards and signs were observed at Community Drive near the beginning of the proposed project.

Table 4-13: LEP Populations of the Preferred Alternative

Census 2010 Geography	Population 5 years & over	Number Who Speak English "Less than Well," "Not Well," or "Not at All"					% LEP
		Spanish Speakers	Other Indo-European Speakers	Asian & Pacific Islander Speakers	Other Speakers	Total	
CT 2515.01	**4,758**	**59**	**0**	**0**	**0**	**59**	**1.2**
BG 1	4,758	59	0	0	0	59	1.2
CT 2516.00	**4,912**	**57**	**0**	**0**	**0**	**57**	**1.2**
BG 1	1,294	21	0	0	0	21	1.6
BG 2	3,618	36	0	0	0	36	1.0
CT 6925.00	**6,955**	**21**	**0**	**0**	**0**	**21**	**0.3**
BG 1	1,506	0	0	0	0	0	-
BG 2	1,122	0	0	0	0	0	-
BG 3	1,269	0	0	0	0	0	-
BG 4	3,058	21	0	0	0	21	0.7
CT 6926.02	**8,142**	**454**	**0**	**0**	**0**	**454**	**5.6**
BG 2	4,477	250	0	0	0	250	5.6
BG 3	1,266	12	0	0	0	12	0.9
CT 6928.02	**3,448**	**103**	**0**	**0**	**0**	**103**	**3.0**
BG 1	1792	103	0	0	0	103	5.7
BG 2	758	0	0	0	0	0	-
CT 7003.00	**8,860**	**689**	**0**	**0**	**0**	**689**	**7.8**
BG 5	1,528	93	0	0	0	93	6.1
CT 7009.00	**6,141**	**86**	**0**	**0**	**0**	**86**	**1.4**
BG 1	449	36	0	0	0	36	8.0
CT 7010.00	**5,127**	**514**	**0**	**0**	**0**	**514**	**10.0**
BG 1	2,975	227	0	0	0	227	7.6
CT 7101.00	**6,320**	**42**	**0**	**0**	**0**	**42**	**0.7**
BG 1	2,250	4	0	0	0	4	0.2
CT 7102.00	**14,055**	**211**	**0**	**21**	**0**	**232**	**1.7**
BG 2	4633	181	0	21	0	202	4.4

Source: U.S. Census Bureau, 2006-2010 American Community Survey Table B16004
ACS data are estimates; they are not counts.

The proposed project would pose no discriminatory barriers to the LEP population because TxDOT has included that population in the planning and public involvement process. Preparation for the May 2007 public meetings and the August 2011 public hearings included the publication of bilingual (English/Spanish) announcements in the following publications: *Houston Chronicle, Baytown Sun, La Subasta* (Spanish only),

Kingwood Observer, *Humble Observer*, *East Montgomery Observer, Atascosita Observer*, *Dayton News*, *Lake Houston Observer, and Liberty Vindicator*. These publications informed citizens of the opportunity to request an interpreter (for language or other special communication needs) to be present at the public meetings, to ensure that such persons have meaningful access to the programs, services, and information that TxDOT provides. Because the vast majority of the residents in the study area are English speaking, LEP has not been and is not expected to be a major concern in the future.

4.2.1.4 Community Cohesion

The New Caney/Roman Forest area between US 59 (N)/I-69 and FM 2100 is the most urban portion of the study area and would have the greatest potential impacts to community cohesion. The Preferred Alternative follows the existing transportation corridors for Community Drive and FM 1485. The Preferred Alternative crosses through a large lot subdivision in the vicinity of Baptist Encampment Road immediately west of the Lake Houston Wilderness Park. The Preferred Alternative would result in x residential displacements within the Baptist Encampment community. An overpass is proposed over Baptist Encampment Road that would maintain the connection and access between the community and allow for continued community cohesion. The Preferred Alternative continues through an area of both residential and commercial development along FM 1485, potentially displacing one church (Peach Creek Baptist Church).

The central and southern portions of the study area are primarily composed of agricultural and undeveloped land; residential development is sparse, and there is little commercial development. Areas near FM 1942 and State Highway (SH) 146 are characterized by industrial development. No significant impacts to community cohesion would occur in the central and southern portions of the study area.

<u>Community Services and Facilities</u>

Schools

New Caney ISD serves the urbanized population of the study area between US 59 (N)/I-69 and FM 2100. The Preferred Alternative would require an aerial easement over the southwest corner of the Kingwood College campus parcel, which is located between US 59 (N)/I-69 and Loop 494 just north of Community Drive, for a direct connector from Grand Parkway to US 59 (N)/I-69. The proposed project would not directly impact any portion of the school property. Access to New Caney High School and Kingwood College would not be affected. Other schools in New Caney ISD would not be affected. Other potential

indirect impacts such as noise, visual and air quality are discussed in subsequent sections. The analyses conducted indicates that indirect impacts are not anticipated.

Schools in the Huffman ISD are located on the western edge of the study area, west of the Preferred Alternative. No schools in the Huffman ISD would be directly impacted by the Preferred Alternative, and access to the schools would not be affected. Schools in the Dayton ISD are located on the eastern edge of the study area and would not be directly impacted by the Preferred Alternative; access to the Dayton schools would also not be affected. Schools in the Barbers Hill ISD are located east of the Preferred Alternative and would not be directly impacted, and access to the schools in the Barbers Hill ISD would not be affected. **Table 4-14** below contains information related to the size and enrollment of the school districts located within the study area.

Table 4-14: Study Area School Districts

District Number	District Name	District City	Number of Schools	District Enrollment	Area (mi^2)	Acres
036-902	Barbers Hill ISD	Mont Belvieu	10	3,708	193	123,468
101-906	Crosby ISD	Crosby	8	4,884	82	52,175
101-911	Goose Creek CISD	Baytown	30	20,354	135	86,290
101-913	Humble ISD	Humble	41	32,970	92	58,659
101-925	Huffman ISD	Huffman	6	3,092	53	33,769
146-901	Cleveland ISD	Cleveland	7	3,539	144	92,108
146-902	Dayton ISD	Dayton	9	4,896	262	167,503
146-907	Tarkington ISD	Cleveland	4	1,994	229	146,777
170-907	Splendora ISD	Splendora	6	3,378	74	47,606
170-908	New Caney ISD	New Caney	16	8,676	87	55,455

Source: Texas Education Agency (TEA), 2012

Current bus routes may require alteration to accommodate roadway system changes. Travel time along current routes may decrease due to reduced congestion on local roads, higher speeds, and more direct access provided by the Preferred Alternative. If school bus routes pass near the intersections of existing roads and Grand Parkway Segments H and I-1, they may experience increased congestion in these areas, as they are likely to undergo increased development. However, safety along existing school bus routes is expected to improve as traffic diverts from arterial roadways to a new facility.

Churches and Cemeteries

There are two churches that fall within the ROW of the Preferred Alternative for Grand Parkway Segments H and I-1. The Preferred Alternative would displace one church, Peach Creek Baptist Church, and take

approximately 3 ac of the front parking lot from East River Baptist Church. Both churches are located on FM 1485 just north of the Lake Houston Wilderness Park. The displacement of the Peach Creek Baptist Church has the potential to impact not only the physical church building, but also religious organizations (both business and social) as well as attendees or members. **Section 4.2.1.7** shows that comparable real estate sites appear to be available within the zip code in which the relocation is located. Therefore, the nearness of suitable buildings for the relocation of the church indicates the religious organizations and communities have the opportunity to be preserved within the immediate geographic area. No cemeteries are located within the proposed ROW for the Preferred Alternative.

Parks and Recreational Areas

The Preferred Alternative would directly impact approximately 11 ac of the approximately 4,990 ac of the Lake Houston Wilderness Park, which does not qualify as a Section 6(f) property. On the eastern side of the park, the required ROW needed would result from avoiding the East River Baptist Church. The impact on the western side of the park is due to a previously unknown tract of land jutting north of the park, which has now been determined to be park property.

A *de minimis* Section 4(f) Determination was prepared to address the potential impacts from the proposed project, as well as efforts to avoid, minimize, and mitigate impacts (**Appendix J**). The proposed construction of the Preferred Alternative would not adversely affect the features, attributes, or activities that qualify the Lake Houston Wilderness Park as a Section 4(f) property. 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, Texas Parks and Wildlife Department (TPWD), and the City of Houston. A public hearing was held on December 18, 2013, to discuss the Lake Houston Wilderness Park De Minimis Section 4(f) determination per requirements of Chapter 26 of the Texas Parks and Wildlife Department Code. A public hearing summary is included in **Appendix J**.

No other parks or recreation areas publicly owned parklands, wildlife or waterfowl refuges, recreational areas, known historic sites, or Section 6(f) properties would be directly impacted by the Preferred Alternative.

4.2.1.5 Access

Access to the mainlanes of Grand Parkway Segments H and I-1 would be limited to those who choose to pay the toll. The proposed project would not include frontage roads except the portion of FM 1485 that would be utilized as part of the Preferred Alternative. At FM 1485, frontage roads would be included in addition to mainlanes, to replace the existing FM 1485 roadway. Under normal operating conditions motorists (including emergency vehicles) using these frontage roads would experience longer travel times than motorists using the tolled mainlanes due to a lower posted speed limit and traffic signals along the frontage roads.

The difference in travel times between the tolled mainlanes and the non-tolled system roads would be the highest during peak periods of travel when traffic congestion within the Grand Parkway Segments H and I-1 project limits would be the greatest. The overall added system capacity that the Preferred Alternative provides would relieve traffic congestion for all motorists using roadways within the travel corridor, whether they use the mainlanes or the existing facilities.

4.2.1.6 Non-Toll Alternatives

Alternative non-toll routes include the existing roadway network within the study area. Motorists using these roads may experience longer travel times than motorists using the tolled mainlanes due to a lower posted speed limit, signalization, and roadway configurations that may provide a less direct route to their destination. The difference in travel times between the tolled mainlanes and the non-tolled roads would be the highest during peak periods of travel when traffic congestion within the proposed project limits would be greatest. The anticipated changes in level of mobility (LOM) associated with the proposed toll project are examined in **Chapter 1 (Purpose and Need)**.

4.2.1.7 Potential Displacements

The Preferred Alternative was selected to avoid and minimize potential displacements. The data used in the following analysis was determined through aerial photo interpretation and field visits. Due to the difficulty of identifying the true purpose for every structure, especially on the larger parcels, for the purpose of this analysis, each building (i.e. barn, home, business, shed, etc.) was identified as a separate displacement. Refer to **Exhibit 4-3** for the locations of the potential displacements and to **Appendix K** for other identifying information. There are 98 potential displacements (see **Table 4-15**) anticipated from the construction of the Preferred Alternative, which includes:

- 77 residential properties (including 19 barns and sheds);
- 1 church (Peach Creek Baptist Church);
- 19 commercial properties; and
- 2 utility displacements.

In January 2014, a site visit was conducted to confirm and identify displacements that may have changed since October 2012. A list of the potential displacements by address, as well as the parcels impacted by the Preferred Alternative, can be found in **Appendix K**.

In addition to the potential displacements, an aerial easement would be required from the Kingwood College north of Community Drive for a direct connector from westbound Grand Parkway to northbound US 59 (N)/I-69. Proposed ROW is also required from the parcel containing the Fighting 15 Volunteer Firefighters storage structure located on FM 1485 just east of the Lake Houston Wilderness Park. However, the Fighting 15 Volunteer Firefighters storage structure would not be displaced, and access to community services is not anticipated to be affected.

Table 4-15: Potential Displacements from the Preferred Alternative

Alternative	Number and Type of Displacement			
	Residential	Church	Commercial	Utilities
1 (No-Build)	0	0	0	0
10R*	77 (29 single-family homes and 28 manufactured homes; 1 multifamily home; and 19 barns/sheds)	1 (Peach Creek Baptist Church)	19 (Colorado Lining International, Valero Roadway Foodmart, Thrifty Peach Resale Shop, Oderco, Inc., Drifter's Bar, Drifter's Recycling, RV Park, Casey Ridge Grocery, firework stand, one unnamed commercial, one abandoned commercial, 4 Wheel Connection, Peach Creek Plantation, Ace Auto Parts, Donut Express Breakfast, M&M Mobile Auto and Parts, Triple S Construction, Triple S Construction Shed, vacant lot)	2 (1 Cell phone tower. Consumers Water Company)

*Preferred Alternative
Source: Study Team, 2013.

One residential displacement is anticipated within the CBs containing significant minority populations (CT 7009.00 BG 1 CB 1019). None of the proposed displacements are located within a BG with a median household income below that of the HHS 2012 poverty guideline of $23,050.

Availability of Comparable Residential Properties

For purposes of assessing availability of replacement housing within the study area, a search of the Houston Association of Realtors Multiple Listing was performed (2012). The multiple listings are constantly updated as properties enter the market. The search simply represents properties that are available at the time the document was being prepared. Other properties may become available in the future.

There are 76 potential residential displacements (19 of which are barns or sheds) located within the New Caney zip code (77357). According to Montgomery County Central Appraisal District (MCAD), property values for the 76 anticipated residential displacements range from $13,920 to $122,290. There is one potential residential displacement located in Liberty County, City of Dayton zip code (77535), with a property value of $48,580.

The Houston Association of Realtors Multiple Listing indicates that there are approximately 79 single-family homes throughout the New Caney (77357) and Dayton (77535) zip codes currently listed for sale near the location of the potential residential relocations. As shown in **Table 4-16**, the price range of available, comparable housing is estimated to range from $17,900 to $950,900. The data represents the availability of housing at a particular point in time (October 6, 2012) and is subject to change as a result of changing market conditions.

Table 4-16: Single Family Housing for Sale During October 2012

Listed Price Range	Zip Code 77357 (New Caney area)	Zip Code 77535 (Dayton area)	Total
17,900 - $50,000	6	0	6
$50,000 - $100,000	15	1	16
$100,000 - $150,000	12	3	15
$150,000 – $950,900	**39**	3	**42**
Total	**72**	7	**79**

Source: Houston Association of Realtors, 2012

While it appears that replacement housing can be found within the general area, replacement housing supplemental payments may be required to relocate some of the displaced property owners into comparable housing. As mandated by the Uniform Relocation Assistance and Real Properties Acquisitions Policies Act, or the Uniform Act, as amended in 1987, assistance would be provided should the local existing housing market be insufficient for relocation. The assistance would apply to the potential displacements if the values of the potentially displaced homes are not commensurate with available

housing values; TxDOT would complete a survey of the housing market and provide housing supplements to displaced residents, if necessary.

Availability of Comparable Church and Commercial Properties

As previously stated, one church and 19 commercial properties would be displaced in the New Caney zip code (77357). The church property is valued at $1,136,470 according to the MCAD. The commercial properties range in value from $4,330 to $483,000 according to the MCAD. A total of one church property priced at $493,000 is currently available in the New Caney zip code (77357) and one commercial/industrial property valued at $75,000 is currently available in the New Caney zip code (77357). Because the New Caney area is largely rural and undeveloped, many parcels exist that could be purchased and developed in order to retain the church or commercial properties within the New Caney zip code (77357). Properties of this type range in price from $50,000 - $1,780,000. Based on current available market data (http://www.loopnet.com/), comparable real estate sites appear to be available within the zip code in which these relocations are located. The nearness of suitable building sites for the relocation indicates the organizations have the opportunity to be preserved within the immediate area.

Relocation Assistance by TxDOT

TxDOT offers relocation counseling and financial assistance to residents and businesses that are displaced by the acquisition of highway ROW in accordance with the URARPAA. Once it has been determined that a structure must be acquired in order to construct the highway, the property owner and/or tenant is contacted by a relocation counselor who provides information on exactly what benefits for which the owner/tenant is eligible and who assists the owner/tenant in applying for those benefits. In general, the relocation counselor would provide listings of comparable housing, transportation to inspect the housing (especially for elderly and handicapped persons), and referrals to other agencies that provide assistance for relocated persons.

When a relocatee is contacted by a relocation counselor the counselor provides a listing of comparable housing which is currently available. The listing is as similar as possible to the dwelling being affected or acquired in terms of number of rooms, living space, location, and square footage. The properties in the listing are currently available on the market and within the financial means of the occupant. Replacement housing has to meet all minimum standards established by the state (decent, safe, and sanitary) and conform to all local building codes.

In the case of the Segments H and I-1 study area, property values are rapidly rising. Newly constructed housing in the area is considerably more expensive than the assessed valuations of the older housing stock. Market values for older housing stock in the Houston Association of Realtors Multiple Listing are also higher than the assessed valuations for these properties. Depending on the difference in prices of properties that are comparable in all other criteria, financial assistance in the form of a purchase supplement, rental assistance payments, or a down payment on a loan may be offered to the relocatee

In addition to residential relocation assistance, TxDOT also provides assistance to relocated businesses, farms, and nonprofit organizations. These benefits may be in the form of reimbursements for reasonable moving expenses and reestablishment expenses.

4.2.1.8 Summary of Social and Economic Impacts

The area traversed by the Preferred Alternative lies within 10 CTs, 16 BGs, and 142 CBs. African-Americans and Hispanic or Latinos of any race represent the dominant minority populations at the CB, and the BG level (**Table 4-2**). The Preferred Alternative has a 33 percent minority population at both the CB level and the BG level. Thirteen CBs were identified as containing a significant minority population for the Preferred Alternative. The CBs with significant minority populations are highlighted in **Table 4-2.** Refer to **Exhibit 4-2** for the locations of the individual CBs for the Preferred Alternative.

Additionally, 4.4 percent (CT 2515.01) to a high of 19 percent (CT 7010.00) of households in the study area have incomes considered to be below the poverty level range (**Table 4-3**).

An O&D analysis was conducted and indicated that an average of 29 percent of trips generated within the H-GAC region would travel the proposed Grand Parkway Segments H and I-1 and have origins or destinations within the BG study area. This represents approximately 16,963 daily trips (trips leaving + trips arriving) associated with the census BGs of the proposed Grand Parkway Segments H and I-1. Additionally the analysis indicated that approximately 16.9 percent of these trips would be from BGs with high proportions of low-income and/or minority populations.

In a windshield survey along the proposed study area, both the Spanish and English languages were observed on billboards and signs. All of the Spanish billboards and signs were observed at Community Drive near US 59/I-69 towards the beginning of the proposed project. According to the LEP data provided in **Table 4-6**, a range of 0.2 percent (CT 7101.00 BG 1) to 8.0 percent (CT 7010.00 BG 1) of the population

5 years and older within the BGs adjacent to or within the reasonable alternatives speak English "less than well," "not well," or "not at all." Specific LEP languages and respective percentages represented in the LEP study area (comprised of 16 BGs) are the following: Spanish (3 percent), and Asian and Pacific Islander (0.001 percent).

The New Caney/Roman Forest area between US 59 (N)/I-69 and FM 2100 is the most urban portion of the study area. The greatest potential impacts to community cohesion would occur in the New Caney/Roman Forest area. The Preferred Alternative follows existing transportation corridors in the area. The Preferred Alternative crosses through a large lot subdivision immediately west of the Lake Houston Wilderness Park and continues through an area of both residential and commercial development along FM 1485, potentially displacing one church, the Peach Creek Baptist Church. The displacement of the Peach Creek Baptist Church has the potential to impact not only the physical church building, but also religious organizations (both business and social) as well as the members. However, due to the nearness of suitable building sites for the relocation of the congregation, the religious organizations and communities have the opportunity to be preserved within the immediate geographic area.

There are 98 potential displacements anticipated from the construction of the Preferred Alternative. These displacements include 77 residential properties (19 are sheds or barns), one church, 19 commercial properties, and two utility displacements. None of the displacements are located within a BG with a median household income below that of the HHS 2013 poverty threshold of $23,550. However, two displacements are anticipated within the CBs containing significant minority populations (CT 7009.00 BG 1 CB 1050, and CT 7009.00 BG 1 CB 1019). There do not appear to be any disproportionately high and adverse impacts on minority or low-income populations associated with the proposed project because: 1.) the majority of displacements would occur in non-environmental justice CBs or BGs; 2.) feedback from GPA or TxDOT-sponsored meetings have not indicated any environmental justice issues as a result of displacements or impacts to community cohesion; 3.) the O&D analysis indicated the majority of trips anticipated to utilize the Preferred Alternative would not originate from areas identified with high concentrations of environmental justice populations; and 4.) non-toll options exist for those who elect or can occasionally afford to pay tolls to access the tolled mainlanes.

Although low-income, minority, and LEP populations are present within the study area, it is not anticipated that they would experience disproportionately high and adverse human health or environmental effects.

The No-Build Alternative is not anticipated to have any adverse impacts on displacements, LEP populations or minority and low-income populations in the study area. Economic impacts such as reduced trip time or tolling fees anticipated to result from the proposed project would also not occur.

Indirect Impacts

Indirect impacts would be driven by changes in travel patterns and access associated with the proposed Grand Parkway project. The potential indirect impacts resulting from implementation of the proposed improvements would include improved vehicular access to employment opportunities, markets, goods or services, residential uses, and public facilities due to increased vehicular mobility. The primary economic benefits of the proposed project are improved accessibility and improved traffic congestion management. The proposed project would provide a route for truck traffic from the Port of Houston to other industrial areas within the study area without traveling through the congested freeways and local roadways. This would result in substantial time and cost savings for travelers and result in some congestion relief on the freeways within Houston. Reduced congestion would result in increased safety, which would be an added economic benefit.

The environmental justice community, as a subset of the communities located within the AOI, would experience indirect impacts that mirror those of the general population. Potential adverse effects would include displacements of low-income or minority persons, or groups of persons, and additional noise and visual impacts. Beneficial effects could also occur to these populations. For example, induced land use development could create additional job opportunities and increased access to job opportunities through enhanced transportation infrastructure. Indirect impacts pertaining to air quality, access to public facilities and services, traffic operations and traffic noise would be experienced by the environmental justice population to the same extent and in the same manner (whether positive or negative) as experienced by the general population. Because indirect effects to environmental justice communities of concern can be both adverse and beneficial, and because proactive public involvement and coordination with local planning officials can help avoid disproportionate impacts, potential indirect effects of Grand Parkway Segments H and I-1 on environmental justice communities of concern are not considered to be substantial.

No indirect socioeconomic impacts are anticipated from the No-Build Alternative. Refer to **Chapter 5** for a detailed indirect impacts analysis.

4.2.2 Pedestrians and Bicyclists

Based on a review of the 2013-2016 Transportation Improvement Program (TIP) Bicycle and Pedestrian Project section, no pedestrian or bicyclist improvements are planned in the Grand Parkway Segments H and I-1 study area (H-GAC, 2012). Grand Parkway Segments H and I-1 would accommodate access to "Proposed Shared-Use Path/Trails" as identified in H-GAC's Regional Bikeway Plan. The use includes a shared-use path/trail along FM 2100. These "Proposed Shared-Use Path/Trails" would begin near the intersection of FM 2100 with Huffman-Cleveland Road on the western edge of the study area, approximately 3 mi west of the Preferred Alternative, and head south. It would not be affected by any of the reasonable alternatives or the Preferred Alternative. The proposed project may result in positive impacts to pedestrians and bicyclists. The proposed project would provide access enhancements to pedestrians and bicyclists and would help by reducing traffic on designated routes.

The Preferred Alternative would not adversely impact any existing bicycle or pedestrian network. No new bicycle or pedestrian facilities are proposed for the controlled access portion of the facility. The restriction of bicycle and pedestrian use of a controlled-access facility is permitted under Texas Transportation Code 545.0651. The proposed project would consider sidewalks on the non-tolled portion. Where sidewalks are considered, they would be compliant with the Texas Accessibility Standards, the Americans with Disabilities Act Accessibility Guidelines and TxDOT's bicycle and pedestrian standards. The Grand Parkway Segments H and I-1 project, as proposed, 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. In the event that a bicycle or pedestrian facility is in place prior to the proposed project, the facility would be reconstructed to maintain continuity and function. The flow of bicycle and pedestrian traffic may be affected by the Grand Parkway Segments H and I-1 at grade separations with access ramps. The proposed project would minimize adverse effects to bicyclists and pedestrians by providing crosswalks, walk signals, and appropriate signage at grade separated intersections (entrance ramp access points).

Under the No-Build Alternative, future urbanization within the Grand Parkway Segments H and I-1 study area is expected to lead to greater traffic volumes on arterial roadways. These greater traffic volumes would likely make these arterial roadways less safe for bicyclists and pedestrians unless significant efforts are made to accommodate bicycle and pedestrian safety in roadway improvement design.

Indirect Impacts

Grand Parkway Segments H and I-1 Preferred Alternative is on new location and would not indirectly impact existing pedestrian or bicyclist facilities. The No-Build Alternative would not indirectly impact pedestrian or bicyclist facilities. Refer to **Chapter 5** for a detailed indirect impacts analysis.

4.2.3 Visual and Aesthetic Qualities

The Grand Parkway Segments H and I-1 study area exhibits few unique or spectacular views. Due to the relatively large overall size of the project, the proposed project would have an effect on the existing aesthetic quality of the surrounding area. Construction of the Preferred Alternative would have a visual impact on adjacent areas. Visual impacts would take two forms: views of the proposed highway from various points along the alternatives; and views from the proposed highway of the surrounding landscape.

At this time the method of toll collection has not been finalized; however, it is anticipated that the toll collection methodology will be electronic and compatible with other toll facilities in the region. Entrance and exit ramps would be lighted; therefore, the presence of roadway illumination light fixtures as well as additional light cast from these fixtures could be considered additional negative visual and aesthetic impacts.

4.2.3.1 Views of the Proposed Roadway

The proposed highway would alter the appearance of the forested and rural/suburban setting of the study area. The scattered nature of the residential development would limit the greatest visual impacts to those residential structures or developments located in proximity to the facility. For others, as the viewer's distance from the new roadway increases, the relatively flat terrain and forest vegetation would limit the visible portions of the highway to the elevated grade separations.

The Preferred Alternative proposes continuous frontage roads where Segment G parallels FM 1485. This section would be reconstructed in a frontage road configuration for overall improved traffic operations. There are proposed "grade separated interchanges" with access ramps where the proposed Preferred Alternative crosses the following locations: US 59 (N)/I-69/Union Pacific Railroad (UPRR), Galaxy Road, FM 1485, US 59/I-69, Future Kingwood Drive, UPRR railroad crossing, US 90/UPRR, FM 1960/UPRR, FM 1413, SH 146, FM 565, and I-10 (E). Overpasses with no access to the cross streets are planned for the following locations: Montgomery planned thoroughfare (Lake Houston), Loop 494 and UPRR, Mansion

Road, CR 615, FM 686, UPRR, CR 479, and Hatcherville Road. Potential views of the at-grade portions of the roadway would be obscured or minimized by the relatively flat topography and forest vegetation. As currently proposed, the lighting system would be restricted to those areas where entrance/exit ramps are located and would consist of low impact, downward directional lighting.

Visual impacts would vary along the proposed project. As the highway approaches existing development and/or communities, more users and all viewers would have a view of the facility, but the proposed project would have less effect on the overall viewshed. Conversely, as the proposed project moves further away from developed areas the result may be a greater change in the overall visual setting, but would be observed by fewer individuals.

4.2.3.2 Views from the Proposed Roadway

Views of the surrounding landscape from the proposed project could be considered a beneficial impact as travelers pass through a predominantly forested and rural vista marked by dense forests, waterways, and scattered agricultural pastoral scenes. Viewshed opportunities may be enhanced at elevated grade separations that would allow motorists expanded views of agricultural fields and pastures, pine-hardwood forests, and rural and suburban communities. These views would be short in duration, as the viewer would be traveling at highway speeds.

In the northern section the Preferred Alternative would create a new roadway in the existing transportation landscape. The northern section crosses through the most urbanized portion of the study area. The Preferred Alternative would intersect with US 59 (N)/I-69 in the vicinity of Community Drive and continue in an easterly direction through Kings Colony property, then curve northward to FM 1485 just west of the Lake Houston Wilderness Park. Some undeveloped forested areas are present north of FM 1485 as well as floodplains and wetland areas in and around Caney Creek and Peach Creek in the vicinity of Patton Village. The view from the existing roadways in the area is characterized and constrained by forested areas. The proposed project would be designed to create an aesthetically and visually pleasing experience for the user and all viewers of the facility. An example of aesthetic treatments that may be proposed would be the placement of vegetative buffer strips along the ROW lines of the Preferred Alternative. The viewshed from several homes in the Commons of Lake Houston would be affected by construction and operation of Segments H and I-1.

All of the reasonable build alternatives, including the Preferred Alternative, would create a new tollway in the suburban landscape. The northern portion of the study area contains developing communities. The southern section of the study area is characterized by heavy oil and gas industrial activities. The tollway would be designed to create an aesthetically and visually pleasing experience for the user and all viewers of the facility. The viewshed from a few rural and suburban single-family homes would be affected by construction and operation of Segments H and I-1.

The Preferred Alternative would primarily create a new tollway in forested and agricultural landscapes. The majority of the central section consists of wide open spaces that are maintained as farms and pastures. The view along FM 1960 and US 90 consists of expansive vistas of open rural areas. The City of Dayton is along the eastern edge of the study area and contains many old homes and buildings including a central business area. The proposed project would be designed to create an aesthetically and visually pleasing experience for the user and adjacent landowners.

4.2.3.3 Summary of Visual and Aesthetic Impacts

Segments H and I-1 would be constructed predominately at-grade with vegetated roadsides, ROW, and medians. The amount of elevated roadway structure would be limited to areas where the proposed project would cross another roadway or a rail line

The No-Build Alternative would not result in visual or aesthetic impacts associated with the construction or operation of the proposed project. The No-Build Alternative would not directly alter any visual resources; however, increased traffic congestion associated with the No-Build Alternative and the current development pressures in the region could lead to short-term and long-term impacts on the visual quality of the area road network and all viewers and users of roads in the network.

<u>Indirect Impacts</u>

Lighting along the Preferred Alternative could result in both positive and negative indirect impacts. These impacts may include a change in the viewshed or ambient light. The design of the proposed project would be in keeping with the TxDOT Houston District's Green Ribbon Project. The Green Ribbon Project is a context sensitive design solution developed to change the City of Houston's image and provide continuity to roadway enhancements (AASHTO, "Green Ribbon Project"). The project integrates landscape, architecture, public art, and architecture into the engineered aspects of Texas highways in the Houston

area. The Green Ribbon Project was such a success in the Houston region that it was expanded to all TxDOT districts, under the Texas Administrative Code [TAC]: Green Ribbon Program, 43(I)(11)(d). The TAC establishes public-private partnerships to develop Landscape and Aesthetic Master Plans within specific cities and regions that have populations greater than 100,000. The TAC also directs TxDOT districts with non-attainment counties to plant trees and plants on the state highway system that help mitigate the effects of air pollution. The vegetation landscaping requirement would also provide beneficial aesthetic treatments to the corridor. Indirect visual and aesthetic impacts are anticipated to be minor. The No-Build Alternative would not indirectly impact visual or aesthetic qualities. Refer to **Chapter 5** for a detailed indirect impacts analysis.

4.3 SOILS AND FARMLANDS

4.3.1 Soils

All reasonable alternatives including the Preferred Alternative and No-Build Alternative were assessed in the discussion below. All reasonable alternatives including the Preferred Alternative traverse similar topography, soils, and geologic features consisting of broad, flat plains on clayey and sandy substrate of the Aluvium, Lissie, Beaumont, and Deweyville formations. Therefore, other than the localized cut and fill areas that would be required by the Preferred Alternative, no further impacts are expected.

Most soil groups traversed by the reasonable alternatives and the Preferred Alternative are characterized by the Natural Resources Conservation Service (NRCS) as having a high shrink-swell potential, which is a measure of the potential volume change of soil from a loss or gain in moisture. Volume change occurs mainly because of interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. If the shrink-swell potential is rated moderate to high, shrinking and swelling may cause damage to buildings, roads, and other structures.

Most soil groups traversed by the reasonable alternatives are characterized by the NRCS as having a moderate to high risk of corrosion to uncoated steel. Corrosion potential is a measure of the potential of soil-induced chemical reaction that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to soil moisture, particle size distribution, total acidity, and electrical conductivity of the soil material. The rating for corrosivity to concrete is based mainly on the sulfate content, soil texture, and acidity.

Construction of a roadway involves compaction of soils and removal of vegetation that may increase the amount of erosion and subsequent sedimentation. Slope, soil texture, and precipitation during construction determine the soil loss potential. Erosion and sediment control measures would effectively minimize erosion and soil loss during construction. Long-term impacts to area soils can be reduced by implementing appropriate Best Management Practices (BMPs) to minimize erosion during ancillary development.

Where required, material excavated from road cuts would be used as fill material to the maximum extent possible. If suitable soils are not found within the ROW, they would be obtained from other sites within a reasonable haul distance of the project. Detailed investigation of soils for construction would be conducted during the final design phase of project development.

Impacts to the project from the natural environment are limited to the effects of land-surface subsidence and fault reactivation, particularly in response to heavy withdrawal of groundwater. The principal effects of subsidence are activation of surface faults, loss of ground elevation in critical low-lying areas already prone to flooding, and alteration of natural slope and drainage patterns (Fisher et al., 1972). In areas of present or projected subsidence, special attention would be given to problems caused by loss of ground elevation and activation of surface faults.

Data from the Harris-Galveston Subsidence District (HGSD) suggest that the study area has experienced between 1 and 2 ft of land surface subsidence from 1906 to 1995. Amounts of future subsidence would depend on groundwater withdrawals in the immediate vicinity of the project. The HGSD has proposed a regulatory plan designed to minimize groundwater withdrawals by converting to surface water use. The projected subsidence by the year 2030 for the study area without groundwater restrictions is approximately 2-4 ft. If the groundwater restrictions identified in the regulatory plan are effective, subsidence by the year 2030 is projected to be limited to 1 ft or less.

Surface faults are common to the region and the potential for future surface expressions of nearby subsurface faults does exist. These subsurface faults do not appear to pose an immediate need for concern. Engineering design may be required to accommodate potential rates of differential movement along active fault planes as they occur.

No impacts to the study area's topography, soils, or geologic resources are anticipated as a result of the No-Build Alternative or the Preferred Alternative.

4.3.2 Farmlands

Bisection of farms that would occur under the reasonable alternatives would convert existing farmland or prime farmland soils to transportation land use. Where possible the reasonable alternatives were aligned along existing property lines to avoid bisecting large tracts of land. Grand Parkway Segments H and I-1 would increase efficiency of accessibility to Farm-to-Market roads. An improved transportation system in Montgomery, Harris, Liberty, and Chambers counties would improve highway safety for the transport of farm products and equipment. Farming has historically been very important to the agricultural economy in the area, but in the last forty years there has been a significant decline in the amount of acreage actively farmed.

Table 4-17 presents the direct impacts to prime farmland soils for each of the reasonable alternatives, including the Preferred Alternative.

Table 4-17: Prime Farmland Soils to be Impacted Within the ROW of Each Alternative

Reasonable Alternative	Prime Farmland Soils (ac)
1 (No-Build)	N/A
2	907
3	917
4	901
5	912
6	1,071
7	941
8	952
9	936
10	947
10R*	960
11	1,106

* Preferred Alternative
Source: Study Team, 2013.

The Preferred Alternative would impact approximately 960 ac of prime farmland soils. Project-related impacts to farmland soils in Montgomery, Harris, Liberty, and Chambers counties have been determined to be minimal according to a final land evaluation and site assessment scoring conducted on the NRCS Form CPA-106, Part VII. Farmland scoring on Form CPA-106 is based upon a possible 260 points. Those alternatives (sites) receiving scores totaling less than 160 points are given a minimal level of consideration for protection. The Preferred Alternative scored too low to require coordination with the NRCS. A copy of

the CPA-106 Farmland Conversion Impact Rating form is located in **Appendix L**. **Exhibit 4-4** identifies the general location of prime farmland soils within the Preferred Alternative.

Prime farmland soils would be avoided where practicable; however, due to the large acreage of the resource in Montgomery, Harris, Liberty, and Chambers counties, each build alternative would have an unavoidable effect on some prime farmland soils. The Preferred Alternative would be placed along and close to existing property lines where possible to minimize the splitting or fragmentation of farms. The No-Build Alternative would not result in soils and/or prime farmland soil impacts associated with the construction or operation of the proposed project. Benefits of the No-Build Alternative (avoidance of these potential farmland impacts) would decrease over time as farmland and potential farmland is converted to residential and commercial land uses, a trend that is already underway.

Indirect Impacts

The indirect farmland conversion due to increased development associated with reasonably foreseeable projects is anticipated to be considered a minor impact based on NRCS ratings; therefore, no substantial indirect impacts to prime farmland soils are anticipated with the proposed project. The No-Build Alternative would not indirectly impact farmland soils; however, conversion of farmland soils in the central area would continue with the current development trend. Refer to **Chapter 5** for a detailed indirect impacts analysis.

4.4 AIR QUALITY

4.4.1 Conformity

The proposed project is located within Montgomery, Harris, Liberty and Chambers counties, which are within the Houston-Galveston-Brazoria (HGB) area, which is designated by the EPA as a marginal nonattainment area for the 2008 ozone NAAQS; therefore, transportation conformity rules apply. The proposed action is consistent with the areas financially constrained 2035 RTP Update, as revised, and the 2013-2016 TIP. Both the RTP and the TIP were found to conform to the TCEQ SIP by FHWA on January 25, 2011 and November 1, 2012, respectively. Copies of the RTP and TIP pages are included in **Appendix M**. All projects in the TIP that are proposed for federal or state funds were initiated in a manner consistent with federal guidelines in Section 450 of Title 23 CFR and Section 613.200, Subpart B of the Title 49e CFR. Energy, environment, air quality, cost, and mobility considerations are addressed in the programming of the TIP.

4.4.2 Carbon Monoxide Traffic Air Quality Analysis (TAQA)

Traffic data for the design year 2039 is 31,443 vehicles per day (vpd) between US 59/I-69 and US 90 and 22,441 vpd between US 90 and I-10. A prior TxDOT modeling study and previous analyses of similar projects demonstrated that it is unlikely that a carbon monoxide standard would ever be exceeded as a result of any project with an annual average daily traffic (AADT) below 140,000 vehicles per day. The AADT projections for the project do not exceed 140,000 vehicles per day; therefore a TAQA was not required.

4.4.3 Congestion Management Process (CMP)/Congestion Reduction Strategies

The congestion management process (CMP) is a systematic process for managing congestion that provides information on transportation system performance and on alternative strategies for alleviating congestion and enhancing the mobility of persons and goods to levels that meet state and local needs. The project was developed from the H-GAC's operational CMP, which meets all requirements of 23 CFR 500.109. The CMP was adopted by the H-GAC on January 25, 2013.

The region commits to operational improvements and travel demand reduction strategies at two levels of implementation: Program level and project level. Program level commitments are inventoried in the regional CMP, which was adopted by the H-GAC; they are included in the financially constrained MTP, and future resources are reserved for their implementation.

The CMP element of the plan carries an inventory of all project commitments (including those resulting from major investment studies) that details type of strategy, implementing responsibilities, schedules, and expected costs. At the project's programming stage, travel demand reduction strategies and commitments will be added to the regional TIP or included in the construction plans. The regional TIP provides for programming of these projects at the appropriate time with respect to the single occupancy vehicle (SOV) facility implementation and project-specific elements.

Committed congestion reduction strategies and operational improvements within the study boundary will consist of signalization and intersection improvements. Individual projects are listed in **Table 2-3**.

In an effort to reduce congestion and the need for SOV lanes in the region, TxDOT and H-GAC would continue to promote appropriate congestion reduction strategies through the Congestion Management Air

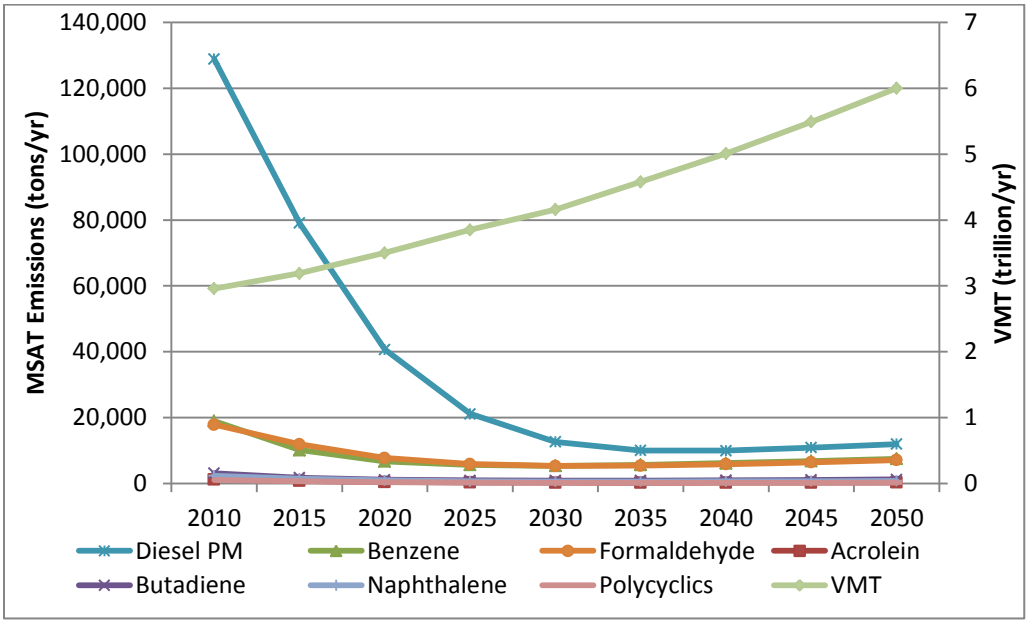
Quality Program (CMAQ), the CMS, and the RTP. According to H-GAC, the congestion reduction strategies considered for the project would help alleviate congestion in the SOV study boundary but would not eliminate it. Therefore, the proposed project is justified. The CMP analysis for added SOV capacity projects in the TMA is on file and available for review with the H-GAC.

4.4.4 Mobile Source Air Toxics (MSAT) Background

Controlling air toxic emissions became a national priority with the passage of the Clean Air Act Amendments (CAAA) of 1990, whereby Congress mandated that the U.S. Environmental Protection Agency (EPA) regulate 188 air toxics, also known as hazardous air pollutants. The EPA has assessed this expansive list in their latest rule on the Control of Hazardous Air Pollutants from Mobile Sources (Federal Register, Vol. 72, No. 37, page 8430, February 26, 2007), and identified a group of 93 compounds emitted from mobile sources that are listed in their Integrated Risk Information System (IRIS) (http://www.epa.gov/iris/). In addition, EPA identified seven compounds with significant contributions from mobile sources that are among the national and regional-scale cancer risk drivers from their 1999 National Air Toxics Assessment (NATA) (http://www.epa.gov/ttn/atw/nata1999/). These are acrolein, benzene, 1,3-butidiene, diesel particulate matter plus diesel exhaust organic gases (diesel PM), formaldehyde, naphthalene, and polycyclic organic matter. While FHWA considers these the priority mobile source air toxics, the list is subject to change and may be adjusted in consideration of future EPA rules.

The 2007 EPA Mobile Source Air Toxics (MSAT) rule mentioned above requires controls that will dramatically decrease MSAT emissions through cleaner fuels and cleaner engines. Based on an FHWA analysis using EPA's MOVES2010b model, as shown in **Figure 4-1** and **Table 4-18**, even if vehicle-miles travelled (VMT) increases by 102 percent as assumed from 2010 to 2050, a combined reduction of 83 percent in the total annual emissions for the priority MSAT is projected for the same time period.

Figure 4-1: Projected National MSAT Emission Trends 2010 – 2050 for Vehicles Operating on Roadways Using EPA's MOVES2010b Model



Source: **Table 4-11** below.
Note: Trends for specific locations may be different, depending on locally derived information representing vehicle-miles travelled, vehicle speeds, vehicle mix, fuels, emission control programs, meteorology, and other factors..

Table 4-18: Projected National MSAT Emission Trends 2010-2050 for Vehicles Operating on Roadways Using EPA's MOVES2010b Model

Pollutant / VMT	Pollutant Emissions (tons) and Vehicle-Miles Traveled (VMT) by Calendar Year									Change
	2010	2015	2020	2025	2030	2035	2040	2045	2050	2010 to 2050
Acrolein	1,244	805	476	318	258	247	264	292	322	-74%
Benzene	18,995	10,195	6,765	5,669	5,386	5,696	6,216	6,840	7,525	-60%
Butadiene	3,157	1,783	1,163	951	890	934	1,017	1,119	1,231	-61%
Diesel PM	128,847	79,158	40,694	21,155	12,667	10,027	9,978	10,942	11,992	-91%
Formaldehyde	17,848	11,943	7,778	5,938	5,329	5,407	5,847	6,463	7,141	-60%
Naphthalene	2,366	1,502	939	693	607	611	659	727	802	-66%
Polycyclics	1,102	705	414	274	218	207	219	240	262	-76%
Trillions VMT	2.96	3.19	3.5	3.85	4.16	4.58	5.01	5.49	6	102%

Source: EPA MOVES2010b model runs conducted during May – June 2012 by FHWA

Air toxics analysis is a continuing area of research. While much work has been completed to assess the overall health risk of air toxics, many questions remain unanswered. In particular, the tools and techniques for assessing project specific health outcomes as a result of lifetime MSAT exposure remain limited. These limitations impede the ability to evaluate how the potential health risks posed by MSAT exposure should be

factored into project level decision-making within the context of NEPA. The FHWA, EPA, the Health Effects Institute (HEI), and others have funded and conducted research studies to try to more clearly define potential risks from MSAT emissions associated with highway projects. The FHWA will continue to monitor the developing research in the emerging field.

Project-Specific MSAT Assessment

A qualitative analysis provides a basis for identifying and comparing the potential differences among MSAT emissions, if any, from the project alternatives. The qualitative assessment presented below is derived in part from a study conducted by the FHWA entitled *A Methodology for Evaluating Mobile Source Air Toxic Emissions Among Transportation Project Alternatives* found at:
http://www.fhwa.dot.gov/environment/air_quality/air_toxics/research_and_analysis/mobile_source_air_toxics/msatemissions.pdf

For each alternative in this document, the amount of MSAT emitted would be proportional to the vehicle miles traveled, or VMT, assuming that other variables such as fleet mix are the same for each alternative. The VMT estimated for the Build Alternatives is slightly higher than that for the No-Build Alternative, because the new roadway capacity increases the efficiency of the roadway and attracts rerouted trips from elsewhere in the transportation network. This increase in VMT would lead to higher MSAT emissions for the preferred action alternative along the highway corridor, along with a corresponding decrease in MSAT emissions along the parallel routes. The emissions increase is offset somewhat by lower MSAT emission rates due to increased speeds; according to EPA's MOVES2010b model, emissions of all of the priority MSAT decrease as speed increases. Also, regardless of the alternative chosen, emissions will likely be lower than present levels in the design year as a result of EPA's national control programs that are projected to reduce annual MSAT emissions by over 80 percent between 2010 and 2050. Local conditions may differ from these national projections in terms of fleet mix and turnover, VMT growth rates, and local control measures. However, the magnitude of the EPA-projected reductions is so great (even after accounting for VMT growth) that MSAT emissions in the study area are likely to be lower in the future in nearly all cases.

The new travel lanes contemplated as part of the Build Alternative would have the effect of bringing some traffic close to nearby homes, schools, and businesses; therefore, under each alternative there may be localized areas where ambient concentrations of MSAT could be higher under the Build Alternative than the

No-Build Alternative. However, the magnitude and the duration of these potential increases compared to the No-Build alternative cannot be reliably quantified due to incomplete or unavailable information in forecasting project-specific MSAT health impacts.

In sum, when a new highway is constructed, the localized level of MSAT emissions for the Build Alternative could be higher relative to the No-Build Alternative, but this could be offset due to increases in speeds and reductions in congestion (which are associated with lower MSAT emissions) along the existing roadway network. Also, MSAT will be lower in other locations when traffic shifts away from them. However, on a regional basis, EPA's vehicle and fuel regulations, coupled with fleet turnover, will over time cause substantial reductions that, in almost all cases, will cause region-wide MSAT levels to be significantly lower than today.

Incomplete or Unavailable Information for Project Specific MSAT Health Impacts Analysis

In FHWA's view, information is incomplete or unavailable to credibly predict the project-specific health impacts due to changes in MSAT emissions associated with a proposed set of highway alternatives. The outcome of such an assessment, adverse or not, would be influenced more by the uncertainty introduced into the process through assumption and speculation rather than any genuine insight into the actual health impacts directly attributable to MSAT exposure associated with a proposed action.

The EPA is responsible for protecting the public health and welfare from any known or anticipated effect of an air pollutant. They are the lead authority for administering the Clean Air Act (CAA) and its amendments and have specific statutory obligations with respect to hazardous air pollutants and MSAT. The EPA is in the continual process of assessing human health effects, exposures, and risks posed by air pollutants. They maintain the IRIS, which is "a compilation of electronic reports on specific substances found in the environment and their potential to cause human health effects" (EPA, http://www.epa.gov/iris/). Each report contains assessments of non-cancerous and cancerous effects for individual compounds and quantitative estimates of risk levels from lifetime oral and inhalation exposures with uncertainty spanning perhaps an order of magnitude.

Other organizations are also active in the research and analyses of the human health effects of MSAT, including the Health Effects Institute (HEI). Two HEI studies are summarized in *Appendix D* of FHWA's *Interim Guidance Update on Mobile Source Air Toxic Analysis in NEPA Documents*. Among the adverse

health effects linked to MSAT compounds at high exposures are; cancer in humans in occupational settings; cancer in animals; and irritation to the respiratory tract, including the exacerbation of asthma. Less obvious is the adverse human health effects of MSAT compounds at current environmental concentrations (HEI, http://pubs.healtheffects.org/view.php?id=282) or in the future as vehicle emissions substantially decrease (HEI, http://pubs.healtheffects.org/view.php?id=306).

The methodologies for forecasting health impacts include emissions modeling; dispersion modeling; exposure modeling; and then final determination of health impacts – each step in the process building on the model predictions obtained in the previous step. All are encumbered by technical shortcomings or uncertain science that prevents a more complete differentiation of the MSAT health impacts among a set of project alternatives. These difficulties are magnified for lifetime (i.e., 70 year) assessments, particularly because unsupportable assumptions would have to be made regarding changes in travel patterns and vehicle technology (which affects emissions rates) over that time frame, since such information is unavailable.

It is particularly difficult to reliably forecast 70-year lifetime MSAT concentrations and exposure near roadways; to determine the portion of time that people are actually exposed at a specific location; and to establish the extent attributable to a proposed action, especially given that some of the information needed is unavailable.

There are considerable uncertainties associated with the existing estimates of toxicity of the various MSAT, because of factors such as low-dose extrapolation and translation of occupational exposure data to the general population, a concern expressed by HEI (http://pubs.healtheffects.org/view.php?id=282). As a result, there is no national consensus on air dose-response values assumed to protect the public health and welfare for MSAT compounds, and in particular for diesel PM. The EPA (http://www.epa.gov/risk/basicinformation.htm#g) and the HEI (http://pubs.healtheffects.org/getfile.php?u=395) have not established a basis for quantitative risk assessment of diesel PM in ambient settings.

There is also the lack of a national consensus on an acceptable level of risk. The current context is the process used by the EPA as provided by the CAA to determine whether more stringent controls are required in order to provide an ample margin of safety to protect public health or to prevent an adverse

environmental effect for industrial sources subject to the maximum achievable control technology standards, such as benzene emissions from refineries. The decision framework is a two-step process. The first step requires EPA to determine an "acceptable" level of risk due to emissions from a source, which is generally no greater than approximately 100 in a million. Additional factors are considered in the second step, the goal of which is to maximize the number of people with risks less than 1 in a million due to emissions from a source. The results of this statutory two-step process do not guarantee that cancer risks from exposure to air toxics are less than 1 in a million; in some cases, the residual risk determination could result in maximum individual cancer risks that are as high as approximately 100 in a million. In a June 2008 decision, the U.S. Court of Appeals for the District of Columbia Circuit upheld EPA's approach to addressing risk in its two step decision framework.

Information is incomplete or unavailable to establish that even the largest of highway projects would result in levels of risk greater than deemed acceptable. Because of the limitations in the methodologies for forecasting health impacts described, any predicted difference in health impacts between alternatives is likely to be much smaller than the uncertainties associated with predicting the impacts. Consequently, the results of such assessments would not be useful to decision makers, who would need to weigh this information against project benefits, such as reducing traffic congestion, accident rates, and fatalities plus improved access for emergency response, that are better suited for quantitative analysis.

Conclusion

In this document, a qualitative MSAT assessment has been provided relative to various alternatives of MSAT emissions and has acknowledged that the Build Alternative of the project may result in increased exposure to MSAT emissions in certain locations, although the concentrations and duration of exposures are uncertain, and because of the uncertainty, the health effects from these emissions cannot be estimated.

4.4.5 Air Quality Construction Emissions Reduction Strategies

During the construction phase of this project, temporary increases in air pollutant emissions may occur from construction activities. The primary construction-related emissions are particulate matter (fugitive dust) from site preparation. These emissions are temporary in nature (only occurring during actual construction); it is not possible to reasonably estimate impacts from these emissions due to limitations of the existing models. However, the potential impacts of particulate matter emissions will be minimized by using fugitive

dust control measures such as covering or treating disturbed areas with dust suppression techniques, sprinkling, covering loaded trucks, and other dust abatement controls, as appropriate.

The construction activity phase of this project may generate a temporary increase in MSAT emissions from construction activities, equipment and related vehicles. The primary MSAT construction related emissions are particulate matter from site preparation and diesel particulate matter from diesel powered construction equipment and vehicles.

Considering the temporary and transient nature of construction-related emissions, as well as the mitigation actions to be utilized, it is not anticipated that emissions from construction of the project would have any significant impact on air quality in the area.

4.5 TRAFFIC NOISE

The DEIS, published in June 2011, presented Reasonable Alternative 10 as the Recommended Preferred Alternative. All of the reasonable alternatives were evaluated for traffic noise impacts to an equal level of detail in the DEIS. Since publication of the DEIS, updated analyses and continual coordination with the public have led to modifications of the Recommended Preferred Alternative as detailed in Chapter 2. Therefore, the Preferred Alternative detailed in the FEIS differs from the Recommended Preferred Alternative presented in the DEIS. The traffic noise presented in the FEIS utilized updated data and analysis beyond the level presented in the DEIS to fully disclose the potential impacts that would result from the Preferred Alternative. A preliminary traffic noise analysis was performed to determine the potential traffic noise impacts resulting from the Preferred Alternative. The analysis was accomplished in accordance with TxDOT's (FHWA approved) 2011 *Guidelines for Analysis and Abatement of Roadway Traffic Noise* (TxDOT, 2011). Traffic noise modeling was performed using the FHWA's approved Traffic Noise Model 2.5 (TNM). This model was used to calculate predicted traffic noise levels. The model primarily considers the number, type, and speed of vehicles; highway alignment and grade; cuts, fills and natural berms; surrounding terrain features; and the locations of activity areas likely to be impacted by the associated traffic noise.

4.5.1 Traffic Data for Noise Prediction

As required by FHWA and TxDOT traffic noise guidelines, the predicted traffic noise condition was modeled assuming the "worst case" scenario represented by the design hourly volume (DHV). The DHV was used to model noise for the design year (2039). The DHV was determined by applying the "K- factor" to the

average daily traffic (ADT). The DHV represents the 30th highest hourly volume for the design year. The design year (2039) ADT volume and DHV for the Segments H and I-1 study area are presented in **Table 4-19**. These values were generated using the H-GAC regional travel demand model as part of the approved 2035 RTP Update. In coordination with the H-GAC regarding the anticipated growth in the region as well as the proposed project, the traffic volumes selected to represent the DHV for the roadways modeled within the project area were 10 percent of their respective ADT volumes. The traffic data and methodology used in this analysis were developed in coordination with the TxDOT Planning and Programming Division (TP&P). Vehicle speeds on the proposed roadway mainlanes were modeled as a toll facility at 70 miles per hour (mph).

Table 4-19: Projected 2039 Traffic Volume Data

Alternative	Design Year Average Daily Traffic (ADT)	Design Hourly Volume (DHV)
10R*	31,443 between US 59/I-69 and US 90 and 22,441 between US 90 and I-10	3,144 between US 59/I-69 and US 90 and 2,244 between US 90 and I-10

* Preferred Alternative
Source: H-GAC Travel Demand Model, 2012

4.5.2 Description of Noise Receivers

The receivers located along the reasonable alternatives and the Preferred Alternative includes residences, a place of worship, a daycare, and commercial locations (noise abatement criteria [NAC] B, D, C, and E, respectively). Residential land uses are common within or along the study area and consist primarily of single-family residences; a number of the residential areas are located directly adjacent to the Preferred Alternative. There are also a number of residences along existing FM 1485 that would be adjacent to the Preferred Alternative. There are scattered residences throughout Segments H and I-1 that are isolated due to the rural nature of the study area. Some undeveloped/vacant lands (NAC G) can also be found within the study area. There are outdoor human activity areas adjacent to the reasonable alternatives and Preferred Alternative; therefore, they were analyzed as NAC B (exterior) and NAC C (exterior), with TxDOT noise abatement criteria of 67 dB(A) (the A-weighted decibel value). See **Table 3-14** for NAC descriptions.

A total of 61 receivers representing residences, a place of worship, a daycare, and commercial establishments were mapped utilizing aerial photography and topographical data. The following noise receivers were modeled along the roadway under NAC activity categories B and C (exterior level of 67 dB(A)), D (interior level of 52 dB(A)), and E (exterior level of 72 dB(A)). The NAC B category was assigned

for single-family residential receivers; NAC C for the Children's Choice Montessori playground receiver R1A; NAC D for the East River Baptist Church, R48A; and NAC E for commercial receiver R56. Refer to **Exhibit 4-5** for the noise receiver locations. A field visit to the project site was conducted in early 2013 to selected representative receivers for verification purposes and to measure the existing ambient background noise.

4.5.3 Potential Traffic Noise Impacts

All noise receivers adjacent to the proposed ROW that could potentially be impacted were identified for the Preferred Alternative. TNM 2.5 was run for the alignment adjustments made to Reasonable Alternative 10, which comprise the Preferred Alternative. Predicted traffic noise levels for the representative receivers are listed in **Table 4-20** and **Exhibit 4-5.** The existing noise conditions were measured in the field with a sound meter at representative receivers, as noted in **Chapter 3**.

Table 4-20: Potential Traffic Noise Impacts for the Preferred Alternative

Receiver	NAC Category	NAC dB(A) Leq	Existing Measured (2013)	Predicted (2039)	Change (+/-)	Noise Impact
R1A-Children's Choice Montessori playground	C	67	51	70	+19	Y
R1-Residence	B	67	51	68	+17	Y
R2-Residence	B	67	51	68	+17	Y
R4-Residence	B	67	51	69	+18	Y
R5-Residence	B	67	51	68	+17	Y
R6-Residence	B	67	51	68	+17	Y
R7-Residence	B	67	51	68	+17	Y
R8-Residence	B	67	51	69	+18	Y
R9-Residence	B	67	51	69	+18	Y
R10-Residence	B	67	51	68	+17	Y
R11-Residence	B	67	51	69	+18	Y
R12-Residence	B	67	51	69	+18	Y
R13-Residence	B	67	51	70	+19	Y
R14-Residence	B	67	51	70	+19	Y
R15-Residence	B	67	51	69	+18	Y
R16-Residence	B	67	51	69	+18	Y
R17-Residence	B	67	51	70	+19	Y
R18-Residence	B	67	51	70	+19	Y
R19-Residence	B	67	51	70	+19	Y
R20-Residence	B	67	51	68	+17	Y
R21-Residence	B	67	51	58	+7	N

Table 4-20: Potential Traffic Noise Impacts for the Preferred Alternative

Receiver	NAC Category	NAC dB(A) Leq	Existing Measured (2013)	Predicted (2039)	Change (+/-)	Noise Impact
R22-Residence	B	67	51	61	+10	N
R23-Residence	B	67	51	68	+17	Y
R24-Residence	B	67	51	63	+12	Y
R25-Residence	B	67	51	65	+14	Y
R26-Residence	B	67	51	60	+9	N
R27-Residence	B	67	51	61	+10	N
R28-Residence	B	67	57	57	+0	N
R29-Residence	B	67	57	62	+5	N
R30-Residence	B	67	57	65	+8	N
R31-Residence	B	67	57	67	+10	Y
R32-Residence	B	67	57	67	+10	Y
R33-Residence	B	67	57	68	+11	Y
R34-Residence	B	67	57	67	+10	Y
R35-Residence	B	67	57	67	+10	Y
R36-Residence	B	67	57	69	+12	Y
R37-Residence	B	67	57	63	+6	N
R38-Residence	B	67	57	66	+9	Y
R39-Residence	B	67	57	66	+9	Y
R40-Residence	B	67	57	67	+10	Y
R41-Residence	B	67	57	64	+7	N
R42-Residence	B	67	57	69	+12	Y
R43-Residence	B	67	57	64	+7	N
R44-Residence	B	67	57	66	+9	Y
R45-Residence	B	67	57	59	+2	N
R46-Residence	B	67	57	65	+8	N
R47-Residence	B	67	57	63	+6	N
R48-Residence	B	67	57	60	+3	N
R48A-East River Baptist Church	D	52	40	48	+8	N
R49-Residence	B	67	59	64	+5	N
R50-Residence	B	67	59	60	+1	N
R51-Residence	B	67	59	63	+4	N
R52-Residence	B	67	59	65	+6	N
R53-Residence	B	67	59	66	+7	Y
R54-Residence	B	67	59	66	+7	Y
R55-Residence	B	67	59	60	+1	N
R56-Restaurant	E	72	59	63	+4	N
R57-Residence	B	67	57	63	+6	N
R58-Residence	B	67	57	60	+3	N

Table 4-20: Potential Traffic Noise Impacts for the Preferred Alternative

Receiver	NAC Category	NAC dB(A) Leq	Existing Measured (2013)	Predicted (2039)	Change (+/-)	Noise Impact
R59A-Residence	B	67	56	68	+12	Y
R59B-Residence	B	67	56	66	+10	Y

Source: Study Team, 2013

As indicated in **Table 4-20**, the Preferred Alternative would result in a traffic noise impact and the following noise abatement measures were considered: traffic management, alteration of horizontal and/or vertical alignments, acquisition of undeveloped property to act as a buffer zone and the construction of traffic noise barriers. Under the No-Build Alternative, no traffic noise impacts are anticipated to occur.

Before any abatement measure can be proposed for incorporation into the project, it must be both feasible and reasonable. In order to be "feasible," the abatement measure must be able to reduce the noise level at greater than 50 percent of impacted, first row receivers by at least 5 dB(A); and to be "reasonable," it must not exceed the cost-effectiveness criterion of $25,000 for each receiver that would benefit by a reduction of at least 5 dB(A) and the abatement measure must be able to reduce the noise level of at least one impacted, first row receiver by at least 7 dB(A).

Traffic management: control devices could be used to reduce the speed of the traffic; however, the minor benefit of 1 dB(A) per 5 mph reduction in speed does not outweigh the associated increase in congestion and air pollution. Other measures such as time or use restrictions for certain vehicles are prohibited on state highways.

Alteration of horizontal and/or vertical alignments: any alteration of the existing alignment would displace existing businesses and residences, require additional ROW and not be cost effective/reasonable.

Buffer zone: the acquisition of undeveloped property to act as a buffer zone is designed to avoid rather than abate traffic noise impacts and, therefore, is not feasible.

Traffic Noise barriers: this is the most commonly used noise abatement measure. Traffic noise barriers were evaluated for each of the impacted receiver locations with the following results:

R1A: This receiver represents a daycare facility along the south side of the Preferred Alternative. A traffic noise barrier approximately 470 ft long and 16 ft high along the ROW would achieve the minimum feasible

reduction of 5 dB(A) and the noise reduction design goal of 7 dB(A) at the daycare; however, it would exceed the reasonable, cost-effectiveness criterion of $25,000.

R1 through R20: These receivers represent 30 residences along the south side of the Preferred Alternative. A traffic noise barrier approximately 4,000 ft long and 14 ft high along the ROW would achieve the minimum feasible reduction of 5 dB(A) and the noise reduction design goal of 7 dB(A) for at least one of the residences; however, it would exceed the reasonable, cost-effectiveness criterion of $25,000.

R23-R25, R31, R38, R40, R42, R44, 59A, 59B: These receivers represent separate, individual residences along the Preferred Alternative. A traffic noise barrier that would achieve the minimum feasible reduction of 5 dB(A) and the noise reduction design goal of 7 dB(A) would exceed the reasonable, cost-effectiveness criterion of $25,000.

R32-R36, R39, R53, and R54: These receivers represent residences along the Preferred Alternative, with driveways facing the roadway. Gaps in a traffic noise barrier placed along the ROW would satisfy access requirements but the resulting non-continuous barrier segments would not be sufficient to achieve the minimum, feasible reduction of 5 dB(A) or the noise reduction design goal of 7 dB(A). A traffic noise barrier along the mainlanes would not restrict views and access and may achieve the minimum feasible reduction of 5 dB(A) or the noise reduction design goal of 7 dB(A) at the homes; however, it would exceed the reasonable, cost-effectiveness criterion of $25,000.

None of the above noise abatement measures would be both feasible and reasonable; therefore, no abatement measures are proposed for the Preferred Alternative.

To avoid traffic noise impacts that may result from future development of properties adjacent to the proposed project, local officials responsible for land use control programs must ensure, to the maximum extent possible, no new activities are planned or constructed along or within the following predicted (2039) traffic noise impact contours shown below:

Table 4-21: Predicted (2039) Traffic Noise Impact Contours for the Preferred Alternative

NAC Category	NAC Impact dB(A) Level	Distance
B&C	66 dB(A)	150 feet from ROW
E	71 dB(A)	50 feet from ROW

Source: Study Team, 2013

Noise associated with the construction of the proposed project is difficult to predict. Heavy machinery (a major source of noise in construction) is constantly moving in unpredictable patterns. However, construction normally occurs during daylight hours when occasional loud noises are more tolerable. None of the receivers are expected to be exposed to construction noise for a long duration; therefore, any extended disruption of normal activities is not expected. Provisions would be included in the plans and specifications that require the contractor to make every reasonable effort to minimize construction noise through abatement measures such as work-hour controls and proper maintenance of muffler systems.

A copy of the traffic noise analysis would be available to local officials. On the date of approval of the document (Date of Public Knowledge), FHWA and TxDOT are no longer responsible for providing noise abatement for new development adjacent to the project.

4.6 WATER QUALITY

4.6.1 Surface Water

Effects to surface water quality can be divided into two broad categories, one directly from construction of the roadway, and one from the long-term operation of the roadway. The direct effects of the reasonable alternatives including the Preferred Alternative and No-Build Alternative on surface water quality are discussed in this section. Long-term effects are addressed in **Chapter 5 (Indirect Impacts)** and **Chapter 6 (Cumulative Impacts)**.

4.6.1.1 Water Quality Impacts During Construction Activities

Construction in the immediate area of stream crossings can be assumed to generate additional sediment loads to the streams if bare earth is exposed for an extended period of time and not controlled using erosion control facilities. Erosion control facilities would be used during construction. The following sections describe the probable effects of the proposed highway on the local and regional water quality and the measures that would be taken to prevent short and long-term water quality degradation.

Because the reasonable alternatives have a ROW area substantially greater than 5 ac, TxDOT would be required to comply with the TCEQ Texas Pollution Discharge Elimination System (TPDES) General Permit for Industrial Activity. A Notice of Intent (NOI) in accordance with the TPDES would be coordinated with TCEQ prior to construction activities stating that TxDOT would have a Storm Water Pollution Prevention Plan (SWPPP) in place during construction. The project SWPPP would be prepared pursuant to the

TxDOT manual, Storm Water Management Guidelines of the Construction Activities (TxDOT, 2002). To minimize impacts to water quality during construction, the proposed project would utilize both temporary and permanent erosion control practices from TxDOT's manual, 2004 Standard Specifications for Construction of Highways, Streets, and Bridges (TxDOT, 2004). These practices would be in place prior to and during the construction period, and would be maintained throughout the construction of the proposed project. The SWPPP includes an erosion control plan and specifications to prevent/minimize sediment laden runoff from entering the study area streams. The erosion control plan may include, but is not limited to, the use of silt fence, inlet protection barriers, hay bales, sediment traps and/or basins, and seeding or sodding of excavated soil. Exposure of the soil surface would be minimized during any clearing activities in order to maintain soil integrity. At the completion of construction, the TxDOT specifications, *Seeding for Erosion Control* (TxDOT, 2004) would be followed to restore and reseed all disturbed areas.

4.6.1.2 Water Quality Impacts from Long-Term Highway Operations

Surface waters can be affected in numerous ways by the operations of a highway. As the highway is constructed, the land would be converted from mostly farmland, prairie, and woodlands to paved surface for the width of the roadway and the vegetation cleared out of the project's ROW. The change in land use typically results in accelerated storm water runoff to the streams. Depending on the amount of land that was converted from a natural condition to a paved or compacted surface within the drainage area of a stream, the stream may experience increased water velocities that can result in streambed and bank erosion and degradation, sediment and pollutant loading, and other morphological changes. Construction of the reasonable alternatives and the Preferred Alternative would produce changes in the quantity and quality of the runoff from the paved roadway. The alternatives would encompass only a small percentage of the watershed for each of the streams.

According to the 2010 Texas 303(d) list, two water bodies have impaired segments within the study area. Cedar Bayou Above Tidal (Segment ID: 0902) is listed as impaired because of low dissolved oxygen from a point 1.4 mi upstream of I-10 (E) to a point 4.6 mi upstream of FM 1960. Alternatives 6 and 11 cross this segment of Cedar Bayou. Cedar Bayou Tidal (Segment 0901) is listed along its entire length as impaired due to dioxin in catfish and crab tissue. No alternative segments cross Cedar Bayou Tidal. No impacts to the constituent of concern by the proposed project are anticipated.

TPWD identifies three ecologically important stream segments within the Grand Parkway Segments H and I-1 study area. Caney Creek, from the confluence with East Fork San Jacinto River upstream to its headwaters northeast of New Waverly in Walker County, serves an important biological function by providing bottomland hardwood habitat that displays substantial overall habitat value and high biodiversity. East Fork San Jacinto River, from the confluence with Caney Creek in Harris County upstream to US 190 in Walker County, functions as groundwater recharge of the Chicot aquifer, and its aquatic habitat displays substantial overall value including high water quality, high biodiversity of aquatic life, and high aesthetic value. Luce Bayou, from the confluence with Lake Houston in Harris County upstream to its headwaters in Liberty County, provides bottomland hardwood and aquatic habitats with substantial overall value (TPWD, 2007). Alternatives 2-6 each cross East Fork San Jacinto River and Luce Bayou, but avoid crossing Caney Creek with Section A-2 passing to the northwest of the creek. The reasonable alternatives 7-11, and the Preferred Alternative cross all three ecologically substantial stream segments.

4.6.2 Groundwater

Groundwater sources within the proposed ROW of the reasonable alternatives draw water from the Gulf Coast major aquifer, which is made up of the Chicot and Evangeline local aquifers. The typical water depth below the land surface of existing wells in these aquifers ranges from approximately 25 ft to 96 ft. Potential adverse impacts to groundwater could occur because of a potential spill of hazardous or toxic material during transport on the completed highway facility. During construction, spills would be mainly limited to fuels (i.e., petrochemicals) and lubricants used for construction equipment. Impacts to the groundwater quality because of surface spills would be greatly minimized by the characteristically low permeability of the clayey soils and clay substrate. Following project construction, substantially new pathways would be created for the highway storm water runoff to the regional aquifers.

Potential impacts to water supply wells were assessed using data gathered from the TCEQ and Texas Water Development Board (TWDB) databases. **Table 4-22** summarizes the potential impacts to public and private water supply wells within each of the reasonable alternatives. For private wells, potential impacts account for wellheads located within the alternative ROWs. For public wells, potential impacts account for all capture zones that cross the ROW for each alternative. A capture zone is defined as the area within an aquifer that drains to and is captured by a pumping well (EPA, 2007). The capture zones used in the project were created by TCEQ using a modified equation that takes into account the hydrogeology and

respective design of each well. When information is missing from the equation, a 0.5 mi fixed radius zone is delineated as the capture zone (TCEQ, 2007).

Table 4-22: Water Supply Wells Within the Reasonable Alternatives

Reasonable Alternative	Private Water Supply Wells	Public Water Well Capture Zones
1 (No-Build)	N/A	N/A
2	2	5
3	2	5
4	2	3
5	2	3
6	1	3
7	3	9
8	3	9
9	3	7
10	3	7
10R*	0	7
11	2	7

* Preferred Alternative
Note: N/A = Not Applicable
Sources: TWDB, 2006; TCEQ, 2007

Well records indicated that groundwater pollution prevention measures might be required for three private wells in Alternatives 7-10; two private wells in Alternatives 2-5 and 11; and one private well in Alternative 6. The Preferred Alternative would not impact any private wells; however, structures associated with the Peach Creek Oaks Consumers Water Company are located within the proposed ROW.

Nine public well capture zones cross the ROWs in Alternatives 7-8; seven public wells in Alternatives 9-11; five public wells in Alternatives 2-3; and three public wells in Alternatives 4-6. The Preferred Alternative would impact seven public wells. **Table 4-23** shows detailed information for each public well capture zone within each Build Alternative.

Table 4-23: Public Water Well Capture Zone Impacts

Public Well Capture Zone ID No.	Segment	Well Owner	Aquifer	Well Depth (ft)	Approximate Distance of Well from ROW (ft)
Reasonable Alternative 1 (No-Build)					
N/A	N/A	N/A	N/A	N/A	N/A
Reasonable Alternative 2					
G1700418A	A2	Peach Creek Grocery	Chicot	220	6032
G1700726A	A2	Casey Ridge Grocery	Evangeline	205	6271
G1460086A	B1	Peterson Place Subdivision Water System	Chicot	360	397
G1460118A	B1	Fairfield Estates	Chicot	372	1043
G0360017F	C2	City of Mont Belvieu	Evangeline	982	5091

Table 4-23: Public Water Well Capture Zone Impacts

Public Well Capture Zone ID No.	Segment	Well Owner	Aquifer	Well Depth (ft)	Approximate Distance of Well from ROW (ft)
Reasonable Alternative 3					
G1700418A	A2	Peach Creek Grocery	Chicot	220	6032
Reasonable Alternative 4					
G1700418A	A2	Peach Creek Grocery	Chicot	220	6032
G1700726A	A2	Casey Ridge Grocery	Evangeline	205	6271
N/A	B2	N/A	N/A	N/A	N/A
G0360017F	C2	City of Mont Belvieu	Evangeline	982	5091
Reasonable Alternative 5					
G1700418A	A2	Peach Creek Grocery	Chicot	220	6032
G1700726A	A2	Casey Ridge Grocery	Evangeline	205	6271
N/A	B2	N/A	N/A	N/A	N/A
G0360017F	C3	City of Mont Belvieu	Evangeline	982	5091
Reasonable Alternative 6					
G1700418A	A2	Peach Creek Grocery	Chicot	220	6032
G1700726A	A2	Casey Ridge Grocery	Evangeline	205	6271
N/A	B5	N/A	N/A	N/A	N/A
G0360017F	C6	City of Mont Belvieu	Evangeline	982	5091
Reasonable Alternative 7					
G1700051A	A4	Peach Creek Oaks Subdivision	Evangeline	525	0
G1700101C	A4	New Caney Municipal Utility District (MUD)	Evangeline	620	1719
G1700121A	A4	Heritage Oaks Subdivision	Chicot	336	8308
G1700418A	A4	Peach Creek Grocery	Chicot	220	289
G1700434A	A4	Chaparral Place Water System	Chicot	330	7042
G1700726A	A4	Casey Ridge Grocery	Evangeline	205	194
G1460086A	B1	Peterson Place Subdivision Water System	Chicot	360	397
G1460118A	B1	Fairfield Estates	Chicot	372	1043
G0360017F	C2	City of Mont Belvieu	Evangeline	982	5091
Reasonable Alternative 8					
G1700051A	A4	Peach Creek Oaks Subdivision	Evangeline	525	0
G1700101C	A4	New Caney MUD	Evangeline	620	1719
G1700121A	A4	Heritage Oaks Subdivision	Chicot	336	8308
G1700418A	A4	Peach Creek Grocery	Chicot	220	289
G1700434A	A4	Chaparral Place Water System	Chicot	330	7042
G1700726A	A4	Casey Ridge Grocery	Evangeline	205	194
G1460086A	B1	Peterson Place Subdivision Water System	Chicot	360	397
G1460118A	B1	Fairfield Estates	Chicot	372	1043
G0360017F	C3	City of Mont Belvieu	Evangeline	982	5091
Reasonable Alternative 9					
G1700051A	A4	Peach Creek Oaks Subdivision	Evangeline	525	0
G1700101C	A4	New Caney MUD	Evangeline	620	1719
G1700121A	A4	Heritage Oaks Subdivision	Chicot	336	8308
G1700418A	A4	Peach Creek Grocery	Chicot	220	289
G1700434A	A4	Chaparral Place Water System	Chicot	330	7042
G1700726A	A4	Casey Ridge Grocery	Evangeline	205	194
N/A	B2	N/A	N/A	N/A	N/A

Table 4-23: Public Water Well Capture Zone Impacts

Public Well Capture Zone ID No.	Segment	Well Owner	Aquifer	Well Depth (ft)	Approximate Distance of Well from ROW (ft)
G0360017F	C2	City of Mont Belvieu	Evangeline	982	5091
Reasonable Alternative 10					
G1700051A	A4	Peach Creek Oaks Subdivision	Evangeline	525	0
G1700101C	A4	New Caney MUD	Evangeline	620	1719
G1700121A	A4	Heritage Oaks Subdivision	Chicot	336	8308
G1700418A	A4	Peach Creek Grocery	Chicot	220	289
G1700434A	A4	Chaparral Place Water System	Chicot	330	7042
G1700726A	A4	Casey Ridge Grocery	Evangeline	205	194
N/A	B2	N/A	N/A	N/A	N/A
G0360017F	C3	City of Mont Belvieu	Evangeline	982	5091
Preferred Alternative (10R*)					
G1700051A	A4	Peach Creek Oaks Subdivision	Evangeline	525	0
G1700101C	A4	New Caney MUD	Evangeline	620	1719
G1700121A	A4	Heritage Oaks Subdivision	Chicot	336	8308
G1700418A	A4	Peach Creek Grocery	Chicot	220	289
G1700434A	A4	Chaparral Place Water System	Chicot	330	7042
G1700726A	A4	Casey Ridge Grocery	Evangeline	205	194
N/A	B2	N/A	N/A	N/A	N/A
G0360017F	C3	City of Mont Belvieu	Evangeline	982	5091
Reasonable Alternative 11					
G1700051A	A4	Peach Creek Oaks Subdivision	Evangeline	525	0
G1700101C	A4	New Caney MUD	Evangeline	620	1719
G1700121A	A4	Heritage Oaks Subdivision	Chicot	336	8308
G1700418A	A4	Peach Creek Grocery	Chicot	220	289
G1700434A	A4	Chaparral Place Water System	Chicot	330	7042
G1700726A	A4	Casey Ridge Grocery	Evangeline	205	194
N/A	B5	N/A	N/A	N/A	N/A
G0360017F	C6	City of Mont Belvieu	Evangeline	982	5091

Note: N/A = Not Applicable
Source: TCEQ, 2007.

4.6.3 Summary of Surface and Groundwater Impacts

Effects to surface water runoff and groundwater from the reasonable alternatives and the Preferred Alternative would be minimal. Quality and quantity of storm water runoff would be altered by the alternatives in two ways: 1) direct effects from construction, and 2) effects from long-term operation of the roadway.

Impacts on three ecologically substantial stream segments from increased surface water runoff would occur as a result of the reasonable alternatives. Alternatives 2-6 would impact East Fork San Jacinto River and Luce Bayou. Alternatives 7-11, including the Preferred Alternative, would impact Caney Creek, East Fork San Jacinto River, and Luce Bayou.

Well records indicate that groundwater pollution prevention measures might be required for three private wells in Alternatives 7-10; two private wells in Alternatives 2-5 or 11; and one private well in Alternative 6. The Preferred Alternative would impact three private wells.

Nine public well capture zones cross the ROWs in Alternatives 7-8; seven public wells in Alternatives 9-11; five public wells in Alternatives 2-3; and three public wells in Alternatives 4-6. The Preferred Alternative would impact seven public wells.

The project would impact greater than 5 ac of surface area. Therefore, a TPDES storm water discharge permit is required. The TPDES permit requires a NOI and completion of a SWPPP in order to avoid adverse impacts potentially resulting from storm water runoff discharges. TxDOT has its own storm water management guidelines and BMPs for construction activities that would be used in development of the SWPPP. Once construction has been completed, a Notice of Termination would be filed per permit requirements. Additionally, in accordance with Clean Water Act Section 402 where storm water from the proposed construction project would discharge to a Municipal Separate Storm Sewer System (MS4), the MS4 permittee would be notified of the construction activity.

The No-Build Alternative would not result in long-term surface or groundwater impacts.

Indirect Impacts

No surface or groundwater would be impacted by the No-Build Alternative. The Preferred Alternative would require groundwater pollution prevention measures to minimize potential impacts to up to seven well capture zones. Indirect impacts to surface water and groundwater wells due to induced development would be minimized and regulated by the TCEQ. Refer to **Chapter 5** for a detailed analysis of indirect impacts.

4.7 WATERS OF THE U.S., INCLUDING WETLANDS AND VEGETATIVE COMMUNITIES

4.7.1 Waters of the U.S.

Major streams and their tributaries that flow through the Segments H and I-1 study area include Peach Creek, Caney Creek, East Fork San Jacinto, Luce Bayou, East Fork Cedar Bayou, Cedar Bayou, and associated unnamed tributaries. The project team reviewed color aerial photographs and topographic maps to determine the location of potential Waters of the U.S., including the reasonable alternatives, the Preferred Alternative and No-Build Alternative as summarized in **Table 4-24.** The acreages presented in

Table 4-24 reflect potential Waters of the U.S., not including wetlands. Potential wetland impacts are presented in **Table 4-25**.

Table 4-24: Potential Waters of the U.S. Within the Reasonable Alternatives

Reasonable Alternative	Potential Waters of the U.S. (ac)
1 (No-Build)	N/A
2	20.4
3	14.9
4	23.5
5	18.0
6	21.4
7	25.7
8	20.2
9	28.8
10	23.4
10R*	22.9
11	26.7

* Preferred Alternative
Source: Study Team, 2012.

Overall, impacts to potentially jurisdictional waters or streams within the footprint of each build alternative ranged from 14.9 ac to 28.8 ac. The Preferred Alternative would impact approximately 22.9 ac of potentially jurisdictional waters or streams.

4.7.2 Wetlands

EO 11990 (Protection of Wetlands) established a national policy "to avoid to the extent possible, the long-term and short-term adverse impacts associated with the destruction or modification of wetlands and to avoid direct or indirect support of new construction in wetlands wherever there is a practicable alternative." The FHWA Technical Advisory T 6640.8A (FHWA, 1987) provides guidelines for addressing wetland impacts in environmental documents, including the identification of the extent of wetlands impacted, their type, quality, and function. Alternatives for avoidance and practicable measures to minimize harm to wetlands should be addressed. The relative importance of the wetland resource, its function within the area, and any uniqueness that may contribute to the importance of the wetland should be presented.

Proposed construction activities associated with Segments H and I-1 would impact wetlands and aquatic systems to varying degrees. Land clearing during construction activities would remove vegetative cover.

These activities may increase surface runoff during storm events and could lead to erosion. If runoff is allowed to flow into streams without erosion and sediment control measures, increased turbidity and sedimentation may modify water chemistry due to elevated levels of sediments, nutrients and pollutants, which would also diminish suitable habitat for aquatic species, including littoral zone plants. To aid in minimizing such impacts, placement and monitoring of erosion control measures at the start of, during, and after construction would be incorporated into project plans according to TxDOT SWPPP guidelines. Revegetation along the ROW would adhere to TxDOT revegetation guidelines.

Wetland functions and values are the processes wetlands perform independent of human opinion and are measurements of the benefit these functions provide. Examples of wetland functions include nutrient cycling, floodflow alteration, sediment stabilization, and providing plant and animal habitat. The wetland values derived from these functions are measured in different ways, such as their ability to improve water quality, provide economic benefits for wetland-dependent businesses, help in stabilizing global levels of carbon dioxide, reduce flood damage, and provide recreation opportunities (TPWD, 2007). Short-term impacts to wetland functions and values would most likely include temporary water quality degradation, wildlife habitat loss, and a decrease in some recreational uses such as wildlife viewing, waterfowl hunting, and recreational fishing depending on the time of year and location. Construction activities that fill wetlands would permanently destroy the ecological and hydrological values and functions of those wetlands. The clearing of vegetation and the filling of wetlands would result in both temporary and permanent losses of wetland wildlife habitat.

Long-term impacts are less predictable than the immediate impacts of construction on wetland habitats, as changes to the wetland/aquatic system can take place over a longer period of time. As previously described, removal of existing wetlands could result in increased sediment and nutrient runoff that could impact nearby wetlands and receiving waters over time. In addition, long-term impacts resulting from wetland removal could include decreased flood control capacity.

Various mitigation measures may be employed to offset unavoidable permanent impacts to wetland functions and values. Short-term and long-term impacts would be mitigated by the replacement of the impacted wetlands and their function and value. Preliminary wetland mitigation measures (on-site and off-site) are described in **Chapter 7 (Mitigation and Permitting)**.

Color aerial photographs, National Wetland Inventory (NWI) maps, and published soil survey maps were reviewed to determine the location of potential wetlands within the reasonable alternatives. Observations at locations in which right-of-entry was granted were used to verify desktop findings. Site access has been obtained for approximately 49 percent of the total acreage for the project. All potential wetland areas were delineated on these maps, transferred to an aerial background image managed with GIS, and classified as agricultural, forested, or non-forested wetlands. The wetlands were also characterized as adjacent (within the 100-yr floodplain and potentially jurisdictional) or isolated. This process allowed the project team to avoid wetland impacts where possible and to minimize those impacts that were unavoidable.

Table 4-25 provides a summary of the potentially jurisdictional wetlands within each of the reasonable alternatives. Acreage calculations have been separated into agricultural, non-forested, and forested wetlands. The total acreages are used when describing maximum potential impacts to wetlands within each alternative. Refer to **Exhibit 4-6** for the location of wetlands potentially impacted by the reasonable alternatives and the Preferred Alternative.

Table 4-25: Potential Wetland Impacts Within Each Alternative

Reasonable Alternative	Agricultural Wetland (ac)			Non-Forested Wetland (ac)			Forested Wetland (ac)			Total (ac)		
	Adjacent**	Isolated	Total	Adjacent**	Isolated	Total	Adjacent**	Isolated	Total	Adjacent**	Isolated	Overall
1 (No-Build)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	113.53	249.88	363.41	31.29	9.64	40.93	3.44	1.01	4.45	148.26	260.53	408.79
3	155.16	211.93	367.09	38.39	0.23	38.62	22.07	1.66	23.73	215.62	213.82	429.44
4	118.20	106.45	224.65	9.31	9.78	19.09	2.79	0.00	2.79	130.30	116.23	246.53
5	159.82	68.51	228.33	16.40	0.37	16.77	21.43	0.65	22.08	197.65	69.53	267.18
6	201.10	23.63	224.73	21.80	1.27	23.07	25.90	1.37	27.27	248.80	26.27	275.07
7	113.53	249.88	363.41	31.29	9.87	41.16	5.12	1.01	6.13	149.94	260.76	410.70
8	155.16	211.93	367.09	38.39	0.46	38.85	23.75	1.66	25.41	217.30	214.05	431.35
9	118.20	106.45	224.65	9.31	10.00	19.31	4.48	0.00	4.48	131.99	116.45	248.44
10	159.82	68.51	228.33	16.40	0.60	17.00	23.11	0.65	23.76	199.33	69.76	269.09
10R*	217.28	68.09	285.37	2.71	12.79	15.50	2.52	24.01	26.53	222.51	104.89	327.4
11	201.10	23.63	224.73	21.80	1.50	23.30	27.58	1.37	28.95	250.48	26.50	276.98

* Preferred Alternative
** Adjacent is defined as areas within the 100-year floodplain and potentially jurisdictional.
Source: Study Team, 2013

In addition to the total acreages of wetlands within each of the alternatives, **Table 4-25** also reflects the maximum potential acreage that could be impacted by the build alternatives. This acreage could be reduced pending results of additional field investigations as additional right-of-entry is obtained and once the schematic design is finalized. Overall potential wetland impacts of the build alternatives ranged from 246.53 ac (Alternative 4) to 431.35 ac (Alternative 8). Alternative 4 was determined to have the least amount of overall potential impacts; as well as the least amount of adjacent non-forested (9.31 ac) wetlands. Alternatives 2 and 7 would have the least amount of adjacent agricultural (113.53 ac) wetlands. Alternative 8 was determined to have the highest amount of overall potential impacts. The Preferred Alternative could potentially impact up to 217.28 ac of adjacent agricultural wetlands, 2.71 ac of adjacent non-forested wetlands, and 2.52 ac of adjacent forested wetlands.

An addition level of investigation will be completed for the Preferred Alternative alignment prior to completion of the Section 404 permit. This next level of investigation consists of a wetland delineation, conducted in accordance with the USACE 1987 Wetlands Delineation Manual. This delineation is continuing pending additional property owner access and will require verification by the USACE Galveston District.

4.7.3 Vegetative Communities

The primary impacts to vegetation resulting from site preparation and construction of the proposed highway project is the removal of existing vegetation from the ROW and any construction staging areas. The reasonable alternatives and the Preferred Alternative would potentially impact six general vegetative community types: agricultural vegetation, agricultural wetland, forest, non-forested wetland, forested wetland, and riparian zones. Although each of these communities would be potentially impacted, only the wetland and agricultural vegetation (containing prime farmlands) communities are regulated by state and federal resource agencies.

Direct impacts would entail the alteration of the vegetation, soils, and hydrology. Vegetation may be mowed and/or removed in preparation for construction. Depending on construction needs, soils would be graded or amended with fill, and heavy equipment would compact soils, which often alters their characteristics. As the topography and vegetation are altered, hydrologic conditions associated with runoff and drainage flow would also change, although appropriate design measures would minimize these

impacts. Unpaved disturbed areas within the ROW and staging areas would be revegetated. BMPs may call for seeding or sodding of disturbed areas.

The construction of a new roadway affects the environment at various levels of a geographic scale, from the microscopic to the landscape level. On a landscape level, the ecological communities currently existing within the Grand Parkway Segments H and I-1 study area are fragmented to some degree. It is difficult to quantify the effect, primarily because there are numerous dynamic variables involved. Many generalizations regarding the concept of habitat fragmentation are well accepted, but specific processes and functional relationships are site specific, dynamic, and are interrelated at various scales of both time and space.

The direct impacts of construction, operation, and maintenance of the new ROW add an element of disturbance to the ecosystem. The vegetative communities occurring along the reasonable alternatives and the Preferred Alternative would be directly impacted by construction-related activities. The potential fragmentation of habitat and riparian corridors, and the potential modifications of hydrologic and nutrient cycling and transfer processes are also likely to have some impact on natural communities. Wetland and aquatic systems would potentially be impacted in a similar fashion through direct disturbance by heavy machinery compaction and scarification, the placement of fill and construction materials, and the disruption of hydrological and nutrient cycling. As with other elements of the ecosystem, some wildlife communities may be impacted by the permanent loss of habitat. In addition to direct construction-related mortality or injury, wildlife populations may suffer impacts associated with habitat fragmentation and displacement into adjacent habitats. In some cases, displacement may be temporary because suitable adjacent habitats may exist to mitigate the occurrence. Where impacts do adversely affect some species, others may receive benefits. Impacts are not likely to adversely affect or jeopardize the continued existence of any species.

Vegetative community acreages were estimated using aerial photo interpretations. **Table 4-26** reflects the vegetative communities acreages identified within each alternative. The total vegetative community acreage also reflects the maximum potential acreage that could be impacted by the build alternatives. Infrared aerials with a 2010 publish date were obtained from TNRIS, and along with 2010 color aerials, were used to map the vegetative communities. Vegetative community characteristics were verified at locations in which right of entry was granted, although these locations were limited throughout the

reasonable alternatives. Refer to **Exhibit 4-6** for the location of vegetative communities within the Segments H and I-1 reasonable alternatives.

Table 4-26: Potential Impacts to Vegetative Communities Within Each Alternative

Reasonable Alternative	Agricultural Wetland (ac)	Agricultural Vegetation (ac)	Total Agricultural (ac)	Forest (ac)	Forested Wetland (ac)	Total Forested (ac)	Non-Forested Wetland (ac)	Riparian Zones (ac)
1 (No-Build)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	363.41	676.13	1039.54	584.17	4.45	588.62	40.93	11.36
3	367.09	727.4	1094.49	570.14	23.73	593.87	38.62	11.36
4	224.65	689.84	914.49	591.74	2.79	594.53	19.09	14.94
5	228.33	741.11	969.44	577.71	22.08	599.79	16.77	14.94
6	224.73	541.0	765.73	707.91	27.27	735.18	23.07	19.29
7	363.41	676.13	1039.54	569.27	6.13	575.4	41.16	13.60
8	367.09	727.40	1094.49	555.24	25.41	580.65	38.85	13.60
9	224.65	689.84	914.49	576.84	4.48	581.32	19.31	17.18
10	228.33	741.11	969.44	562.81	23.76	586.57	17.0	17.18
10R*	285.37	741.75	1027.12	596.19	26.53	622.72	15.5	24.21
11	224.73	541.00	765.73	693.01	28.95	721.96	23.3	21.53

Note: These impacts do not include impacts to residential, commercial, industrial, transportation, streams and canals, lakes or other areas that are not included in the six vegetation types.
* Preferred Alternative
Source: Study Team, 2013.

Agricultural vegetation is the most common vegetative community type found within the ROW of the reasonable alternatives. It is anticipated that the entire ROW would be cleared of all vegetation for the reasonable alternatives. Alternatives 3 and 8 would have the highest potential impacts on agricultural vegetation (1,094.49 ac). Alternatives 6 and 11 would have the least potential impacts to agricultural vegetation (765.73 ac). Potential forest impacts vary from a high of 735.18 ac in Alternative 6 to a low of 575.40 ac in Alternative 7. Potential riparian zone impacts vary from 21.53 ac in Alternative 11 down to 11.36 ac in Alternatives 2 and 3. Potential non-forested wetland impacts vary from 15.50 in the Preferred Alternative up to 41.16 in Alternative 7. The Preferred Alternative would potentially impact up to 1027.12 ac of total agricultural vegetation, 635.48 ac of forest, 26.53 ac of forested wetlands, 15.5 ac of non-forested wetlands, and 24.21 ac of riparian zone. These values reflect the Preferred Alternative potential impacts to the various vegetative communities. These values do not show the Preferred Alternative impacts to non-vegetative required ROW.

4.7.3.1 TxDOT-TPWD MOU

Provision (4)(A)(i) of the 1998 Memorandum of Understanding (MOU) between TxDOT and the TPWD requires that the vegetation and habitat for the project are characterized, as defined by Sections 1, 2, and 3 of the 2001 TxDOT-TPWD Memorandum of Agreement (MOA), and the impact to vegetation described.

Regarding unusual vegetation features as defined by Section 1 of the TxDOT-TPWD MOA:

- Unmaintained vegetation is restricted to approximately 30 percent of the alternative alignments and located primarily in Section A where agriculture is not present.
- Fence row vegetation is common throughout Sections B and C in all of the alternative alignments.
- Approximately 40 ac (total) of riparian vegetation is present along the 10 alternative alignments. The Preferred Alternative contains approximately 24.21 ac of riparian habitat. The amount of riparian habitat in the other alternative alignments ranged from approximately 11 to 24 ac.
- Trees that are unusually larger than other trees in the area were not noted based on the limited investigations performed due to the limited right of entry.
- Unusual stands or islands of vegetation were not present based on the investigations performed.

The following list describes special habitat features as defined by the TxDOT-TPWD MOA that were considered during the evaluation:

- Bottomland hardwood communities cover approximately one third of the study area. These areas are included within the acreages for "total forested" in **Table 4-26** above.
- Caves, cliffs, and bluffs were not noted.
- Native prairies were not noted, as the area in the Gulf Coast prairies region has been disturbed by agricultural practices.
- The alternative alignments have a total of 52 river, creek, or stream crossings.

The above information is based on investigation of aerial imagery, GIS data, and limited field investigations. Due to lack of access, a detailed characterization and impact assessment would be performed for the selected Preferred Alternative after the ROW is acquired.

4.7.3.2 Texas Parks and Wildlife Coordination Triggers

Per the MOU with the TPWD TAC 43(1)(2)(B)(22.2), coordination would be initiated with the TPWD if the project met any of the coordination triggers. The coordination triggers were met by the proposed project, because the proposed project:

- does involve more than 1 acre of new ROW within floodplains or creek drainages in rural or undeveloped urban areas; does not involve a channel re-alignment involving the creation of new drainage ways or other excavation impacting more than 1 acre of mature woody vegetation;
- does affect dense mature brush or woody vegetation, including any significant remnant native vegetation (e.g., undisturbed native prairie or bottomland hardwood, etc.); and
- is within range of suitable habitat for any federal- or state-listed threatened or endangered species.

Therefore, coordination with the TPWD would be required. The proposed project does not have previous environmental clearance. During the next phase of design, the GPA and TxDOT will determine if the proposed project:

- does not require channel modifications to streams, rivers, or water, and
- does not involve mitigation plans of otherwise involve proposals to redress project impacts on fish, wildlife, or plant resources.

4.7.4 Summary of Waters of the U.S., Including Wetlands, and Vegetative Communities Impacts

Impacts to Waters of the U.S. present within the reasonable alternatives ranged from 14.9 ac (Alternative 3) to 28.8 ac (Alternative 9). The Preferred Alternative would impact 22.9 ac of potential Waters of the U.S. A Clean Water Act (CWA) Section 404 permit would be required by the USACE for the Preferred Alternative. Water quality certification from the TCEQ would also be necessary per Section 401 of the CWA. No navigable Waters of the U.S. exist in the study area; therefore, the need for a Section 9 permit from the U.S. Coast Guard (USCG) or a Section 10 permit from the USACE is not required.

Potential impacts to wetlands ranged from 246.53 ac (Alternative 4) to 431.35 ac (Alternative 8). Alternative 4 was determined to have the least amount of overall potential impacts, as well as the least amount of adjacent non-forested (9.31 ac) wetlands. Alternatives 2 and 7 would have the least amount of adjacent agricultural (113.53 ac) wetlands. Alternative 8 was determined to have the highest impact amount overall, as well as the highest amount of adjacent non-forested (38.39) wetlands. Alternatives 6 and 11 would have the highest amount of adjacent agricultural (201.10 ac) wetlands. The Preferred Alternative would impact a total of 327.40 ac of wetlands, including 222.51 ac of adjacent wetlands and 104.89 ac of isolated wetlands.

Agricultural vegetation is the most common vegetative community type found within the reasonable alternatives. Alternatives 3 and 8 would have the highest impacts on agricultural vegetation (1,094 ac). Alternatives 6 and 11 would have the least impacts to agricultural vegetation (766 ac). Forest impacts vary from a high of 735 ac in Alternative 6 to a low of 575 ac in Alternative 7. Riparian zone impacts range from 11.36 ac in Alternative 2 and 3 to 24.21 ac in the Preferred Alternative. The Preferred Alternative would impact up to 1,027.12 ac of agricultural vegetation, 622.72 ac of forest, 24.21 ac of riparian zone, and 15.50 ac of non-forested wetland.

The No-Build Alternative would not result in Waters of the U.S., wetland, or vegetative community impacts. The No-Build Alternative would avoid impacts to larger wetlands (forested and non-forested), but could impact smaller wetlands associated with short-term, minor restoration activities (e.g., resurfacing, bridge repairs, road widening) to existing transportation facilities. The No-Build Alternative would also avoid impacts to other vegetative communities (agricultural vegetation, riparian habitat, upland forests, etc.). The No-Build Alternative would likely avoid impacts to larger vegetative communities, but could result in smaller community impacts associated with improvements to existing transportation facilities.

Indirect Impacts

Construction of the new corridor may indirectly impact vegetation communities due to induce development; however, indirect impacts to vegetative resources are not expected to be substantial when compared to the acreage of vegetation available within the AOI. The potential indirect impacts to Waters of the U.S. and wetlands due to induced development within the AOI is anticipated to be zero acreage of Waters of the U.S. and 2,997 ac of wetlands for the Preferred Alternative. The No-Build Alternative would not indirectly impact waters, wetlands, or vegetation; however, impacts to these resources would continue with the planned development trends. Refer to **Chapter 5** for a detailed indirect impacts analysis.

Mitigation

Preliminary mitigation options include on-site mitigation and off-site mitigation. On-site mitigation (i.e., immediately adjacent to the new highway) may include stabilization of disturbed stream banks, re-vegetation, and creation or enhancement of wetlands within the final Grand Parkway Segments H and I-1 ROW. Creation or enhancement of wetlands would primarily involve development of shallow forested wetlands very similar in function and value to the forested wetlands impacted during roadway construction.

Off-site mitigation, such as the purchase of credits at a mitigation bank or permittee responsible mitigation, for wetlands must be designed to reestablish, to the extent reasonable, similar wetland functions, values, and types as the pre-existing site. Off-site mitigation would be conducted in the same geographic vicinity or in proximity, and most likely within the same watershed as the project, particularly for wetlands. Waters of the U.S. mitigation may include expanding existing wetlands, restoration with hydrophytic species, or regulating water levels in impoundments or streams.

Natural resource agencies (including TPWD, USFWS, USACE, EPA, and TCEQ) would be involved in decisions regarding the appropriate type of mitigation, mitigation ratios, and the location, size, and character of the mitigation. A compensatory mitigation plan would be submitted to the USACE as part of the Section 404 permit review process. Preliminary wetland mitigation measures are described in **Chapter 7 (Mitigation and Permitting)**.

4.8 WILDLIFE

4.8.1 Terrestrial Wildlife

Potential impacts to wildlife resulting from the proposed project can be attributed to direct impacts to wildlife from construction machinery, the loss of wildlife habitat, habitat fragmentation, and wildlife/vehicle collision mortalities. These impacts would occur during the construction and operation of the proposed project and would potentially result in direct impacts to fish and wildlife resources in the study area.

Wildlife inhabiting areas within the reasonable alternatives and the Preferred Alternative would likely relocate to adjacent habitats during construction activities. Heavy machinery and other construction equipment may induce mortality of wildlife species that are slow moving such as the armadillo (*Dasypus novemcinctus*), Gulf Coast toad (*Bufo valliceps*), and five-lined skink (*Eumeces fasciatus*). Fossorial species such as the Baird's pocket gopher (*Geomys breviceps*) and prairie kingsnake (*Lampropeltis calligaster*) or those species that seek cover in debris and fallen vegetation like the eastern wood rat (*Neotoma floridana*), Texas rat snake (*Elaphe obsoleta lindheimeri*), and southern copperhead (*Agkistrodon contortrix contortrix*) may also be impacted by heavy machinery and other construction equipment. Construction related impacts would be short-term and primarily occur during initial ROW clearing activities.

Wildlife populations adjacent to the study area would also be impacted by construction noise and activity that could stress adjacent wildlife or cause adjacent wildlife populations to seek refuge further away from the edge of the construction area. Once completed, noise and traffic activity would continue to persist, albeit at a lower level. Studies have indicated that breeding activity and population size of certain avian species such as the eastern meadowlark (*Sturnella magna*) and horned lark (*Eremophila alpestris*) decrease as traffic (i.e. traffic noise) increases, while other species such as the red-winged blackbird (*Agelaius phoeniceus*) increase (Forman, 2002; Clark, 1979). However, it is difficult to differentiate the effects of visual disturbance, habitat fragmentation, or increased mortality due to increased noise of the roadway. Species that benefit from edge habitats and tolerate increased noise and visual disturbances would occupy the ROW upon completion of the proposed project. Overall, it is expected that wildlife diversity and composition would be altered as a result of the proposed project; however, no substantial long-term impacts to wildlife populations would result from increased noise and visual disturbances adjacent to the project ROW.

The Segments H and I-1 study area is comprised of bottomland hardwood forests, upland pine/hardwood forests, Gulf Coast prairie rangelands, and cultivated cropland habitats. Of these habitats, bottomland hardwood forests provide the most diverse ecosystems in Texas. Over 50 percent of all neotropical songbirds that occur in Texas live, nest, or migrate through bottomland hardwood forests. Bottomland hardwoods, forested wetlands, emergent wetlands, and riverine wetlands also provide habitat for the beaver (*Castor canadensis*), river otter (*Lutra canadensis*), marsh rice rat (*Oryzomys palustris*), waterfowl, herons, egrets, and other waterbirds. Loss of these habitats would result in direct impacts to these and other species requiring woodland and wetland habitats. Loss of forested habitat would impact arboreal species such as the eastern red bat (*Lasiurus borealis*), hoary bat (*Lasiurus cinereus*), northern yellow bat (*Lasiurus intermedius*), Seminole bat (*Lasiurus seminolus*), fox squirrel (*Sciurus niger*), gray squirrel (*Sciurus carolinensis*), southern flying squirrel (*Glaucomys volans*), and the golden mouse (*Ochrotomys nuttalli*). Rangelands and the herbaceous and shrubland habitats that occur within managed pine forests provide habitat for Bachman's sparrow (*Aimophila aestivalis*), Henslow's sparrow (*Ammodrammus henslowii*), and the prairie warbler (*Dendroica discolor*). Loss of rangeland and shrubland habitat would directly impact these species as well as other grassland and shrubland species. Migrating waterfowl and waterbirds utilize cultivated croplands as food resources; however, cropland vegetation as a whole provides limited habitat for wildlife. Therefore, impacts to wildlife would be minimal on cultivated lands. **Table 4-28**

identifies the specific wildlife habitats (excluding croplands, transportation ROWs, and residential areas) and the areal extent for each alternative. For each build alternative, the wildlife habitat present, and which may be impacted, is presented in **Table 4-27** is considered the maximum potential impact acreage.

Table 4-27: Wildlife Habitat Within the Reasonable Alternatives

Reasonable Alternative	Forested Wetland Habitat (ac)	Non-Forested Wetland Habitat (ac)	Total Wetland Habitat ** (ac)	Forest Habitat (ac)	Total Habitat
1 (No-Build)	0.00	0.00	0.00	0.00	0.00
2	4.45	40.93	45.38	584.17	629.55
3	23.73	38.62	62.35	570.14	632.49
4	2.79	19.09	21.88	591.74	613.62
5	22.08	16.77	38.85	577.71	616.56
6	27.27	23.07	50.34	707.91	758.25
7	6.13	41.16	47.29	569.27	616.56
8	25.41	38.85	64.26	555.24	619.5
9	4.48	19.31	23.79	576.84	600.63
10	23.76	17.00	40.76	562.81	603.57
10R*	26.53	15.50	42.03	622.72	664.75
11	28.95	23.30	52.25	693.01	745.26

* Preferred Alternative
** excludes agricultural wetland areas
Source: Study Team, 2013

In addition to reducing the size of wildlife habitat, habitat fragmentation can result in the reduction of the quality of suitable wildlife habitat and the disruption of wildlife movement, dispersal, and gene flow. The isolation of populations is dependent upon the species dispersal capabilities, probability of surviving highway crossing attempts, and/or the species tendency to avoid areas adjacent to highways (Conrey, 2001). Wildlife species such as the American redstart (*Setophaga ruticilla*), prothonotary warbler (*Protonotaria citrea*), brown creeper (*Certhia americana*), hermit thrush (*Catharus guttatus*), and pine warbler (*Dendroica pinus*) that require mature, unfragmented habitats would be negatively impacted by the fragmentation of habitats, while species that prefer edge habitats such as pine siskin (*Carduelis pinus*), brown-headed cowbird (*Molothrus ater*), white-tailed deer (*Odocoileus virginianus*), eastern cottontail rabbit (*Sylvilagus floridanus*), and bobwhite quail (*Colinus virginianus*) would thrive (Keller, M.E. and S.H. Anderson, 1991). In addition, habitat fragmentation can negatively affect nest success and age/sex ratios of neotropical migrant birds that avoid edge habitats (Hoover, 1995; Hunt, 1996; Roberts, 1999).

Wildlife/vehicle collisions are a leading cause of human induced mortality on wildlife (Forman, 1998; Schwabe, 2002). The number of vehicle collisions with deer (*Odocoileus* spp.) in the U.S. is estimated to be between 0.5 and 1.5 million per year (Cook, 1995; Romin, 1996; Conover, 1997). Road kill surveys indicate that other taxa are equally, if not more, impacted than mammals. Studies indicate that reptiles and amphibians comprise between 45 to 90 percent of road kill species while avian species make up between 5 to 40 percent (Ashley, 1997; Kline, 1998). Mortality from vehicle collisions increases for wildlife species that are less mobile, exhibit a freeze response to stimuli, or migrate between seasonal or breeding habitats. In addition, ectothermic species such as snakes often utilize paved surfaces to regulate their body temperatures; therefore, they are more susceptible to roadway mortalities. The result of the non-compensatory wildlife/vehicle induced mortalities can affect the demographic structure and dynamics of roadside wildlife populations (Mumme, 2000).

Roadway pollutants including heavy metals, salts, organic compounds, oil and grease, and suspended solids could impact wildlife adjacent to the proposed roadway. These impacts would be minimized utilizing BMPs designed to minimize erosion and filter contaminants before entering aquatic systems.

4.8.2 Migratory Bird Treaty Act

The forested, wetland, and rangeland landscapes all provide potential habitat for migratory birds which are protected under the Migratory Bird Treaty Act (MBTA). These areas all provide nesting habitat for migratory birds. A cursory nest survey would be conducted by qualified personnel once right of entry is obtained. In accordance with the MBTA, no vegetation would be removed containing nests, eggs, or young, should clearing occur during the nesting season (March 1 through August 31). Additionally, to avoid impacts to migratory birds any active breeding areas found during the cursory survey would be avoided entirely during the breeding season of any migratory birds identified within the alternatives.

4.8.3 Aquatic Habitat

The water bodies crossed by the alternatives are designated as warm freshwater fisheries. No tidally influenced or cold water fishery streams are crossed by the alternatives. Aquatic habitats crossed by the alternatives can be potentially impacted due to the physical disturbance of bank and streambed material during construction activities, increased sedimentation and turbidity due to construction activities, and/or a decrease in water quality due to non-point source runoff or point source pollution due to toxic spills on the roadway.

Physical impacts to the bank and bed of a waterbody can occur during the installation of culverts and bridges. Impacts resulting from the installation of bridge structures include increased turbidity and sedimentation downstream of the water body crossing. These effects are short term and limited to the duration of construction activities at the site. Although increased turbidity and sedimentation could affect aquatic species, especially during spawning seasons, the impacts would be of a localized and temporary nature.

Storm runoff events would potentially provide the pathway for non-point source pollutants to enter the aquatic ecosystem. Because the most toxic fraction of petroleum based products are volatile organic compounds that readily evaporate and the introduction of non-point source pollutants would occur during rain events that dilute the remaining contaminants, the potential impacts to aquatic resources would be minimal. Conversely, accidental toxic spills could introduce undiluted contaminants directly to the aquatic system. The potential impacts to aquatic wildlife would depend on the aquatic species, the toxicity of the toxicant, and the quantity or concentration of toxicant added to the system.

4.8.4 Summary of Wildlife Impacts

The Preferred Alternative would impact up to 664.75 ac of wildlife habitat. The primary substantial impacts to wildlife species inhabiting the study area are loss of habitat and habitat fragmentation. The No-Build Alternative would not result in wildlife impacts.

Indirect Impacts

Potential indirect effects on wildlife habitat from roadway projects include impacts from induced development. Of the approximate 427,830 ac of potential wildlife habitat located within the AOI, approximately 25,944 ac of vegetation, including land in agricultural use, may be indirectly impacted by induced development. The portion of undeveloped land that would be indirectly impacted contains wildlife habitat consisting of forested wetlands, non-forested wetlands, and forest. Existing habitat has largely been fragmented by development, the timber industry, and agricultural practices. Activities within the AOI may have the potential to impact foraging, breeding, or roosting activities of some species, and some terrestrial species may relocate due to change in available habitat. However, species within the AOI are largely found throughout the region, and substantial impacts to individual species are not anticipated.

Under the No-Build Alternative, approximately 270,000 ac are developed and/or planned for development independently of the Grand Parkway. Refer to **Chapter 5** for a detailed indirect impacts analysis.

Mitigation

Construction of the project would impact vegetative communities that provide wildlife habitat. It is anticipated that a non-wetland component would be included in the mitigation plan to compensate for impacts to non-regulated natural resources **(Section 7.7.5 Habitat Mitigation - Non-Regulatory)**. Impacts to wildlife and habitat resources can be minimized through the use of a combination of any of the BMPs listed in **Section 7.8 of Chapter 7 (Mitigation and Permitting)**. Coordination with the appropriate resource agency would ensue (per the TPWD MOU) should wildlife and habitat or sensitive natural resource areas be encountered during construction.

4.9 THREATENED AND ENDANGERED SPECIES

Chapter 3 (Affected Environment) provides a complete listing, status, and habitat requirements of all federally- and state-listed threatened and endangered species that are known to occur within the four-county study area. **Section 4.9** presents the potential impacts to federal- and state-listed threatened and endangered species for the Segments H and I-1 reasonable alternatives (**Exhibit 2-5**) and the Preferred Alternative.

4.9.1 TxNDD Listed Species

A check of the TPWD's "mimic" version of the Texas Natural Diversity Database (TxNDD) was obtained on February 24, 2013. The TxNDD does not show any known location records for any federal-listed species in the study area, but the TxNDD did show occurrences for two state-listed threatened species, three state-listed species of concern, and two rare plant communities that have been documented within a 1.5-mi radius of the study area. There have been no other recorded sightings of any federal- or state-listed species within close proximity of the study area. It should be noted that an absence of data for a particular species does not mean an absence of occurrence for threatened, endangered, and rare species. The following are the results of the TxNDD search, including the element of occurrence identification (EOID).

- Rafinesque's big-eared bat (*Corynorhinus rafinesquii*) – EOID 5412
    - State-listed threatened
    - TxNDD element of occurrence within study area
- Bald eagle (*Haliaeetus leucocephalus*) – EOID 7972

  - State-listed threatened
  - TxNDD element of occurrence 0.29 miles from the study area
- Correll's false dragon-head (*Physostegia correllii*) – EOID 4512
  - state-listed species of concern
  - TxNDD element of occurrence 0.11 miles from the study area
- Threeflower broomweed (*Thurovia triflora*) – EOID 7357
  - state-listed species of concern
  - TxNDD element of occurrence within the study area
- Texas windmill-grass (*Chloris texensis*) – EOID 7812
  - state-listed species of concern
  - TxNDD element of occurrence 0.87 miles from the study area
- Loblolly pine-white oak-southern red oak series (*Pinus taeda-Quercus alba-Quercus falcata* series) – EOID 1489 and EOID 5487
  - state-listed special habitat (G4, S4)
  - TxNDD element of occurrence within the study area
- Water oak-willow oak series (*Quercus nigra-Quercus phellos* series) – EOID 1910 and EOID 1092
  - state-listed special habitat (G4, S3)
  - TxNDD element of occurrence within the study area and 0.42 miles from the study area

Rafinesque's Big-eared Bat (*Corynorhinus rafinesqui*)

Rafinesque's big-eared Bat is a medium-sized bat with long rabbit-like ears (27-37 millimeters). The bat has large facial glands protruding from each side of its snout. Its fur is grayish brown above and conspicuously bicolored underneath; it has a forearm length of 39-43 millimeters and weighs 7-13 grams. Rafinesque's Big-eared Bats roost in cave entrances, hollow trees, abandoned buildings, and under bridges in the forests of southeastern United States. Like others in the order Chiroptera, these bats are insectivores (eat only insects). They also hibernate during the winter. Rafinesque's big-eared bat has the potential or a known presence in multiple counties in eastern Texas, including Harris, Liberty, and Montgomery counties within the study area. Because the reasonable alternatives may contain suitable

habitat, a survey for Rafinesque's big-eared bat habitat would be conducted prior to construction once right of entry is obtained to ensure that the proposed project would not have an impact on the species.

Bald Eagle (*Haliaeetus leucophalus*)

The bald eagle is a large raptor generally weighing seven to ten pounds with a wingspan sometimes reaching more than seven feet. Adult bald eagles are easily recognized with their stark white coloration on the head contrasting with a solid black or dark brown body. Bald eagles are opportunistic predators and commonly feed on water birds, bottom dwelling fish, and turtles in Texas. In Texas, bald eagles nest from October to July in nests measuring up to six feet in width and weighing hundreds of pounds (TPWD, 2013). In Texas, the winter and nesting range for the bald eagle is general restricted to the eastern portion of the state. Because the reasonable alternatives may contain suitable habitat, a survey for bald eagles and their habitat would be conducted once right of entry is obtained and prior to construction, to ensure that the proposed project would not have an impact on the species.

Correll's false dragon-head (*Physostegia correllii)*

Correll's false dragon-head is a perennial herbaceous plant that flowers from May to September. Extent populations of Correll's false dragon-head are found in Texas, Louisiana, and Mexico. Habitat for this plant in Texas includes riverbanks, streamsides, creekbeds, roadside ditches, and irrigation canals. Because the reasonable alternatives may contain suitable habitat, a survey for Correll's false dragon-head and their habitat would be conducted once right of entry is obtained and prior to construction, to ensure that the proposed project would not have an impact on the species.

Threeflower broomweed (*Thurovia triflora*)

Threeflower broomweed is a herbaceous annual endemic to coastal Texas. Threeflower broomweed is found in black clay soils of remnant grasslands, tidal flats, and sparsely vegetated, saline areas in coastal prairie. Threeflower broomweed blooms from September to October. Because the reasonable alternatives may contain suitable habitat, a survey for threeflower broomweed and associated habitat would be conducted once right of entry is obtained and prior to construction, to ensure that the proposed project would not have an impact on the species.

Texas windmill-grass (Chloris texensis)

Texas windmill-grass is a tufted perennial grass that flowers in October and November. Texas windmill grass occurs in open or barren areas within prairies along the Texas coast. Microhabitat for Texas windmill grass includes sandy openings on or at the base of pimple mounds. The reasonable alternatives could contain habitat for Texas windmill grass. A survey for Texas windmill grass and associated habitat would be conducted once right of entry is obtained and prior to construction, to ensure that the proposed project would not have an impact on the species.

Loblolly pine-white oak-southern red oak series (*Pinus taeda-Quercus alba-Quercus falcata* series) and Water oak-willow oak series (*Quercus nigra-Quercus phellos* series)

The loblolly pine-white oak-southern red oak series (*Pinus taeda-Quercus alba-Quercus falcata*) occurs within the study area. Additionally, the rare water oak/willow oak vegetation series is known to occur within the Lake Houston Wilderness Park and surrounding areas. This vegetation supports many animal species, such as the state threatened Rafinesque's big-eared bat, that depend on mature, bottomland hardwood habitats. The water oak/willow oak habitat is a deciduous bottomland hardwood forest located in often inundated floodplains of East Texas. Plant species commonly associated with this vegetation series include sweetgum, cherrybark oak (*Q. pagoda*), ash (*Fraxinus* spp.), and overcup oak (*Q. lyrata*). Ironwood, eastern hop-hornbeam (*Ostrya virginiana*), deciduous holly (*Ilex decidua*), and Florida maple (*Acer barbatum*) often compose the understory of this vegetation series. Because both of the rare vegetative series are reported by TxNDD as occurring within the study area, a survey to assess the location and extent of these series would be conducted once right of entry is obtained and prior to construction, to ensure that the proposed project would not have an impact on the series.

4.9.2 State-Listed Threatened and Endangered Species and Species of Concern

The state-threatened bald eagle, white-faced ibis, wood stork, swallowtail kite, Rafinesque's big-eared bat, Louisiana pine snake, northern scarlet snake, and timber rattlesnake require the forested, forested wetland, and wetland habitats existing within the proposed study area and potentially in the Preferred Alternative. In addition, habitat for the Bachman's sparrow and red-cockaded woodpecker could potentially occur within the open pine wood landscapes of the Preferred Alternative. Although these species are mobile and can seek shelter in adjacent habitats, the proposed project would potentially impact these species' habitat.

Surveys to identify the locations of potential habitat for these species would be conducted prior to construction activities to avoid and/or minimize adverse impacts to these species.

Remnant prairie habitats or improved pastures within the Preferred Alternative could provide habitat for the white-tailed hawk, smooth green snake, and Texas prairie dawn. Surveys to identify potential prairie habitat for these species would be conducted prior to construction activities to avoid and/or minimize adverse impacts to these species.

The bald eagle was delisted by the U.S. Fish and Wildlife Service (USFWS) on August 8, 2007, although it is still listed as threatened in Texas by the TPWD. Additionally, the bald eagle is protected by the MBTA and the Bald and Golden Eagle Protection Act. Increases in traffic and construction noise may increase stress levels in any potential breeding eagles. Construction outside of the breeding season may be considered in proximity to nesting eagles to reduce stress. Species surveys and mitigation for potential displaced species or loss of habitat would be discussed with the USFWS upon identification of definitive impacts.

Impacts to aquatic state-threatened species such as the creek chubsucker, paddlefish, alligator snapping turtle, Louisiana pigtoe, Sandbank pocketbook, Texas pigtoe, and Texas heelsplitter would be minimized by bridging streams and rivers located in the Preferred Alternative. The use of temporary and permanent BMPs to control sediment and runoff would further minimize impacts of the proposed project; therefore, no impacts are expected to occur to these species. Once right of entry is obtained for the entire project area, additional investigations would be conducted to determine if potential aquatic threatened and endangered species or their habitat occurs within the Preferred Alternative. The additional investigations would include identifying potential mussel habitat. If habitat is present and it is determined that construction of the Preferred Alternative may impact protected mussel species, TxDOT would take appropriate measures to minimize those impacts. The measures may include mussel surveys and relocation, measures to limit direct impacts during construction, and appropriate best management practices to limit stormwater runoff reducing the likelihood of increased turbidity and sedimentation in the waterbodies during construction.

The state-listed American peregrine falcon could potentially occur within the Preferred Alternative as they migrate through the area. American peregrine falcons are known to assemble on the Texas coast to rest and replenish fat stores before continuing their migrations; therefore, it is possible that the falcons could

forage near the Preferred Alternative during the spring and fall. However, as the falcon's use of the study area would be temporary and the species would avoid construction activities, the proposed project would not impact peregrine falcons.

The TPWD list of threatened and endangered species identifies four federally-listed endangered species as occurring within the four-county area that the USFWS federal list does not include: Louisiana black bear, red wolf, Houston toad, and whooping crane. The red wolf and the Houston toad have been extirpated from the four-county area; therefore, the proposed project would have no effect on these species. The whooping crane is known to winter at Aransas National Wildlife Refuge and its primary migration route is several hundred miles west of the study area. It is unlikely that a whooping crane would migrate through the study area. Although black bears are reported to be moving into the eastern part of Texas along the Louisiana border, there are no known breeding populations of black bears in east Texas. Most of the black bears observed in Texas have been transient solitary males. Since 1977, TPWD has documented reliable sightings of black bears in 24 locations; however, none of the sightings occurred in the four-county study area (TPWD, 2005). Therefore, the proposed project would have no effect on the Louisiana black bear, red wolf, Houston toad, or whooping crane.

The TPWD lists species of concern along with the state list of threatened and endangered species. Potential habitat for the arctic peregrine falcon, Henslow's sparrow, snowy plover, western snowy plover, black rail, American eel, two species of mayfly, gulf coast clubtail, Texas emerald dragonfly, plains spotted skunk, southeastern myotis bat, creeper (squawfoot), fawnsfoot, little spectaclecase, Wabash pigtoe, coastal gay-feather, Correll's false dragon-head, Texas meadow-rue, Texas windmill-grass, and threeflower broomweed may occur in the four counties within the study area. Therefore, the proposed project would potentially impact these species' habitat. Mitigation for displaced species or loss of habitat would be discussed with the TPWD upon identification of definitive impacts.

4.9.3 Federal-Listed Threatened and Endangered Species and Species of Concern

Potential habitat for the endangered red-cockaded woodpecker and the endangered Texas prairie dawn exists within the study area. Red-cockaded woodpeckers prefer long-leaf pine forests, using 60-year and older pines for nesting and 30-year and older pines for foraging. Texas prairie dawn has relatively specific habitat requirements consisting of poorly drained areas in open grasslands. The species often grows on or at the base of pimple mounds. Neither species has designated critical habitat. The Preferred Alternative

proposed ROW primarily consists of cultivated agricultural land or forested areas dominated by loblolly pine. Due to the lack of suitable habitat, work within the ROW for the Preferred Alternative will not affect any federally listed species. Mitigation for displaced species or loss of habitat would be coordinated with the USFWS upon identification of definitive impacts.

4.9.4 Bald and Golden Eagle Protection Act

On August 8, 2007, the bald eagle was removed from the USFWS threatened and endangered species list. The USFWS could propose to relist the species if it appears that the bald eagle needs further protection under the Endangered Species Act (ESA). Although the bald eagle is no longer protected under the ESA it is currently protected under the Bald and Golden Eagle Protection Act and the MBTA. In addition, the bald eagle currently retains its status as a state-threatened species on TPWD's annotated list of rare, threatened, and endangered species. Although no bald eagles are known to nest within the proposed ROW of the reasonable alternatives or the Preferred Alternative, eagles are known to feed along the riparian corridors of waterways that cross the proposed project. Potential impacts to the bald eagle are discussed in **Section 4.9.2 (State-Listed Threatened and Endangered Species and Species of Concern).**

4.9.5 Summary of Threatened and Endangered Species Impacts

Forested, forested wetland, and non-forested wetland habitats have been identified within the Preferred Alternative proposed ROW through limited field surveys and with the use of aerial photography, soil surveys, and existing records. Due to the lack of suitable habitat, the Preferred Alternative will not affect any federally listed species. Further investigations, especially field surveys, would be conducted once right of entry is obtained to determine if additional potential threatened and endangered species habitat occurs within the study area. Should threatened or endangered species occur within the study area, coordination with the USFWS and TPWD would commence to determine the need for further investigations or consultation under Section 7 of the ESA.

The No-Build Alternative would have no effect on any federally listed threatened or endangered species, nor would it adversely impact any state-listed species.

<u>Indirect Impacts</u>

It is expected that any undeveloped areas, both planned and unplanned, could be developed under the No-

Build Alternative, and continued loss of habitat may occur if these areas are not developed in compliance with the ESA. It is impossible to determine the degree to which future development would comply with the ESA. However, based on the land use analysis and current federal and state laws and regulations, it is expected that the development of properties containing threatened or endangered species preferred habitat within the AOI would not be affected by the Preferred Alternative. Therefore, indirect impacts to the bald eagle, red-cockaded woodpecker, or Texas prairie dawn are not anticipated as a result of the proposed Grand Parkway Segments H and I-1 project. Refer to **Chapter 5** for a detailed indirect impacts analysis.

Mitigation

Potential habitat for multiple federally- or state-listed species may occur within the study area. Surveys for these species and their habitat would be conducted for the Preferred Alternative, after right of entry is granted and prior to construction activities, to ensure that the proposed project would have no effect on the listed species. TPWD has been involved in the planning process. Species specific mitigation strategies and coordination would be continued to avoid, minimize, and/or compensate for any potential impact to a threatened or endangered species. A compensatory mitigation plan would be developed, with coordination with TPWD and USFWS, if habitat or individuals of the federally- or state-listed species discussed in **Chapter 3** are located during pre-construction surveys.

4.10 FLOODPLAINS

4.10.1 Hydrology and Drainage

Major streams and their tributaries that flow through the Segments H and I-1 study area include Peach Creek, Caney Creek, East Fork San Jacinto, Luce Bayou, East Fork Cedar Bayou, and Cedar Bayou. These streams are located within the San Jacinto and Trinity River Basins, which have a combined drainage area of over 20,765 square miles (mi^2). The headwaters of the San Jacinto River start out at two forks, one located in Grimes and Walker counties on the west and another in Walker, San Jacinto, and Liberty counties on the east. The East and West Forks of the San Jacinto River converge in northeast Harris County at Lake Houston, an impoundment built as a key water supply source for the City of Houston. The East Fork receives drainage from a 1,050 mi^2 area. The Trinity River Basin serves as a primary water supply to more than 4.8 million people on the upper Gulf Coast of Texas centered on the greater Houston metropolitan area.

The study area streams generally flow in a southeast direction. The reasonable alternatives and the Preferred Alternative generally run in an eastern to southeastern direction to the terminus at I-10 (E). These reasonable alternatives would transverse floodplain crossings at each of the six streams within the Grand Parkway Segments H and I-1 study area. No stream relocations are anticipated. The number of water resource crossings for each alternative is listed in **Table 4-28**.

Table 4-28: Water Resource Crossings Within the Reasonable Alternatives

Reasonable Alternative	Number of Major Stream Crossings	Number of Minor Stream Crossings, Including Ditches	Number of Lakes or Ponds	Totals
1 (No-Build)	N/A	N/A	N/A	N/A
2	3	19	1	23
3	3	16	1	20
4	5	17	1	23
5	5	14	1	20
6	7	10	1	18
7	4	19	1	24
8	4	16	1	21
9	6	17	1	24
10	6	14	1	21
10R*	5	13	5	23
11	8	10	1	19

* Preferred Alternative
Source: Study Team, 2010

The number of water resource crossings varies from 18 (Alternative 6) to 24 (Alternatives 7 and 9). The Preferred Alternative would impact 23 water resource crossings. The watersheds within the Grand Parkway Segments H and I-1 study area are comprised of residential and commercial development and undeveloped acreage, such as farmlands and wooded areas. Each of the reasonable alternatives would increase the amount of impervious areas within the watersheds, resulting in increased surface runoff. The increased surface runoff would not be considered substantial due to the required drainage (mitigation) facilities that would be incorporated into the project design.

Each of the reasonable alternatives and the Preferred Alternative has the potential to impact overland sheet flow patterns due to the construction of the roadway and associated structures. Therefore, sheet flow patterns would be considered when designing cross drainage structures due to the lack of natural drainage features and the flat topography in the area.

4.10.2 Floodways and Floodplains

The floodplain assessment compares the amount of floodplain encroachment anticipated by each alternative and includes a discussion of the flooding risks, beneficial functions and values, and measures taken to avoid and minimize potential impacts. The floodplains assessment follows the guidance of FHWA's Technical Advisory T 6640.8A: Guidance for Preparing and Processing Environmental and Section 4(f) Documents (FHWA, 1987). The assessment methodology is based on the requirements provided in EO 11988 Floodplain Management, FHPM 6-7-3-2, *Location and Hydraulic Design of Encroachments on Floodplains*, and USDOT 5650.2 Floodplain Management and Protection. FHPM 6-7-3-2 essentially references 23 CFR § 650 Subpart A, *Location and Hydraulic Design of Encroachments on Floodplains*. The floodplain regulations require that a Location Hydraulics Study be performed to address and discuss the following items for the Preferred Alternative:

- The risk of flooding associated with the implementation of the highway facility;
- The impacts on natural and beneficial floodplain values;
- The support of incompatible development within the floodplain; and
- Measures to minimize floodplain encroachments.

Floodplain regulations also require the utilization of National Flood Insurance Program (NFIP) maps to identify the limits of the base (100-year) floodplain. The NFIP was established by Federal Emergency Management Agency (FEMA) and is administered and enforced through communities affected by floodplains. The intent of these regulations is to avoid or minimize transportation encroachments within the base floodplain, where practicable, and to avoid supporting land use development that is incompatible with floodplain values. Sections 60.3(c), 65.3, 65.6, and 65.12 of FEMA's NFIP and related regulations, revised October 1, 2005, specify that "the cumulative effect of the proposed [roadway] development, when combined with all other existing and anticipated development in the area, would not increase the water surface elevation of the base flood more than 1 ft at any point within the community" (44 CFR 60.3[d][3]).

Flood Insurance Rate Maps (FIRMs) were obtained for Montgomery, Harris, Liberty, and Chambers counties showing the regulatory floodways and base floodplains for the major rivers and streams (see **Section 3.10** for description of FIRMs). The floodplains and floodways were transferred onto the project mapping in GIS. GIS software was used to calculate the amount of floodway and floodplain acreage within the Segments H and I-1 study area and the amount of floodway and floodplain encroachment associated with each alternative.

The reasonable alternatives, the Preferred Alternative, and the No-Build Alternative were quantitatively examined for encroachments on the Segments H and I-1 study area's water resources and associated floodplains. Study area floodways and floodplains are shown in **Exhibit 4-6**. **Table 4-29** presents the potential floodway and floodplain encroachments within the ROWs of each alternative. These represent substantially more acreage than would be impacted by the project because final design would include bridging most if not all of the floodways and much of the floodplain acreage found within the ROW. The table also provides two comparisons to regional floodplains: the total amount of each individual floodplain in the study area and the total amount of all floodplains in the study area. To assess the potential risk of flooding associated with each alternative, each potential encroachment was identified as one of three categories:

- Longitudinal encroachments occur when the Build Alternative falls within the floodplain parallel to the stream;
- Transverse encroachments occur when the Build Alternative would cross the stream and its associated floodplain perpendicularly, or nearly so; and
- Complex encroachments are a combination of longitudinal and transverse encroachments.

Table 4-29: Floodway and Floodplain Encroachments Within the Reasonable Alternatives

Reasonable Alternative	Stream Name	Floodway within ROW (ac)	100-yr Floodplain within ROW (ac)	Type of Encroachment*	Encroachment as % of Total Floodplain within the Proposed ROW
Alternative 1 (No-Build)		**N/A**	**N/A**	**N/A**	**N/A**
2	East Fork San Jacinto River	18.31	30.24	T	2.62
	Peach Creek	11.59	39.66	T	2.77
	Luce Bayou	8.61	14.18	T	1.23
Alternative 2 Total		**38.52**	**84.08**		**6.62**
3	East Fork San Jacinto River	18.31	30.24	T	2.54
	Peach Creek	11.59	39.66	T	2.68
	Luce Bayou	8.61	14.18	T	1.19
Alternative 3 Total		**38.52**	**84.08**		**6.42**
4	East Fork San Jacinto River	18.31	30.24	T	2.83
	Peach Creek	11.59	39.66	T	2.99
	Cedar Bayou	N/A	20.43	T	1.19
	East Fork Cedar Bayou	2.52	10.99	T	0.79
	Luce Bayou	14.00	27.66	T	2.43
Alternative 4 Total		**46.42**	**128.99**		**10.22**
5	East Fork San Jacinto River	18.31	30.24	T	2.73
	Peach Creek	11.59	39.66	T	2.89
	Cedar Bayou	N/A	20.43	T	1.15
	East Fork Cedar Bayou	2.52	10.99	T	0.76
	Luce Bayou	14.00	27.66	T	2.35
Alternative 5 Total		**46.42**	**128.99**		**9.88**
6	East Fork San Jacinto River	18.31	30.24	T	2.83
	Peach Creek	11.59	39.66	T	2.99
	Cedar Bayou	22.11	94.63	T	6.80
	Luce Bayou	5.79	18.45	T	1.41

Table 4-29: Floodway and Floodplain Encroachments Within the Reasonable Alternatives

Reasonable Alternative	Stream Name	Floodway within ROW (ac)	100-yr Floodplain within ROW (ac)	Type of Encroachment*	Encroachment as % of Total Floodplain within the Proposed ROW
Alternative 6 Total		**57.80**	**182.98**		**14.03**
7	Caney Creek	9.53	30.62	T	2.09
	East Fork San Jacinto River	9.06	27.22	T	1.89
	Peach Creek	8.14	41.62	T	2.59
	Luce Bayou	8.61	14.18	T	1.18
Alternative 7 Total		**35.35**	**113.64**		**7.74**
8	Caney Creek	9.53	30.62	T	2.02
	East Fork San Jacinto River	9.06	27.22	T	1.83
	Peach Creek	8.14	41.62	T	2.50
	Luce Bayou	8.61	14.18	T	1.15
Alternative 8 Total		**35.35**	**113.64**		**7.49**
9	Caney Creek	9.53	30.62	T	2.24
	East Fork San Jacinto River	9.06	27.22	T	2.03
	Peach Creek	8.14	41.62	T	2.78
	Cedar Bayou	N/A	20.43	T	1.14
	East Fork Cedar Bayou	2.52	10.99	T	0.76
	Luce Bayou	14.00	27.66	T	2.33
Alternative 9 Total		**43.26**	**158.55**		**11.28**
10	Caney Creek	9.53	30.62	T	2.17
	East Fork San Jacinto River	9.06	27.22	T	1.96
	Peach Creek	8.14	41.62	T	2.69
	Cedar Bayou	N/A	20.43	T	1.10
	East Fork Cedar Bayou	2.52	10.99	T	0.73
	Luce Bayou	14.00	27.66	T	2.25
Alternative 10 Total		**43.26**	**158.55**		**10.90**
10R**	Caney Creek	9.53	30.62	T	2.17
	East Fork San Jacinto River	9.06	27.22	T	1.96
	Peach Creek	8.14	41.62	T	2.69
	Cedar Bayou	N/A	20.43	T	1.10
	East Fork Cedar Bayou	2.52	10.99	T	0.73
	Luce Bayou	14.00	27.66	T	2.25
Alternative 10R Total		**43.26**	**158.55**		**10.90**
11	Caney Creek	9.53	30.62	T	2.24
	East Fork San Jacinto River	9.06	27.22	T	2.02
	Peach Creek	8.14	41.62	T	2.77
	Cedar Bayou	22.11	94.63	T	6.51
	Luce Bayou	5.79	18.45	T	1.35
Alternative 11 Total		**54.64**	**212.54**		**14.89**

Notes: Acreages represent total amount in ROW and do not represent impacts. All floodways would be bridged or culverted by the selected Preferred Alternative, and further avoidance and minimization of floodplain encroachments would be considered during preliminary and final design of the selected Preferred Alternative.
*Encroachment Types: T = Transverse, C = Complex (Combination of Transverse and Longitudinal), see Section 4.12.2.1 for definitions.
** Preferred Alternative
Sources: TSARP, 2010; FEMA Digital Q3 Data, 2010

Alternatives 2 and 3 would impact the least amount of floodplains (84.08 ac), while Alternatives 7 and 8 would impact the least amount of floodways. Alternative 3 would have the lowest percent of total floodplains (6.42 percent) within the proposed ROW. Alternative 11 would impact the highest acreage amount of floodplains (212.54 ac), while Alternative 6 would impact the highest acreage amount of floodway (57.8 ac). Alternative 11 would have the highest percent of total floodplain (14.89 percent) within

the proposed ROW. The Preferred Alternative would impact 43.26 ac of floodway, 158.55 ac of 100-yr floodplain, and would have 10.90 percent of proposed ROW consisting of floodplain. The No-Build Alternative would not result in direct impacts to floodways or floodplains.

4.10.3 Natural and Beneficial Floodplain Values

Floodplains provide several natural and beneficial values. Floodplains provide floodwater detention, water quality maintenance, and groundwater recharge. Many types of aquatic and terrestrial plants and animals find their habitats on floodplains. Archeological and historical resources, as well as recreation sites, are often located on floodplains. Floodplains are often utilized for agriculture because they contain rich, fertile soil and are typically flat to gently sloping. The following discussions describe the functions and values that floodplains provide.

4.10.3.1 Flood Flow Moderation

Floodplains serve a flood detention function by temporarily storing water from a flood event. By temporarily storing floodwaters they reduce peak flows by extending flood durations. Encroachments within a floodplain tend to diminish the flood flow detention capability of a floodplain by reducing the floodwater storage volume in the floodplain, causing it to pass through the floodplain in a shorter time period. As a result of the diminished flood flow detention capability, flood peaks decrease downstream.

4.10.3.2 Water Quality

Floodplain vegetation maintains the chemical and biological integrity of water by reducing the flow velocity and allowing impurities such as sediment, to settle and be removed from the water column. Sediment and toxicant retention in floodplains can reduce the impurity concentrations in downstream watercourses. However, sediment and toxicant retention can also destroy biological communities supported on floodplains by overloading nutrients, decreasing dissolved oxygen, and increasing water temperature. When undisturbed, these water quality values exist in a state of equilibrium. Floodplain encroachments modify these values until a new equilibrium is achieved.

4.10.3.3 Groundwater Recharge

As floodplain vegetation reduces water flow velocity, more water has the ability to infiltrate and recharge the groundwater table. In addition to the surface storage of a floodplain, groundwater recharge provides sub-

surface storage which contributes to the reduction of downstream flood flows. Floodplain encroachments increase the water flow velocity, reducing groundwater infiltration/recharge rates.

Restoration and preservation of the natural and beneficial values associated with the floodplains would include a detailed hydraulic analysis and minor alignment modifications during final design and the implementation of BMPs during construction. Some of the BMPs may include:

- Vegetative fencing to restrict contractor access to sensitive areas;
- Limit construction staging to locations outside the floodplains, or minimize the size of the staging area;
- Implementation of a SWPPP to protect water quality;
- Implementation of a stormwater management plan to prohibit increases in water velocity;
- Revegetation of cleared areas within the floodplains that are needed for construction; and
- Analyze the use of other BMPs on a location-by-location basis.

4.10.4 Floodplain Avoidance and Minimization

EO 11988 seeks to avoid adverse impacts associated with the use and modification of floodplains and to avoid direct or indirect support of floodplain development. The order directs federal agencies to evaluate the potential effects of its actions on floodplains. For actions located in a regulatory floodplain, the agency is required to consider alternatives to avoid adverse effects and incompatible development.

The alternatives were designed to avoid impacts to floodplains to the maximum extent feasible and practicable. All reasonable alternatives were located to minimize encroachment on regulatory floodways and floodplains and maintain a transverse encroachment to the extent possible. Each of the alternative alignments was shifted to some degree to avoid wetlands and longitudinal encroachments. All floodways would be bridged or culverted by the Preferred Alternative, and further avoidance and minimization of floodplain encroachments would be considered during preliminary and final design of the selected Preferred Alternative.

4.10.5 Flooding Risks

Due to the flat topography in the area and the low number of natural drainage features, the floodplains associated with the watercourses in the region are typically characterized as wide and flat. These wide floodplains cover thousands of acres of mostly rural land within the Grand Parkway Segments H and I-1 study area, where the risk of flooding is generally high.

The majority of highways constructed in the Houston area are very near to at-grade facilities. Highways are typically elevated on 1-3 ft of fill to ensure no road closures from local flooding during heavy rain falls. The highways/roadways are raised on fill material and structures in order to cross over other roadways and/or streams and rivers. While the cuts/fills for the proposed highway are not determined at this time, it is likely that the construction technique would be consistent with the existing highways in the region.

An at-grade highway facility for Grand Parkway Segments H and I-1 would not result in substantial increases in flooding in the study area. Bridge structures and/or culverts would be used to allow passage of the base flood without increasing the established FEMA base flood levels.

4.10.6 Summary of Floodways and Floodplains Impacts

Avoidance of floodways and floodplains during the development of the reasonable alternatives was carefully balanced with avoidance of other sensitive resources in the study areas. All of the reasonable alternatives 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 number of water resource crossings varies from 18 (Alternative 6) to 24 (Alternatives 7 and 9). Alternatives 2 and 3 would impact the least amount of floodplains (84.08 ac), while Alternatives 7 and 8 would impact the least amount of floodways. Alternatives 2 and 3 would have the lowest percent of total floodplains (0.18 percent) of the study area. The Preferred Alternative would impact 43.26 ac of floodway, 158.55 ac of 100-yr floodplain, and would impact 0.35 percent of the floodplain within the study area. Alternative 11 would impact the highest acreage amount of floodplains (212.54 ac), while Alternative 6 would impact the highest acreage amount of floodway (57.8 ac). Alternative 11 would have the highest percent of total floodplain (0.47 percent) within the study area.

The Preferred Alternative was selected based on its ability to best meet the purpose and need of the project while minimizing impacts to the natural, physical, and social environment. The hydraulic design for this project would be in accordance with current FHWA and TxDOT design policies. The facility would permit the conveyance of the 100-year flood, inundation of the roadway being acceptable, without causing significant damage to the facility, stream, or other property. The proposed project would not increase the base flood elevation to a level that would violate applicable floodplain regulations and ordinances.

Further avoidance and minimization of floodplain encroachments would be considered during preliminary and final design of the 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 would 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 result in floodway or floodplain impacts.

Indirect Impacts

Based on the expert panel survey estimates of potential developed areas, the potential indirect impacts to floodplains are approximately 2,006 ac under the Preferred Alternative. Indirect impacts to floodplains would be considered minor because the areas located within the 100-year floodplain are subject to local regulations and would pose a challenge for development. Refer to **Chapter 5** for a detailed indirect impacts analysis.

4.11 WILD AND SCENIC RIVERS

Neither the Preferred Alternative nor the No-Build Alternative would result in impacts to wild and scenic rivers in association with the construction or operation of the proposed project. The proposed project is not located near any river segment listed on the Nationwide Rivers Inventory (NRI) or identified as a National Wild and Scenic River (National Wild and Scenic Rivers System, 2007; NPS, 2007).

Indirect Impacts

There would be no potential indirect impacts to wild or scenic rivers under the Preferred Alternative or the No-Build Alternative.

4.12 COASTAL BARRIERS

Neither the Preferred Alternative nor the No-Build Alternative would result in impacts to coastal barriers in association with the construction or operation of the proposed project. The proposed project is located outside any coastal barrier systems and would not have any impacts to coastal barrier resources.

Indirect Impacts

There would be no potential indirect impacts to coastal barriers under the Preferred Alternative or the No-Build Alternative.

4.13 COASTAL ZONE MANAGEMENT

The southern limit of the proposed project abuts the Coastal Management Zone (CMZ) boundary; however, the Preferred Alternative would occur outside of the CMZ area. Coordination with the Coastal Coordination Council under the Texas Coastal Management Program is not required. The No-Build Alternative would not result in coastal zone management impacts.

Indirect Impacts

There would be no potential indirect impacts to coastal zone management under the Preferred Alternative or the No-Build Alternative.

4.14 ESSENTIAL FISH HABITAT

The Grand Parkway Segments H and I-1 study area contains Cedar Bayou which is mapped as a tidally influenced water north of I-10 (E) by the National Oceanic and Atmospheric Administration National Marine Fisheries Service (NOAA Fisheries). Cedar Bayou is mapped as tidally influenced up to 1.4 mi on the north side of I-10 (E) west of Mont Belvieu and could potentially contain essential fish habitat (EFH). None of the reasonable alternatives or the Preferred Alternative intersect Cedar Bayou in the tidally influenced area. NOAA Fisheries also has mapped the East Fork San Jacinto River to approximately 3 mi upstream of Lake Houston as containing EFH. None of the reasonable alternatives or the Preferred Alternative intersect the area of the East Fork San Jacinto River. Therefore, no impacts to EFH are anticipated under either the Preferred Alternative or the No-Build Alternative.

Indirect Impacts

There would be no potential indirect impacts to EFH under the Preferred Alternative or the No-Build Alternative.

4.15 CULTURAL RESOURCES

4.15.1 Archeological Resources

Known site locations were researched using the THC's online Texas Archeological Sites Atlas.

As a result of the official archeological records review, no previously recorded sites were identified within the Grand Parkway Segments H and I-1 reasonable alternatives or Preferred Alternative ROWs. For more details refer to **Appendix N**. The archeological survey report was reviewed and coordinated with the State Historic Preservation Officer (SHPO) and the Texas Historical Commission (THC). The coordination was

submitted on August 19, 2013 and THC concurred with the findings and recommendations as shown in **Appendix N**. TxDOT further asked for THC's concurrence to allow the remainder of the survey to be deferred and to allow the NEPA process to continue and for property acquisition to proceed. TxDOT will be obligated to complete the survey and coordinate the results with THC once the remainder of the proposed ROW has been acquired

Section 106 consultation with federally recognized Native American tribes with a demonstrated historic interest in the area was initiated on February 22, 2008. The tribal consultation comment period ended on July 26, 2013 without any expressions of concern.

High Probability Areas (HPA) were identified for areas that may contain archeological resources based on the assumptions set forth in the Houston District- PALM and the review of historical literature. The Houston District-PALM was consulted to determine the potential presence of archeological sites; however, the Houston District-PALM has a limited reach within the study area. The Houston District-PALM only applies to the portions of the study area that are within Harris and Montgomery counties (**Exhibit 3-14**). While the Houston District-PALM has been shown to illustrate the potential for prehistoric sites in the area, it is not intended to predict the location of historical archeological sites.

Following the identification of a Preferred Alternative, an archeological field survey was initiated to examine HPAs along the alternative in compliance with Section 106 regulations, 36 CFR 8001.14 of the NHPA. The APE was defined as the required ROW for the Preferred Alternative. Archeological fieldwork was conducted by qualified archeologists between June 21 and July 3rd 2012. Only one previously unknown site (41MQ300) was found and its significance was evaluated by the project archeologist, under the supervision of TxDOT Environmental Affairs Division (ENV) archeologists. During the duration of the project the Texas Archeological Sites Atlas, maintained by the THC, was accessed at various times to identify previously recorded archeological sites and historic properties, and previous archeological work in the vicinity of the APE.

Site 41MQ300, located during the survey of a previous alignment of Segment H, is located within the APE and is a low-density, prehistoric scatter representing a short-term occupation by an unidentified cultural group, with a small historic mid-to-late 20th century component consisting of a single metal wire fragment. The site has limited research potential and is not considered potentially eligible for listing on the NRHP

under Criterion D. Criteria A, B, and C do not apply. No further archeological work is recommended for the site.

Over 56 percent of the APE was not tested. This included parcels where RODS Surveying did not contact the owner, and the area of the alignment shift at FM 1960. These areas will need to be examined by a qualified archaeologist once right of entry has been secured. Additionally, 11 percent of the APE has previously been tested. These previous surveys did not locate any cultural resources within the current APE. The remaining 33 percent of the APE was examined for cultural resources. One previously unknown archaeological site was discovered. No further archaeological work is recommended for the 33 percent that was tested.

The project will be coordinated according to the First Amended Programmatic Agreement among the FHWA, TxDOT, the THC, and the Advisory Council on Historic Preservation (ACHP) regarding the implementation of Transportation Undertakings (PA-TU) and Memorandum of Understanding between TxDOT and the THC (MOU) (13 TAC 26.14(e)(1) and 43 TAC 2.24(e)(1)) to ensure that any archeological materials associated with the construction of the project would be properly evaluated, including any accidental discovery situations that arise following the archeological field survey. If archeological materials or human remains are identified within the ROW during construction, or a department-designated material source, all construction and related activities must cease. The find is to be reported to the TxDOT project inspector or the area engineer in accordance with TxDOT's Emergency Discovery Guidelines. If archeological materials or human remains are introduced into the ROW or easements in materials obtained from a material source under option to the contractor, all use of materials from the source must cease and the find reported to TxDOT project inspector or the area engineer in accordance with TxDOT's Emergency Discovery Guidelines. The No-Build Alternative would not result in archeological resources impacts associated with the construction or operation of the proposed project.

<u>Indirect Impacts</u>

Land use changes have the potential to impact archeological resources through site clearing, grading, or excavation during development. Within the AOI, numerous archeological sites may exist, especially within undeveloped areas adjacent to creeks. Indirect impacts to archeological sites could result from the Preferred Alternative; however, it cannot be determined whether construction would result in substantial

impacts to these sites because the quantity, location, and integrity of individual resources are unknown. Refer to **Chapter 5** for a detailed indirect impacts analysis.

4.15.2 Non-Archeological Historic Resources

Overview and Methodology

A Non-Archeological Historic-Age Resources Survey Report (HRSR) was completed for the proposed project. The report is on file at both TxDOT Houston District and TxDOT ENV offices and included in its entirety in **Appendix F**. The survey included all historic-age resources located on parcels wholly or partially within the APE for the proposed project in Montgomery, Chambers, Liberty and Harris Counties, Texas. An Area of Potential Effects (APE) of 300 feet from the existing or proposed ROW was used. A cut-off date of 2016 was used to determine historic-age for all resources. The HRSR was reviewed and coordinated with the State Historic Preservation Officer (SHPO) and the Texas Historical Commission (THC). The coordination was submitted on June 25, 2013, and THC concurred with the findings and recommendations as shown in **Appendix F**.

There are a total of four previously determined or recommended NRHP Eligible resources within the project APE and are depicted on **Exhibit 4-7**. Two of these resources were previously determined NRHP eligible. Both resources are components of the Dayton Canal rice irrigation system. **Resource 039a** is the Big Ditch drainage ditch and **Resource 039b** is the Main Canal. These resources were evaluated in the HRSR as to whether or not they are contributing to the overall canal system. Both resources are recommended **Contributing** to the eligible Dayton Canal system. Two additional historic-age resources were identified within the APE and recommended NRHP **Eligible** in the HRSR. **Resources 030a and 030b** are a house and garage in the Craftsman Bungalow style located at 2669 FM 1485 in Harris County.

4.15.3 Results of Field Survey

As a result of the field survey conducted for the HRSR, a total of 50 historic-age resources were identified within the APE. **Table 4-30** lists these resources by county and property type.

Table 4-30: Historic Age Resources in APE

County	Property Type	Number of Resources
Montgomery	Residential	31
	Commercial	2
	Funerary	1
	Religious	1
Harris	Residential	2
	Transportation	1
Liberty	Residential	7
	Agricultural	2
	Industrial	1
Chambers	Transportation	1
	Industrial	1*
Total		**50**

CWA Cedar Point Lateral (Resource 039b-1, 2, 3 and 4 is located within the APE at four locations in Chambers County but is listed as one resource in the above table.

The HRSR recommends two properties, each with two resources, NRHP eligible. TxDOT ENV will make the final determinations of eligibility and effects and will coordinate with State Historic Preservation Office (SHPO). Detailed NRHP evaluations for each of the historic-age resources recommended not eligible for the NRHP are also contained in the HRSR.

Resource 038a – Dayton Canal Big Ditch

Resource 038a is a portion of the Dayton Canal system known as the Big Ditch. The Dayton Canal is a linear rice irrigation system that is an agricultural resource, originally constructed in 1910 and expanded in 1935. The Big Ditch extends east-west along the north side of FM 1413 in Liberty County. The extent of the Big Ditch within the Dayton Canal system is illustrated in the HRSR. A portion of the Big Ditch was evaluated in the 2006 intensive survey of the Dayton Canal system and determined NRHP eligible as described in the HRSR. Within the APE the proposed project crosses the Big Ditch at one location east of the intersection of FM 1413 and County Road 491. Photographs of this resource are included in the HRSR. The Big Ditch drain of the Dayton Canal system was determined to be historically significant at the local level under **Criterion A: Agriculture** with periods of significance being 1910-1927 and 1935 -1962. At the direction of TxDOT ENV, through the approved Research Design, the HRSR evaluated the eligible component of the canal system (the Big Ditch) within the proposed project's APE to determine if it contributed to the overall eligibility of the canal system.

Resource 038a is an earthen-lined drainage ditch component of the Dayton Canal system. Its historic function when used for agriculture was two-fold as it served both as a lateral and as a drain. At certain

periods during the rice crop growing cycle, the fields were flooded to submerge the young rice plants. Later the water was drained to allow the rice crop to dry sufficiently for harvesting. In this way, the Big Ditch served to bring water to the fields and also drain water off of the fields when needed. At certain times of the year the ditch was also used to store water when needed.

The Dayton Canal system has been defunct since 2001 and ceased operation in connection with rice farming when rice prices fell and the agricultural focus in this area of the coastal plain shifted to livestock grazing and sod production. Although portions of the canal system continue to be used for other agricultural purposes, it is unknown whether the portion of the Big Ditch within the APE and SSA is still in irrigation use as much of it contained no water, was overgrown with foliage, and strewn with debris including old tires and trash. No ancillary features such as pump houses, pipeline, and standpipes associated with the Big Ditch were observed within the APE or SSA during the field survey.

Based on field observation and map research, **Resource 038a,** the Big Ditch, retains basic integrity of location, design, materials and workmanship. It retains the appearance of, and is recognizable as, an irrigation drainage ditch capable of retaining water. It has not undergone changes to its historic alignment. It retains the form, plan and spatial organization typical of a drainage ditch in a rice canal design. The resource has lost some integrity of association and feeling because it is no longer actively used for its historic function of rice production. However, it may still provide an irrigation function for other agricultural purposes. The fields adjoining the ditch remain open and agricultural and the resource retains integrity of setting and feeling. In addition to field observation, map research was conducted for the integrity evaluation of **Resource 038a**. Current and historic aerial, topographic, highway and county maps were accessed and indicate that the design, materials and workmanship of **Resource 038a** has remained essentially the same through the present. Map research also illustrates that land use within the APE has remained essentially unchanged from its historic use for agricultural purposes. Because the portion of the Big Ditch within the APE retains most aspects of integrity **Resource 038a** is recommended as **Contributing** to the eligible Dayton Canal system as a whole.

<u>Resource 038b– Dayton Main Canal</u>

Resource 038b is the Main Canal of the Dayton Canal linear rice irrigation system. It is an agricultural resource originally constructed in 1910, expanded in 1935, and previously determined NRHP Eligible by SHPO in 2006 as documented in the HRSR. The Dayton Main Canal was determined to be historically

significant at the local level under **Criterion A: Agriculture** with periods of significance being 1910-1927 and 1935 -1962. Within the APE, the proposed project crosses the Main Canal at one location. At the direction of TxDOT ENV, through the approved Research Design, the Dayton Main Canal was evaluated to determine if it contributes to the overall eligibility of the canal system.

The portion of the Main Canal within the APE is earthen lined and runs diagonally, northwest to southeast, just south of US 90 in Liberty County. The Main Canal crosses the proposed alignment once on agricultural land. Photography of the resource within the APE was not possible during the field survey due to lack of access to the location where the Preferred Alternative would cross the canal and limited access via existing public roads. The closest public access to the portion of the Main Canal within the APE is at CR 491 (Cox Road). The location of the APE is located approximately 1 mile southeast of US 90 and approximately 1.25 miles northeast of CR 491 (Cox Road) in Liberty County. Photographs related to this resource are available in the HRSR. The HRSR illustrates the entire location of the Main Canal within the Dayton Canal system.

The Dayton Canal system has been defunct since 2001 and ceased operation in connection with rice farming when rice prices fell and the agricultural focus in this area of the coastal plain shifted to livestock grazing and sod production. Portions of the Dayton Canal continue to be used for these other agricultural purposes. It is unknown whether the portion of the Main Canal within the APE and SSA is still in use as photography of the area was not possible and aerial photography was not conclusive as to whether the canal is currently carrying water. No ancillary canal features, such as pump houses, pipeline, and standpipes, associated with the Main Canal were observed during the field survey. However, topographic maps indicate that pump stations were present at various locations throughout the canal system and various types of gates were observed in the vicinity of the APE during the field survey as shown in the HRSR.

A combination of map research and field observation was completed to make a recommendation regarding the integrity of the **Resource 038b**. The Main Canal retains basic integrity of location, design, materials and workmanship. Aerial photography indicates that the portion of the canal within the APE retains the appearance of, and is recognizable as, an irrigation drainage ditch capable of retaining water. Topographic and historic highway maps confirm that the location and design of the Main Canal remains intact and has not undergone changes to its historic alignment and retains the form, plan and spatial organization typical

of a drainage ditch in a rice canal design. The resource has lost some integrity of association because it is no longer actively used for rice production, however, it may still provide an irrigation function for other agricultural purposes. The fields adjoining the ditch remain open, agricultural land and the resource retains integrity of setting and feeling. Because the portion of the Main Canal within the APE retains these aspects of integrity **Resource 038b** is recommended as **Contributing** to the eligible Dayton Canal system as a whole.

Resources 031a and 031b - 2669 FM 1485

This residential resource is a one-story Craftsman style bungalow and garage dating to 1943 located in rural Harris County. The house, **Resource 031a**, is constructed of rusticated concrete block with a cross-gable composition shingle roof, exposed rafter ends and projecting front room. A partial width porch wraps around two sides and has battered columns and rusticated concrete block piers, a shed roof and concrete floor. There are louvered gable vents on the front façade, original 1/1 wooden double hung windows and a one-light front door. There are no visible alterations to the resource. **Resource 031b** is a one-vehicle garage constructed with similar rusticated concrete block and a front facing composition shingle roof. The original garage doors have been replaced. The house and garage are set on a large wooded lot facing FM 1485. Although FM 1485 was first designated in 1949, the alignment existed historically throughout the early 20th century and appears as East River Road on historic maps. This alignment likely also existed during the 19th century because Casey Family Cemetery, dating to the 1870s, is located along this route to the west.

Resources 031a and 031b exhibit distinctive stylistic characteristics and original construction details not typically seen in this part of the project area. These resources exhibit integrity of location, design, setting, materials, workmanship, feeling, and association. The specific craftsman details of the house are basically unaltered. The house and garage are good and unusual examples of the use of concrete cladding materials rather than wood on a rural bungalow in the area of Harris County in which they are located. **Resource 031a** is recommended **Eligible** for the NRHP under Criteria C for Architecture at the local level of significance. **Resource 031b** is recommended **Contributing** to the recommended eligible residence.

4.15.3.1 No-Build Alternative

Effects to historic resources in the study area would not occur with the No-Build Alternative. The table below describes the four resources within the APE that are either already determined NRHP eligible or

have been recommended NRHP eligible in the HRSR. Pending eligibility determinations from TxDOT ENV and additional design information, **Table 4-31** lists the anticipated effects to each resource.

Table 4-31: Effects to Non-Archeological Historic-Age Resources

Resource #	Name	NRHP Eligibility Status	Anticipated Effect
031a	Residence at 2669 FM 1485	Recommended Eligible	No direct effect. Possible indirect effects
031b	Garage at 2669 FM 1485	Recommended Contributing to Recommended Eligible house	No direct effect. Possible indirect effects
038a	Dayton Canal Big Ditch	Recommended Contributing to Determined Eligible Resource	No Adverse Effect
038b	Dayton Canal Main Canal	Recommended Contributing to Determined Eligible Resource	No Adverse Effect

Source: Study Team, 2013

Resources 031a and 031b – Residence and Garage at 2669 FM 1485

Resource 031a and 031b are located on the south side of FM 1485, outside of the proposed ROW but within the APE. Because the proposed project would take no property from the parcel on which these resources are located, it is anticipated that there would be no direct effect to these resources. According to preliminary design plans, these resources would be separated by existing FM 1485. FM 1485 would become a frontage road as part of the proposed project and remain at the same grade as Resources 031a and 031b. The orientation of the resources to the roadway would also remain the same.

Resource 038a and 038b – Dayton Canal Big Ditch and Main Canal

Resource 038a and 038b are two components of the previously determined NRHP eligible Dayton Canal rice irrigation system. Although the canal system consists of miles of linear canal, the APE of the proposed project crosses each feature one time. Because the proposed project would take no property from the parcel on which these resources are located, it is anticipated that there would be no direct effect to these resources. According to current design plans, these resources would be spanned by pilings or bents that are separated from the resources by a twenty foot buffer. No components of the proposed project would physically impact the resources and their historic function, the ability to carry water, would be maintained.

Conclusion

Pursuant to Stipulation VI "Undertakings with the Potential to Cause Effect" of the PA-TU among the FHWA, SHPO, the ACHP, and the TxDOT MOU, TxDOT ENV historians will determine NRHP eligibility for the historic-age resources identified in the HRSR. TxDOT is committed to avoiding impacts to historic-age resources determined eligible. Because the design is preliminary and detailed design plans are not yet

available, it is not currently possible to evaluate effects to historic-age resources. Further information concerning the avoidance of direct and indirect impacts to NRHP eligible resources will be addressed further along in the project development process. TxDOT ENV will determine if the proposed project would have no adverse effect to any historic-age resources. Because this project is a major federal action requiring the preparation of an EIS, individual project coordination with SHPO is anticipated.

4.16 HAZARDOUS MATERIALS

Construction of the Preferred Alternative would have a low potential for exacerbating the hazardous material impacts on the environment. Impacts associated with hazardous materials would most likely occur during construction and would be related to activities on or near existing hazardous material sites. These hazardous material sites either have already impacted and/or have the potential to impact the existing environment. Regulated sites also create the potential of contaminating sites adjacent to them, creating a risk for the acquisition of those properties. Prior to ROW negotiation and/or acquisition, an American Society for Testing and Materials (ASTM) Phase I Environmental Site Assessment (ESA) would need to be conducted for the Preferred Alternative. A Phase II ESA may also be necessary depending on the findings of the Phase I ESA. The Phase II ESA would provide additional testing and sampling of all potential hazardous sites and would include a remediation plan, if warranted.

The relocation and/or removal of all existing structures along the Preferred Alternative would require asbestos and lead-based paint surveys to be completed for these structures. Asbestos and lead paint inspections, specifications, notification, license, accreditation, abatement and disposal, as applicable, would comply with federal and state regulations. Asbestos and lead-based paint issues would be addressed during the ROW acquisition process prior to construction.

4.16.1 Regulated Hazardous Materials Sites

All 18 sites associated with the regulatory database search **(Appendix G: Hazardous Materials Database Search 2012)** within the preferred alignment were reviewed for potential impacts. Appropriate search distances, as shown in **Table 4-32**, were determined for the Preferred Alternative.

Table 4-32: Search Distances for Regulated Sites

Federal/State Databases	Search Distance from Project Limits
National Priority List (NPL)	1.6 kilometer (km) (1.0 mi)
Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS)	0.8 km (0.5 mi)
Resource Conservation and Recovery Act – Treatment Storage and Disposal Facilities (RCRA TSDF)	1.6 km (1.0 mi)
National response Center (NRC)	Project Limits
Emergency Spill Response Notification System (ERNS)	Project Limits
Resource Conservation and Recovery Act - Generators (RCRA Gen)	Project Limits (each alternative or adjacent to ROW)
TEXAS SUPERFUND	1.6 km (1.0 mi)
Leaking Petroleum Storage Tank (LPST)	0.8 km (0.5 mi)
Municipal Solid Waste Landfill (MSWLF)	0.8 km (0.5 mi)
LANDFILLS	0.8 km (0.5 mi)
Registered Petroleum Storage Tanks (RPST)	Project Limits

Source: Study Team, 2012

Of the 18 regulated hazardous material sites identified within the ASTM search distance, there are only nine sites located within or adjacent to the proposed ROW of the Preferred Alternative that could impact the proposed improvements. TCEQ, Railroad Commission of Texas (RRC), and the identified regulated facilities were contacted to gather any additional information pertinent to the project. **Table 4-33** lists the sites and **Exhibit 4-8** shows the location of each site.

Table 4-33: Regulated Hazardous Materials Sites

Align Site #	Company	Address	City	Database
1	Roadway Food Mart	26153 FM 1485	New Caney	Underground storage tank (UST)
2	Big ES 4 (Coleman's Food Store)	25982 FM 1485	New Caney	UST
3	Peach Creek Grocery	26662 FM 1485	New Caney	UST
4	No Name Facility	27000 BLK FM 1485	New Caney	LPST
5	Casey Ridge Grocery	27630 FM 1485	Montgomery	UST
6	Linda Carter	2000 blk of FM 1485, north side	Harris	Closed Landfill Inventory (CLI)
7	Placid Refining	12927 FM 146 North	Mont Belvieu	RCRA/Voluntary Cleanup Program (VCP)
8	Targa Corporation (Mont Belvieu Fractionator)	10119 Hwy 146 North	Mont Belvieu	CERCLIS/RCRA Non-Gen
9	ABC Nitrogen Service Corporation	11425 I-10 East	Baytown	Tier 2

Source: EDR, 2012

Preferred Alternative Map ID No. 1, Roadway Food Mart: This site is registered as an underground storage tank (UST) and is a convenience store that sells groceries and gasoline. There are two 6,000-gallon USTs located on the property. One of the storage tanks holds gasoline, the other tank holds diesel, and both tanks were installed on October 15, 2008. The facility appears to be maintained on a regular basis. No violations or issues were documented for the location.

Preferred Alternative Map ID No. 2, Big ES 4 (formerly Coleman's Food Store): This site at one time had four regulated facilities; however, three of the gasoline storage tanks were removed from the property including two 1,000-gallon storage tanks and one 8,000-gallon storage tank. Currently, the site has one 15,000-gallon gasoline UST that was installed March 22, 1999. The facility operates as a convenience store that sells groceries and gasoline and appears to be maintained on a regular basis. No violations or issues were documented for the location.

Preferred Alternative Map ID No. 3, Peach Creek Grocery: This site was registered as an UST facility and is a convenience store that sells groceries. There were four gasoline USTs that were removed including three 6,000-gallon tanks and one 8,000-gallon tank. The location continues to operate as a store. There are no existing violations or issues documented for the location.

Preferred Alternative Map ID No. 4, No Name Facility: This location is not a facility, but a site of confirmed gasoline contamination on June 2, 2008 with no responsible party recorded. Groundwater was deemed to be affected, and there was concern due to a domestic water supply well within 0.25 mi. No further action has been taken, and no additional information is currently available.

Preferred Alternative Map ID No. 5, Casey Ridge Grocery: This site is registered as an UST and is a convenience store that that sells groceries and gasoline. The site has three gasoline USTs located on the property including a 10,000-gallon storage tank, a 6,000-gallon storage tank, and an 8,000-gallon storage tank. All of the gasoline storage tanks were installed on January 1, 1984. The facility appears to be maintained on a regular basis. No documented violations or issues were identified for the location. There was a gasoline fuel release confirmed on April 2008, with enforcement and remediation completed in 2008. The facility has no current violations or actions pending.

Preferred Alternative Map ID No. 6, Linda Carter: This facility was an unpermitted local dump that has been officially closed. The dump had no permits while it was operated. There are currently no remediation

action or enforcement orders on the site. A windshield survey conducted on July 18, 2007 revealed no visible evidence of a dump near the proposed location. Also property records were reviewed in the area and Linda Carter was not identified as a property owner in the area.

Preferred Alternative Map ID No. 7, Placid Refining: This site was listed in the Voluntary Cleanup Program (VCP) on July 27, 1998, but was withdrawn from the program in 1999. The site was not listed on any of the additional databases that were searched. The site has an EPA number (TXD076727528); however, little information is provided for the site. In reviewing the updated hazardous waste report, including project notes documenting previous contact with TCEQ, hydrocarbons were identified as the main contamination impacting the soil and groundwater.

In addition to the original investigation, a visit was made to the TCEQ's regional office in Houston Texas and TCEQ's headquarters office in Austin Texas. Documentation obtained from TCEQ files for Placid Refinery indicated that the plant was shut down in 1986-87 and a closure report was submitted in 1988. Over the next several years the site was sold several times. In 1999 a letter from Zaring Materials, L.C. appears to have been interested in the purchase of the property and with the intention of placing it in the Voluntary Cleanup Program (VCP). Ultimately, however, Zaring Martials, L.C. contacted TCEQ and stated that the Phase I information originally provided to the TCEQ (formerly the Texas Natural Resource Conservation Commission) was incorrect and that the onsite pond had been used for wastewater impoundment and contained benzene. Zanring also stated that the stated levels of soil contamination were incorrect and that they had decided not to purchase the property. The only additional documentation found was a letter dated February 28, 2000 from TCEQ addressed to a Vice President of Placid Refining Company, approving the closure and that the cleanup of the site had attained Risk Reduction Standard No.1 and had been released from deed recordation and post-closure requirements.

Files reviewed at the TCEQ Headquarters in Austin indicated that the site had a VCP #0811 and Solid Waste Registration #32206. There were no additional documents found that would either confirm or deny the status of the site other than the closure letter. Additional studies at the site are recommended prior to possible acquisition or construction activities.

Preferred Alternative Map ID No. 8, Targa Midstream Services LLC (Targa): This company operates a natural gas liquids (NGL) fractionator plant in Mont Belvieu, Chambers County, Texas (Mont Belvieu Plant).

The site is designed to fractionate NGLs into specification NGL components (ethane, propane, iso-butane, normal-butane and natural gasoline). A portion of the natural gasoline produced is further processed to remove contained sulfur compounds and to saturate contained benzene. In addition to the fractionation system, gas hydrating units and hydrotreating systems, other sources of air emissions include flares (process and back-up), fugitives and utility systems (boilers for steam production, fire water pumps, and emergency generator pumps).

Targa is proposing to construct a new fractionation train at the facility, which will be operated independent of existing operations at the facility. The facility has operated under several different names and has been acquired by various groups over its recent history. Enterprise Products and NGC Corporation both owned the facility prior to Targa. The site is registered as a Resource Conservation and Recovery Act – Large Quantity Generator (RCRA–LQG) and is listed on the Facility Index System (FINDS) database. There is one violation of the Texas Solid Waste Rule reported; information on compliance was not reported. Currently, there are no enforcement actions pending on the facility.

Preferred Alternative Map ID No. 9, ABC Nitrogen Service: This company provides oil field, industrial and inland marine markets with supplies for oil and well pumping. Nitrogen gas is one of the products used throughout the oil and gas industry. As a naturally occurring gas, it can be used for many different uses as it is inert, non-reactive, non-toxic and non-corrosive. There is no known contamination at the facility and no violations are documented within the databases searched for the facility.

Of the nine hazardous materials sites that have the potential of being impacted by the reasonable alternatives or the Preferred Alternative, eight would be directly affected while the remaining sites are located adjacent to or in close proximity of the proposed ROW alternatives. Further investigations of the sites are recommended prior to ROW acquisition.

4.16.2 Other Sites of Concern

Databases for sites and facilities located in or adjacent to the Preferred Alternative that were within a quarter mile to just over half of a mile and that were found on the federal or state regulatory databases were researched. Nine (9) sites of potential concern that are adjacent to the Preferred Alternative are described below. Although there are other facilities within a mile of the Preferred Alternative, these other facilities have been determined to have no potential to affect the Preferred Alternative.

- Tri-Star Productions, ID No. 10 (22 Dogwood, New Caney, TX 77357)

  Tri-Star Protector Service provides thread protectors, recovery, and recycling services to the oilfield tubular industry. Tri-Star services a large segment of the oilfield tubular industry. The market includes oil and gas exploration companies, pipe supply companies, drilling contractors, and various other oilfield customers. The facility is a large quantity generator (RCRA Gen-LQG) due to use of ignitable hazardous materials and wastes. No violations were found at the facility.

- Tisdale Company Inc., ID No. 11 (25000 FM 1485, Conroe, TX 77306)

  The facility designs and builds custom heating, ventilation, and air conditioning (HVAC) and refrigerator systems. The EDR report identified the site as a small-quantity waste generator in 1989. However, by 2001, the RCRA database indicates that it was identified as non-generator of waste. The site is currently listed as a non-generator of hazardous waste on the RCRA database. The facility does have a waste stream of the typical chemicals and solvents that are used by the cooling and heating industry.

- Targa Midstream Services, ID No. 12 (10119 Highway 146, Mont Belvieu, TX 77580)

  Targa Midstream Services is an industrial chemical manufacturing facility which does not show a waste stream or a generator status. Records show the facility to have a 12,000 gallon UST for diesel fuel.

- Mont Belvieu Storage Facility, ID No. 13 (10902 Fitzgerald Rd, Mont Belvieu, TX 77580)

  The facility is owned and operated by Conoco Oil Company, and at one time had one 3,000 gallon UST. The tank was cited as being removed on the UST database in August 1991. The Leaking Petroleum Storage Tank (LPST) database reported the soil contamination in October 1991. Soil contamination was reported from the spill but no remediation was required, and the case was closed by TCEQ in 1992.

- Hi-Fi North Dayton Containment, ID No. 14 (FM 1960 Texaco Rd, Dayton, TX 77535)

  The site is part of Hunter Industrial Facilities and is registered as a RCRA-SQG. The site is also listed on the aboveground storage tank (AST), FINDS, and CORRACTS databases. A windshield survey was conducted to locate the facility; however, the facility was unable to be located during the field investigation. There was one reported violation of the Texas Administrative Code 335.6 and compliance was reported to have been achieved in May 2005 per the EPA database. In a letter dated August 5, 1994 from the Texas Natural Resource Conservation Commission (TCEQ), the facility was identified as a proposed waste treatment facility that would use the North Dayton Salt Dome for storage of hazardous waste. Additional efforts made to contact the company were unsuccessful. The Texas RRC was contacted on July 9, 2007, and they indicated that they were unaware of any problems associated with the site. No other violations or

issues were documented for the location. In addition to the original investigation a visit to TCEQ's regional office in Houston Texas was conducted and their records reviewed. It appeared from those records that the facility was never built. Due to the inability to locate the property, care should be taken during the ROW acquisition, and property records should be searched to further investigate the site.

- KTRH Radio Transmitter Site, ID No. 15 (740 County Road 491, Dayton, TX 77535)

  KTRH 740 AM is a radio station in the Houston metropolitan area owned by Clear Channel Communications. The site consists of a field transmitter for the radio station and a 6,000 gallon diesel fuel UST. FEMA is named as owners of the registered UST tanks. No violations have been reported for the facility.

- Cox Road Dump Site, ID No. 16 (1 MI N of FM 1413 on Cox Road, Houston, TX 77052)

  The Cox Road Dump site is an 83-ac landfill that was operated by the Joiner Oil Company from 1969 to 1983. The site is now owned by the Joiner Liquidation Trust. The Cox Road Dump site was designated as a state Superfund site on the TCEQ web site March 17, 2006. The Cox Road Dump (also known as Liberty Waste Disposal Landfill) is located one mile north of FM 1413 on the west side of County Road 491 (Cox Road), Dayton, Liberty County, Texas. The site was evaluated by TCEQ in August 2004 using the Hazard Ranking System (HRS); the principle screening guide used by TCEQ, and was given the ranking of 13.14. A ranking of 28.50 or greater is required before a site can be eligible for the NPL (Superfund Program). On February 10, 2006, a legal notice was published in the Texas Register (31 Tex Reg 907-908) proposing the site for listing on the state Superfund registry. The site falls within the TCEQ Region, Houston-12. It is unknown at this time the extent of contamination or migration of waste into groundwater and the surrounding areas.

  Reviews of aerial photography and a windshield survey were conducted to determine the location of the Cox Road Dump site for the purposes of avoidance during the development of preliminary corridors. A buffer of one-mile was set around the Cox Road Dump site to reduce the possibility of project corridors impacting potential contaminated areas associated with the site. The size of the buffer was determined by the search criteria set by TxDOT for a state Superfund site as noted in TxDOT's Hazardous Materials in Project Development Guidance Document.

  On April 17, 2006, TCEQ was notified by the Cox Road Group (a group of potentially responsible parties associated with Cox Road Dump site) of their intent to conduct a remedial investigation under the Texas VCP. On August 25, 2006, a legal notice was published in the Texas Register (31 Tex Reg 7021), officially deleting the site from the state Superfund registry. The site was accepted into the Voluntary Cleanup

Program. A web site (http://www.coxroadlandfill.com/status.htm) provides information about the site. It states that in 2010 the Response Action Plan (RAP) had been reviewed and approved by the TCEQ. It also provided that quarterly groundwater sampling and site maintenance activities are ongoing.

- City of Dayton Landfill at North Church Street Site, D No. 17 (on FM 1413 approximately 1.6 mile SE OF US Highway 90 .6 mile N of FM 1413 W of Cox Rd, Dayton, TX)

  According to the TCEQ database, the landfill has been closed and there is minimal data and information regarding the facility. The site was closed in 1911 as shown in TCEQ database. No additional information was identified.

- City of Dayton Landfill, ID No. 18 east end of Luke Street, Dayton, TX

  The TCEQ database shows that the landfill has been closed and there was no additional information regarding the facility. According to TCEQ, the site was closed in 1977.

4.16.3 Oil/Gas Well and Pipeline Sites

Based on the RRC GIS data, there are approximately 6,664 oil and gas well sites located within the original study area boundary. There were 11 wells identified within or adjacent to the Preferred Alternative. A summary of these oil and gas wells is provided in **Table 4-34** and their locations are shown in **Exhibit 4-8.**

Table 4-34: Oil and Gas Wells Within and Adjacent to Preferred Alternative ROW

Map ID	Well Status	Well Type	Well ID No.	API NUM
1	N/A	Dry Hole	156657	42291
2	Plug	Plugged Gas Well	154964	4207131774
3	Plug	Plugged Gas Well	156661	42291
4	N/A	Permitted Location	157237	42291
5	Historic	Dry Hole	300875	4229103867
6	N/A	Canceled Location	300877	42291
7	N/A	Plugged Oil Well	300879	42291
8	Plug	Plugged Oil Well	300880	42291
9	N/A	Canceled Location	300886	42291
10	N/A	Canceled Location	300887	42291
11	N/A	Canceled Location	300888	42291

Source: RRC, 2006

Of the 11 well sites listed, there were two dry holes, four canceled locations, four plugged wells, and one permitted location. The one injection well is associated with the ONOEK brine pit (ONEOK - East of SH 147 at the end of Fitzgerald Road is outside of the Preferred Alternative footprint). Oil and gas wells

located within the Preferred Alternative would be required to be plugged. Requirements for the proper procedures in plugging these types of wells are provided in the TAC, Title 16, Part I, Chapter 3, Section 3.14 under the jurisdiction of the RRC. Additional investigation is warranted at any of these sites prior to property acquisition.

Naturally Occurring Radioactive Material (NORM) can be brought to the ground's surface in the formation of water and accumulate during oil and gas production. NORM levels from the water are typically low and are not a problem in Texas unless accumulation occurs. The accumulation of NORM could pose health risks to exposed workers if digested or inhaled. Health effects from potential impacts should not be an issue if wells are plugged and abandoned properly.

4.16.4 Petroleum Pipelines

There are approximately 88 petroleum pipelines that cross one or more of the reasonable alternatives. The Preferred Alternative crosses 64 pipelines. These petroleum pipelines range in size from 2.38 inches to 40 inches in diameter. The petroleum pipelines do not appear to have a positive or negative impact within the study area. During ROW acquisition, additional investigation would be required to determine if removal or adjustments to the pipelines would be necessary. A summary of the petroleum pipelines identified within the study area is presented in **Appendix G (Hazardous Materials Database Search: Condensed Version).**

4.16.5 Asbestos and Lead-based Paint

Construction of any of the proposed reasonable alternatives or the Preferred Alternative would require demolition and/or relocation of building structures. The buildings may have materials containing asbestos. If suspect asbestos material is encountered, a mitigation plan for the removal and disposal of any hazardous materials would be developed according to federal, state, and local regulations, such as the Texas Asbestos Health Protection Act and the National Emissions Standards for Hazardous Air Pollutants. Prior to project letting, an asbestos inspection and subsequent abatement would be conducted for any bridge structures or buildings that would require renovation or demolition. Additionally, the Department of State Health and Human Services shall be notified (10-day notification) prior to asbestos contaminated materials abatement and/or the demolition of a bridge structure.

The presence or absence of Lead-Based Paint on structures to be demolished should be determined through testing or process knowledge prior to project letting. If lead-based paint is discovered, contingencies would be developed to address worker safety, material recycling, and proper management and disposal of any paint-related wastes, as necessary.

4.16.6 Potential Impacts from Construction Activities

Storage and use of hazardous materials would be necessary during construction of the Preferred Alternative. Temporary ASTs containing oil and diesel are typically used to provide fuels for equipment and vehicles used in roadway construction. These ASTs would be regulated and would require control measures for spills and leaks. Potential impacts could occur from small spills and leaks from fueling and maintenance of equipment and vehicles. These impacts should be minimal and would not pose a substantial impact to the environment. Every effort would be taken to reduce these types of impacts during the construction of the proposed Preferred Alternative.

4.16.7 Summary of Hazardous Materials Impacts

As Houston and the outlying communities continue to grow, the need for available land would also grow; current land uses and conditions would continue to change over time. Residential, commercial, and industrial growth would also continue within the study area. The number of hazardous materials sites such as oil wells, gas stations, and industrial petroleum facilities is likely to continue to increase due to the geographical location and its conduciveness for petroleum based businesses.

The Preferred Alternative would have minimal risks for hazardous materials impacts. Impacts would most likely occur on or near existing hazardous materials sites that are within the proposed ROW or within 1.0 mi of the ROW depending on the impact category. These distances are further defined in **Table 4-32**. There were 18 total sites identified from reviewed databases that are located within or near the Preferred Alternative. 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 sites listed above may affect the Preferred Alternative, and should be further reviewed prior to ROW acquisition.

RRC records indicate that there are 11 well sites located within or adjacent to the ROW for the Preferred Alternative. The Preferred Alternative would cross 10 identified well locations. Due to the inaccuracy of the well bore data, additional verification of the exact location of all the wells would be required for the

Preferred Alternative. During the ROW acquisition and negotiation process, well operators/owners would be contacted to determine appropriate actions to take for each site. Wells would be plugged and abandoned according to applicable plugging and supervision requirements provided in the Texas Administrative Code, Title 16, Part 1, Chapter 3, Section 3.14 under the jurisdiction of the RRC.

Well plugging would need to be performed by cementing companies, service companies, or operators approved by the RRC. TxDOT standard specification Item 103, Disposal of Wells, would be required if well sites are not plugged prior to construction.

The Preferred Alternative would cross or impact approximately 64 petroleum pipeline segments. The pipelines may cross more than one alternative. During further project development, owners and/or operators of these pipelines would be contacted. Exact locations and depths of these lines would need to be established. During ROW negotiation, determinations would be required to make necessary adjustments and/or relocations of these pipelines. Location and depth of pipelines that would remain in place would need to be marked on the ground (in the field) prior to construction activities in order to prevent damage to the pipelines. If proper precautions are taken, impacts related to petroleum lines within the Preferred Alternative alignment should be minimal.

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. If suspect material is encountered, a mitigation plan for the removal and disposal of materials containing hazardous materials would be developed according to federal, state, and local regulations.

Potential development associated with construction of the Preferred Alternative could have additional impacts on potential hazardous material sites. Risks can be minimized by conducting Phase I ESAs according to the ASTM standards to identify, avoid, and mitigate hazardous material sites. Additional investigation, including Phase 1 and Phase 2 assessment as needed, would be conducted for sites identified as potentially impacting the proposed improvements. Additional assessment would be conducted during the ROW acquisition and negotiation phase, or as soon as practical after right-of-entry is obtained. If hazardous materials concerns are confirmed, then preventive action plans would be developed to avoid or minimize impacts to project activities.

The No-Build Alternative would not result in hazardous materials impact. The No-Build Alternative would provide no changes within the study area.

4.17 RAILROADS

The Preferred Alternative would cross four rail lines in the project corridor owned by UPRR (**Exhibit 4-9**). 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. No long term adverse impact to any railroad line or operation is anticipated from the Preferred Alternative. No impact would occur to rail lines in the corridor from the No-Build Alternative.

4.18 ENERGY

The Preferred Alternative and each of the reasonable alternatives, excluding the No-Build Alternative, would require short-term energy consumption during construction activity. Construction-related energy consumption would be associated with construction activities from the Preferred Alternative. The amount of energy required for the production and placement of materials (asphalt, structures, cut, fill, etc.) during construction would be a fixed one-time cost. Construction-related energy consumption would be short-term in nature and could be offset by operational energy efficiencies gained through the use of an improved transportation facility over many decades. Energy impacts are a function of several variables including average running speed, VMT, and the mix of vehicle types in the system.

The Preferred Alternative could improve fuel efficiencies as traffic moves from the existing roadway network to the new facility, thereby improving traffic mobility (uniform speeds, less congestion) across the study area. The designation of the proposed project as a toll road is not expected to result in an adverse impact to energy resources. The proposed project is anticipated to be an electronic toll collection facility. An electronic toll collection system provides operational efficiencies and would help reduce the stop-and-go conditions that are associated with conventional cash booths at toll plazas, resulting in lower consumption of energy resources.

Estimates of VMT were used to calculate the amount of energy that would be consumed under the proposed project. Energy consumption was determined for the Segments H and I-1 study area for both the No-Build and Build Alternative. Energy calculations used a value of 6,273 British thermal units (Btu) per

VMT; this value represents the average energy consumption of cars and light trucks (two-axle, four-tire trucks including vans, pickup trucks, and sport utility vehicles) combined for model year 2005 (Transportation Energy Data Book, Edition 26, 2007). Fuel calculations used a value of 25.3 miles per gallon (mpg); the value represents the estimated fuel economy of cars and light trucks (two-axle, four-tire trucks including vans, pickup trucks, and sport utility vehicles) combined for model year 2005 (Transportation Energy Data Book, Edition 26, 2007).

Table 4-35 details the 2019 and 2039 VMT for the Build Alternative and the No-Build Alternative. Based on the analysis, the Preferred Alternative could result in approximately 352,556 more VMT per day in the study area in 2039. The increased VMT would equate to an increase of about 14,000 gallons of fuel per day. The Preferred Alternatives would require short-term energy consumption during construction. It would also result in a 4.7 percent increase in energy consumption per day, which suggests that the Preferred Alternative would produce an increase in energy consumption due to the increase in VMT/day.

Table 4-35: Energy Consumption in Segments H and I-1 Traffic Study Area

Year	Vehicle Miles Traveled (VMT/day)		British Thermal Units (million Btus/day)	
	Build	No-Build	Build	No-Build
2019	4,446,046	4,275,683	27,890	26,821
2039	7,830,993	7,478,437	49,124	46,912
Year	**Vehicle Miles Traveled (VMT/day)**		**Gallons/day**	
	Build	**No-Build**	**Build**	**No-Build**
2019	4,446,046	4,275,683	175,733	168,999
2039	7,830,993	7,478,437	309,525	295,590

Source: H-GAC, 2012, Study Team, 2012

The No-Build Alternative would not result in energy impacts.

4.19 CONSTRUCTION IMPACTS

The Preferred Alternative for Segments H and I-1 discussed in **Chapter 2 (Alternatives Analysis)** would result in construction impacts affecting the residents within the study area and the traveling public in the vicinity. These impacts may include, but would not be limited to:

- Temporary degradation of air, noise, and water quality;
- Temporary disruption of traffic for residents, businesses, and travelers, including maintenance, control and safety concerns;
- Public health and safety hazards;

- Stockpiling and disposal of construction materials and waste;
- Use of borrow areas and the construction and use of haul roads; and
- Temporary disruption of utilities.

The construction impacts listed above and discussed in the following sections are temporary in nature. An approximate estimate of construction time for Segments H and I-1 is two to four years for the Phase I construction. A more precise construction duration would be established during the final design phase. As funding become available, Phase II construction timelines will be developed. Postings on up-to-date project status and milestone construction schedules would be available on the GPA website at http://www.grandpky.com.

4.19.1 Air Quality Construction Impacts

During the construction phase of the proposed project, temporary increases in air pollutant emissions may occur from construction activities. The primary construction-related emissions are particulate matter (fugitive dust) from site preparation. These emissions are temporary in nature; it is not possible to reasonably estimate impacts from these emissions due to limitations of the existing models. The potential impacts of particulate matter emissions would be minimized by using fugitive dust control measures such as covering or treating disturbed areas with dust suppression techniques, sprinkling, covering loaded trucks, and other dust abatement controls, as appropriate.

Considering the temporary and transient nature of construction-related emissions, as well as the mitigation actions to be utilized, it is not anticipated that emissions from construction of the Preferred Alternative would have any significant impact on air quality in the area.

4.19.2 Water Quality Construction Impacts

Construction work on the proposed project would require a USACE Section 404 permit. One of the conditions for a USACE Section 404 permit is that appropriate sediment controls must be implemented and maintained throughout the construction phase. The contractor would be required to apply BMPs for erosion and sedimentation control. Effects to water quality resulting from erosion and sedimentation, as well as pollutants such as chemicals, sewage and other harmful waste would be strictly controlled in accordance with TxDOT's *Seeding for Erosion Control Manual* (TxDOT, 2004).

As specified in the regulations, the contractor would exercise every reasonable precaution during construction to prevent pollution of rivers, bayous, streams and other water bodies of the kind. High priority would be given to the treatment of stream banks, existing inlets and construction exits. Temporary erosion control features would consist of berms, dikes, temporary seeding, sediment traps, geotextile fiber mats, silt fences, hay bales, slope drains, mulches, crushed stone, and any other measures applicable under TxDOT guidelines (TxDOT, 2000).

4.19.3 Construction Noise Impacts

Noise levels during all phases of the project, such as site preparation and roadway construction, are essentially non-predictable. One reason is that heavy machinery, the major source of construction related noise, operates in unpredictable patterns. Construction activities normally occur during the daylight hours when high noise levels are more tolerable. Receivers are not expected to be exposed to construction noise for extended periods. Disruption of normal activities as a result of construction noise is not anticipated. Provisions would be incorporated in the construction plans and specifications that require the contractor to make reasonable efforts on noise abatement measures such as work hour adjustments and proper equipment maintenance.

4.19.4 Maintenance and Control of Traffic

Construction work would be planned and scheduled in order to maintain the flow of traffic on the existing roadway network and minimize adverse impacts on travelers. Traffic control measures would be implemented through traffic control plans and construction contract specifications as outlined in TxDOT guidelines. News releases of major construction activities and schedules would be provided to the local public.

Although Segments H and I-1 would be constructed on new location, traffic on intercepted roadways would be disrupted. Segments required to stay open for traffic would be relatively short since the Preferred Alternative does not parallel existing facilities except FM 1485 in Montgomery County north of Lake Houston Wilderness Park. The area would require special attention and traffic control plans. The number of disturbances in a single community would be limited as much as possible. Because of the limited nature of traffic disturbance on existing streets, most of the traffic control practices would use flagging operations and temporary widening of existing roads. Work zone signage in accordance with *Texas Manual on Traffic*

Control Devices would be utilized. Coordination would occur with track owners for any rail line crossed to minimize delays in train movements or queuing.

4.19.5 Health and Safety

The contractor would comply with all federal, state, and local laws including Occupational Health and Safety Administration (OSHA) regulations governing safety, health and sanitation. Reasonable safety measures and safeguarding actions would be taken in order to protect the life, health, and property of project personnel and the general public in connection with roadway construction. The contractor would develop a site specific health and safety plan for areas that are determined to have risks associated with potential hazardous materials contamination.

4.19.6 Pollution Control

Roadway and bridge construction activities would involve excavation of possibly unsuitable materials, placement of embankments, and use of materials such as crushed aggregates, asphalt, and cement. Stockpiling and disposal of excavation and construction materials may be considered aesthetically displeasing by some residents and businesses along the project corridor. Stockpiling would be a temporary condition and would cause no adverse permanent impacts with the use of BMPs for erosion control measures. The contractor would place erosion and pollution control measures on haul roads, construction exits, borrow pits, embankments, and areas designated for disposal of waste materials.

The Preferred Alternative for Segments H and I-1 and associated facilities such as ramps would be adjusted during final design to avoid or minimize impacts to streams and other environmentally sensitive areas.

4.19.7 Construction Impact Coordination

Utilities in the study area include water, sewer, oil and gas pipelines, electric transmission lines, and telephone lines. To minimize impacts to and avoid disruption of any utility facility, the contractor would contact the appropriate utility vendor or officials to coordinate work schedules. Other construction activities requiring coordination with local and state officials may include stockpiling of borrow and waste materials, materials collected as a result of clearing and grubbing, and construction of haul roads. The construction contractor would obtain the necessary permits and clearances for borrow pits and project specific locations (PSLs) identified outside the project ROW.

4.19.8 Summary of Construction Impacts

Construction of the Preferred Alternative would result in construction impacts. These impacts may include temporary degradation of air and water quality, increase in 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 for PSLs. Construction activities would temporarily affect residents and businesses along the project corridor as well as travelers in the vicinity. The No-Build Alternative would not result in impacts.

4.20 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.

4.21 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

Construction of the proposed Segments H and I-1 Preferred Alternative 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. The 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 fossil fuel 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.

4.22 PREFERRED ALTERNATIVE

The purpose of the proposed project is to provide system linkage, improve mobility, and enhance safety by providing an additional evacuation route, and provide infrastructure to support population growth. As discussed in **Chapter 2 (Alternatives Analysis)**, the No-Build Alternative would not accommodate projected traffic volumes within the Grand Parkway Segments H and I-1 study area. In addition, the No-Build Alternative would not enhance safety by providing an additional emergency evacuation route.

After review of public and agency input and the evaluation of environmental, engineering, and traffic criteria, Reasonable Alternative 10R was selected as the Preferred Alternative. Reasonable Alternative 10R received the most support from the general public and elected officials. The Preferred Alternative is 37.4 mi in length and would require approximately 1,933 ac of proposed ROW. Refer to **Table 2-11** for a summary of the potential environmental impacts resulting from the Preferred Alternative.

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CHAPTER 5
INDIRECT IMPACTS

5.1 Methodology

In order to maintain a level of consistency among Grand Parkway (SH 99) environmental documents, a workshop was held between the Federal Highway Administration (FHWA) and the Texas Department of Transportation (TxDOT) on October 16, 2008. The intent of this workshop was to develop guidance that would aid in the analysis of the Indirect and Cumulative Impacts (ICI). The preparers of the Draft Environmental Impact Statement (EIS) document(s) were instructed to use this October 2008 guidance. However, in September 2010, the Environmental Affairs Division of TxDOT (TxDOT ENV) issued updated guidance for preparing ICI analyses. The Final EIS has been updated to follow TxDOT's September 2010 revised guidance on preparing ICI analyses.

The following proposed methodology describes the indirect impacts analysis. Resources such as decennial census data, Houston-Galveston Area Council (H-GAC) 2035 population projections, and the *Envision Houston Region* report were used. Additional information was obtained using Texas Education Agency data, stakeholder interviews, expert panel surveys, and employment forecasts and analyses. This information allows for the establishment of quantitative assumptions which have been utilized to develop the findings discussed in the following sections. A Geographic Information System (GIS) based analysis was used to quantify the data gathered. Given the nature of indirect impacts, it must be stated that the analysis heavily relies upon projected data and qualitative assumptions. Various qualitative assumptions used during the analysis include anticipated demographic trends and associated travel demands along with recognized development trends.

The Council on Environmental Quality (CEQ) defines indirect impacts as those that are "caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable. Indirect impacts may include growth inducing effects and other effects related to induced changes in the pattern of land use, population density or growth rate, and related effects on air and water and other natural systems, including ecosystems" (40 Code of Federal Regulations [CFR] §1508.8). Indirect impacts were assessed based on requirements and process outlines in 23 CFR 771, and guidance described in the Transportation Research Board's (TRB) National Cooperative Highway Research Program (NCHRP) *Report 466: Desk Reference for Estimating the Indirect Effect of Proposed Transportation Projects* (TRB, 2002), NCHRP *Report 25-25, Task 22*: *Forecasting Indirect Land Use Effects of Transportation Projects* (TRB, 2007), FHWA

Technical Advisory 6640.8A, *Questions and Answers Regarding the Consideration of Indirect and Cumulative impacts in the NEPA Process* (FHWA 2003), and the TxDOT Revised *Guidance on Preparing Indirect and Cumulative Impacts Analysis* (TxDOT 2010). Indirect impacts differ from the direct impacts associated with the construction and operation of the proposed project and are caused by an action or actions that have an established relationship or connection to the proposed project. As to the cause and effect relationship between the project and the indirect impact, CEQ states that indirect effects may include induced changes to land use resulting in resource impacts (40 CFR 1508.8). Other indirect effects include the potential alteration of or encroachment on the affected environment. Examples of indirect impacts of several types of transportation projects are summarized in **Table 5-1**.

Table 5-1: Example of Indirect Impacts

Project Action	Indirect Impact
Bypass Highway	Farmland converted to residential use. New residences produce new labor force attracting new businesses.
New Light Rail	New businesses open producing jobs/taxes. Traditional businesses/residents priced out.
New Highway	Development alters character of historic area. Visitors increase to historic area.

Source: TRB 2002, NCHRP Report 466

Indirect impacts are commonly related to changes in land use. Changes in travel patterns may also occur if the project is on new location, adds capacity, or is one where tolling is involved. When a project is constructed, indirect impacts may occur as development is induced by the project. This induced development would likely include a variety of commercial land uses, such as convenience stores, gas stations, retail shops, restaurants, office buildings, and residential uses, including single and multi-family developments.

The NCHRP has developed procedures for estimating indirect impacts of transportation projects (NCHRP Report 466, TRB 2002). This guidance utilizes an eight-step approach to assess the indirect impacts of transportation projects on resources within the defined study area. The eight steps are listed in **Table 5-2**.

Table 5-2: NCHRP Eight-Step Approach to Estimate Indirect Impacts

Step No.	Step
1	Scoping.
2	Identify the Study Area's Direction and Goals.
3	Inventory the Study Area's Notable Features.
4	Identify Impact-Causing Activities of Proposed Action and Alternatives.
5	Identify Potentially Significant Indirect Effects for Analysis.
6	Analyze Indirect Effects.
7	Evaluate Analysis Results.
8	Assess Consequences and Develop Mitigation.

Source: TRB 2002, NCHRP Report 466

The eight-step process outlined above served as the initial approach for this indirect impacts analysis. The analysis was updated in 2012 to include the most recent TxDOT *Revised Guidance on the Preparation of Indirect and Cumulative Impacts Analysis* (TxDOT 2010). Under the TxDOT's Revised 2010 Guidance, there are three categories of indirect effects:

- Encroachment-Alteration Effects;
- Induced Growth Effects, and
- Effects Related to Induced Growth-Related Effects.

Encroachment-Alteration Effects are those that alter the behavior and functioning of the physical environment. These effects are related to project design features, but are separated from the project by time and/or distance.

Induced Growth Effects are also known as Project-Influenced Effects or the Land Use Effect. Changes in access and mobility can result in changes in land use. Highway projects may promote development or influence an increase in the rate of development.

Effects Related to Induced Growth-Related Effects are those effects that are attributable to the induced growth itself.

The TxDOT 2010 *Revised Guidance* uses a variation of the 2002 NCHRP Report 466 process, and recommends conducting an Indirect Impact Analysis using a seven-step process, as shown in **Table 5-3** below.

Table 5-3: TxDOT Seven-Step Approach to Estimate Indirect Impacts

Step 1 – Scoping: The basic approach, effort required, and geographical boundaries of the study are determined.
Step 2 – Identify the Study Area's Goals and Trends: Information regarding the study area is compiled with the goal of defining the context for assessment.
Step 3 – Inventory the Study Area's Notable Features: Additional data on environmental features are gathered and synthesized with a goal of identifying specific environmental issues by which to assess the project.
Step 4 – Identify Impact-Causing Activities of Proposed Action and Alternatives: Fully describe the component activities of each project alternative
Step 5 – Identify Potentially Substantial Indirect Effects for Analysis: Indirect effects associated with project activities and alternatives are catalogued, and potentially substantial effects meriting further analysis are identified.
Step 6 – Analyze Indirect Effects and Evaluate Results: Qualitative and quantitative techniques are employed to estimate the magnitude of the potentially substantial effects identified in Step 5 and describe future conditions with and without the proposed transportation improvement. The uncertainty of the results of the indirect effects analysis is evaluated for its ramification on the overall assessment.
Step 7 – Assess Consequences and Consider/Develop Mitigation (when appropriate): The consequences of indirect effects are evaluated in the context of the full range of project effects. Strategies to avoid or lessen any effects found to be unacceptable are developed. Effects are reevaluated in the context of those mitigation strategies.

Source: TxDOT *Revised Guidance on the Preparation of Indirect and Cumulative Impacts**Error! Bookmark not defined.** Analysis* (2010)

All indirect effects would occur outside of the existing or proposed ROW. As to the cause and effect relationship between the proposed improvements and the indirect impact, CEQ states that indirect effects may include induced changes to land use resulting in resource impacts (40 C.F.R. § 1508.8). Indirect effects can be linked to direct effects in a causal chain (NCHRP Report 466). The chain can be extended as indirect effects produce further consequences. Probability also helps distinguish indirect effects from direct effects; direct effects are often inevitable while indirect effects are merely probable. Each step of the seven-step indirect impact analysis has been applied to the proposed project and the findings documented in this FEIS.

5.1.1 Stakeholder and Expert Panel Involvement

Analyzing the likelihood of development in a defined study area once construction is completed is a key component of evaluating the potential for indirect impacts. Agency and community stakeholders were engaged in the project from the early planning stages to determine the likelihood of indirect and cumulative impacts from the proposed project. A full list of stakeholders involved in the project is included in the Project Coordination Plan **(Appendix B)**. **Table 5-4** includes a general list of the project stakeholders.

Table 5-4: Project Stakeholders

Community Level	Agency Level
Elected Officials Local – Council Members, County Officials and Mayors	Local Private – Utility companies, Railroads, Industries Public – Counties, HCTRA, Municipalities, TxDOT Houston, TxDOT Beaumont, H-GAC
Communities and Stakeholders Homeowner Associations Developers Various Special Interest Groups Sierra Club	Regional Federal – FHWA, USACE, USFWS, NRCS, EPA State – TCEQ, TxDOT Environmental Affairs Division, THC, TPWD FAST – FHWA, TxDOT Environmental Affairs Division, TxDOT Houston and Beaumont Districts, Grand Parkway Association

Source: Study Team, 2007

The indirect effects analysis includes evaluating population and land use trends in a defined study area and identifying areas of development that may be induced by the proposed project. To determine the extent of potential induced development, city and county land use planning authorities in the study area were consulted in 2007 and 2008 during meetings called to gather local data for the planning process. Meetings with local city and county officials, officials from area school districts, and H-GAC officials were organized to discuss existing, proposed, and potential development within a 15-minute travel shed. The 15-minute travel shed factored heavily into the development of the "indirect impacts study area, or area of influence (AOI)" **(Exhibit 5-1).** Questions asked during these meetings with stakeholders included:

Existing Development

- Are you aware of any other land development, land use changes, building activity, or infrastructure improvements by others that do not appear on the constraints map provided?

Proposed Development

- Are there any pending subdivision applications in the defined study area?
- Are you aware of any infrastructure improvement (including transportation and utilities) or land development plans by other agencies or private interests in the defined study area? If yes, by whom/request information?

Relation to Proposed Project

- Would improvements, development, or other land use designations have occurred if there were no plans to construct the proposed Grand Parkway Segments H and I-1?
- Are you aware of any development that has occurred in response to plans to construct the proposed Grand Parkway Segments H and I-1 and that would not have occurred otherwise? (For any, follow-up for specifics – location, size, when developed, etc.)

Development Patterns/Trends

- If constructed, how would Grand Parkway Segments H and I-1 affect land development in the defined study area?
- In which areas would you expect development to be concentrated if the proposed roadway is constructed?
- In which areas would you expect development to be concentrated if the proposed roadway is not constructed?
- To what degree would you expect the proposed project to influence development patterns within the defined study area?
- To what degree would you expect the proposed project to influence development patterns at interchanges? Within what distance of these interchanges would you expect development to be concentrated?

The data gathered during the stakeholder meetings held during 2007-2008 included specific information for planned development within the region. This data was used to initially map and document reasonably foreseeable development within the 15-minute travel shed.

In addition to these initial stakeholder meetings held during 2007-2008, a panel of experts (including H-GAC personnel, as well as local and county planning personnel) was consulted for the analysis of indirect impacts. In late 2008 and early 2009, formal surveys were sent to the original stakeholders queried during 2007-2008, as well as additional stakeholders identified in the winter of 2008-2009. The expert panel survey questionnaire was developed by the project team, in conjunction with TxDOT, TxDOT-ENV, and FHWA representatives. To determine the extent of potential induced development, regional, city, and county land use planning authorities were contacted and asked to fill out a questionnaire regarding the potential for the proposed project to induce development. The surveyed experts were also asked to give their opinions on the percentage of planned growth dependent on the Grand Parkway Segments H and I-1, and if possible, provide information on the size and location of this growth. The AOI (study area) for the indirect impacts questionnaire was the 15-minute travel shed. **Table 5-5** lists the expert panel that returned responses to the survey.

Table 5-5: Expert Panel

Name	Agency or Municipality Affiliation
Jeff Taebel	Director, Community and Environmental Planning; Houston-Galveston Area Council (H-GAC)
Bill Cobabe	City of Mont Belvieu, City Planner
Dave Draz	City of Dayton, Director of Planning
Don Brandon, P.E.	Chambers County, County Engineer
Harold Cheek	City of Baytown, City Planner

Source: Study Team, 2008-2009

Based on analysis of the expert panel survey results, it was determined that areas with the greatest potential for induced development are located at major intersections and adjacent to existing cities. The H-GAC also provided the *Envision Houston Region* report with the survey response (2035 RTP Update Appendix A). Scenario A of the *Envision Houston Region* report includes the current growth forecast and development for the region, based on the H-GAC's 2035 population forecast, and assumes the complete build-out of the planned regional toll system. In this scenario, development follows the pattern of the planned Grand Parkway segments.

The results of the expert panel survey conducted in 2008-2009 were combined with the data from the 2007-2008 stakeholder meetings and data provided in the *Envision Houston Region* report to project the future reasonable and foreseeable development within the AOI, including induced development. All future reasonable and foreseeable development data was digitized and is shown on **Exhibit 5-2**.

In 2013, the survey results and future development information provided by the 2008-2009 expert panel were reviewed for applicability to the Preferred Alternative in the current year. The land use planning documents provided by the 2008-2009 expert panel and those analyzed in the **Indirect Land Use Impacts Assessment** (**Appendix O)** are still in use by local area planners and city officials. Therefore, the analysis presented in the Indirect Land Use Impacts Assessment (**Appendix O**) and future development information provided by the expert panel remains valid for the Preferred Alternative, and can be considered conservative given the current economic climate.

5.2 Step 1: Scoping

Scoping is the key to proper and timely identification and analysis of indirect effects. Scoping is a process used to determine the extent of the potential area of impact. The scoping process has two overall goals:

(1) determining the level of effort and approach needed to complete the analysis, and (2) determining the location and extent of the indirect impact study area.

The geographic boundary of the AOI for the indirect impact analysis is defined by a 15-minute travel shed extending from the proposed Grand Parkway Segments H and I-1 study area **(Exhibit 5-1)**. The methodology for developing the AOI was based on the approach applied for Grand Parkway Segment G. This methodology used the travel assumption that a typical Houston area commute is 45 minutes long. This 45-minute commute is further assumed to be broken into three 15-minute segments: from the starting point 15 minutes is spent on streets getting to the tollway, 15 minutes is spent driving on the tollway, and 15 minutes is spent getting from the tollway to the end destination. This shape was then modified to coincide with the boundaries of the nearest Traffic Analysis Zones (TAZ). The AOI includes the area in which the proposed Grand Parkway Segments H and I-1 could influence local traffic patterns and/or land development. It is assumed that areas outside the AOI are better served by other roadways.

The total AOI is comprised of 770,300 acres (ac) or 1,204 square miles (m^2) within Harris County, Montgomery County, Liberty County, Chambers County, San Jacinto County. The AOI encompasses the cities of Huffman, Patton Village, Roman Forest, Baytown, Mont Belvieu, and Dayton. **Table 5-6** provides the land area detail.

Table 5-6: Area of Influence (15-Minute Travel Shed)

	Acres (rounded)	Square Miles	Percentage of AOI
Harris County	222,100	347	28.8
Montgomery County	177,720	278	23.1
Liberty County	258,280	403	33.5
Chambers County	106,740	167	13.9
San Jacinto County	5,460	9	0.7
Total Land in the AOI	770,300	1,204	100.0

Source: Study Team, 2007

The project team gathered reasonable and potential scenarios of future land use and associated demographics through a planning horizon of 2035. For this analysis, the No-Build Alternative is defined as the existing and planned developments within the AOI without improvements to Grand Parkway Segments H and I-1. The Build Alternative is defined as the existing and planned developments within the AOI including the construction of Grand Parkway Segments H and I-1. Change in land use is seen as the most influential indirect impact for all resources, both human and natural, in the AOI. Data was gathered through

various resources which included meetings with officials from the Cities of Houston, Baytown, Mont Belvieu, Splendora, Woodbranch, Patton Village, Roman Forest, and Dayton, Harris County, Liberty County, Chambers County, Montgomery County, the H-GAC, U.S. Environmental Protection Agency (EPA), US Fish and Wildlife Service (USFWS), U.S. Army Corps of Engineers (USACE), U.S. Coast Guard (USCG), Texas Parks and Wildlife Department (TPWD), and the Texas Historical Commission (THC). A complete list of stakeholders consulted is included in the Project Coordination Plan in **Appendix B**. As previously stated, a panel of experts (refer to **Table 5-5**) in planning and development of this region were consulted and provided estimates of the acreage of potential development that could be induced by the proposed project.

5.3 Step 2: Identify the Study Area's Goals & Trends

After scoping and delineation of the study area are complete, it is important to gather a wide range of data about the study area. This second step in the indirect impacts analysis framework focuses on assembling information regarding trends and goals within the AOI. The trends and goals within the AOI are independent of the proposed transportation project and typically concern social, economic, ecological, and/or growth-related issues. Social, economic, and environmental goals expressed through formal plans reflect a vision of the future. Consideration of various goals early in the planning process can help focus the effort towards balancing transportation and other needs, and also towards understanding potential indirect effects.

5.3.1 Study Area Goals

The proposed toll facility has been planned for many years, and the (minimal) existing land use planning for the region reflects the anticipated presence of the Grand Parkway Segments H and I-1. Publicly planned development goals for each of the jurisdictions in the study area are discussed in further detail in the **Indirect Land Use Impacts Assessment** (**Appendix O**) and assume that the proposed Grand Parkway Segments H and I-1 would be constructed. The H-GAC 2035 Regional Transportation Plan (RTP) Update defines transportation systems and services within the boundaries of the AOI (2010). The RTP Update addresses regional transportation needs that are identified through forecasting current and future travel demand, developing and evaluating system alternatives, and selecting those options which best meet the mobility needs of the region. The proposed facility is included in this plan. The basic land use patterns surrounding the anticipated construction and the proposed Preferred Alternative alignment for Grand Parkway Segments H & I-1 is also similar to the alignment included in the City of Mont Belvieu master plan.

Refer to **Appendix O** for the **Indirect Land Use Impacts Assessment** which is a report initially developed in 2008 that identifies and analyzes the potential for indirect land use impacts related to the proposed construction of Grand Parkway Segments H and I-1.

5.3.2 Study Area Trends

The majority of Liberty County is agricultural to the central and northern portions of the county and industrial in the southern areas of the county, with selected areas of residential development concentrated around cities and small towns. Portions of Harris, Montgomery, and Chambers counties have recently experienced higher rates of residential growth. Current H-GAC models used for the 2035 RTP Update show these development patterns—slower in the central project corridor, and faster paced growth in the northern and southern areas of the project—continuing into the future.

Other Indicators of Growth

Residential growth, specifically home construction, was utilized as an indicator of historical growth in the AOI. Research indicates that prior to 1939, 114 homes were constructed in the municipalities that are located within the AOI. In the 1970s and 1980s, there was a boost in new home construction. During the 1990s, new housing construction showed no substantial growth, yet remained steady.

These past development trends defined the construction of public facilities and implementation of public services as well as commercial/retail land uses that occurred after the 1930s. See **Table 5-7** for historic housing characteristics for the municipalities located within the AOI.

Table 5-7: New Home Construction

Geographic Area	Number of New Homes Built & Year Built								
	2005 or later	2000-2004	1990-1999	1980-1989	1970-1979	1960-1969	1950-1959	1940-1949	1939 or Earlier
City of Dayton	85	369	380	382	251	173	171	149	86
City of Mont Belvieu	157	162	247	156	324	67	7	6	41
City of Patton Village	6	28	35	92	167	70	34	0	2
City of Plum Grove	0	27	36	38	51	24	15	8	0
City of Roman Forest	118	231	705	872	707	173	125	55	13
City of Woodbranch	0	15	76	89	210	72	6	0	0

Source: U.S. Census Bureau, *2006-2010 American Community Survey*

Real Estate Center

Single-family building permit information was collected for Chambers, Harris, Liberty, and Montgomery counties from 1997 to 2011. The number of building permits has fluctuated during the past 14 years as

shown in **Table 5-8**. The year 2006 is documented as the peak year for single-family building permits during this timeframe; this trend is attributed to the rise in population growth the H-GAC region experienced.

Table 5-8: Single-Family Building Permits

Year	Chambers County		Harris County		Liberty County		Montgomery County	
	No. of Permits	% Change	No. of Permits	% Change	No. of Permits	% Change	No. of Permits	% Change
1997	128	-	13,407	-	195	-	3,110	-
2000	209	63.2	18,148	35.3	213	9.2	4,049	30.1
2003	417	99.5	26,450	45.7	258	21.1	5,581	37.8
2006	368	-11.7	32,919	24.4	292	13.1	7,309	30.9
2011	216	-41.3	17,388	-47.2	260	-11	4,009	-45.1

Source U.S. Census Bureau: State and County QuickFacts, 2010

Texas Education Agency

Ten school districts are located within the AOI. New Caney Independent School District (ISD) was identified as the fastest growing school district within the AOI with a 20.9 percent enrollment change from the 2006-07 to 2010-11 school years, followed by Barber's Hill (18.9 percent growth) at the opposite termini. The growth trends from the school enrollment data suggest strong growth surrounding both areas of the project logical termini, with little to negative growth through the center of the AOI corridor. The 10 school districts and their growth trends located within the AOI are listed in **Table 5-9**.

Table 5-9: School District Enrollment Growth Trends

District Name	2006-2007 Enrollment	2007-2008 Enrollment	2008-2009 Enrollment	2009-2010 Enrollment	2010-2011 Enrollment	5-year Growth	% Growth
Barbers Hill ISD	3,549	3,708	3,903	4,121	4,220	671	18.9%
Cleveland ISD	3,478	3,539	3,672	3,779	3,866	388	11.2%
Crosby ISD	4,715	4,884	4,998	5,034	5,119	404	8.6%
Dayton ISD	4,967	4,896	4,772	4,912	4,927	-40	-0.8
Goose Creek ISD	20,293	20,354	20,698	20,954	21,283	990	4.9%
Huffman ISD	3,071	3,092	3,054	3,152	3,168	97	3.2%
Humble ISD	31,327	32,970	33,883	34,923	35,913	4,586	14.6%
New Caney ISD	8,362	8,676	9,122	9,609	10,106	1,744	20.9%
Splendora ISD	3,365	3,378	3,413	3,382	3,487	122	3.6
Tarkington ISD	1,974	1,994	1,934	1,986	1,909	-65	-3.2%

Source: Texas Education Agency, September 2012

5.4 Step 3: Inventory of Study Area's Notable Features

The baseline conditions for the environmental resources that exist before project construction are included in **Chapter 3 (Affected Environment)**. The AOI is mostly undeveloped with pockets of residential,

industrial, commercial, and parkland development. As stated in **Chapter 3**, most of the developed land is within and adjacent to the northern portion of the study area along US 59 (N)/Interstate Highway (I) 69 and FM 1485 and along the southern portion in Mont Belvieu. Notable features that could be indirectly impacted within the AOI are listed below and illustrated in **Exhibits 5-1** and **5-2**.

- Lake Houston;
- Lake Houston Wilderness Area;
- Salt domes (e.g. Humble, Esperson, Barbers Hill, Lol Rich, Conroe, North Dayton, South, Moss Bluff, and Turtle Bay salt domes);
- The Dayton Canal System (rice irrigation system, of which the Dayton Main Canal and Big Ditch are NRHP-eligible components); and
- The Coastal Water Authority Canal system.

These notable features are composed of valued environmental components. Lake Houston serves as a municipal water supply for the City of Houston as well as a major local recreational area. Lake Houston Wilderness Area serves as an ecological and recreational resource in a largely urban area. Salt domes are unique geological and notable ecological features along the Gulf Coast. The Dayton Canal System and Coastal Water Authority Canal system provide water to municipal, industrial, and agricultural entities throughout the area. As generally documented throughout the FEIS, each of these notable features plays a unique role in the ecological, economic, and agricultural contexts within the AOI.

5.5 Step 4: Identify Impact-Causing Activities of Proposed Action and Alternatives

Gaining a thorough understanding of project design features and the range of impacts they may cause is the first step toward the identification of indirect effects. Transportation projects on new locations such as the proposed Grand Parkway Segments H and I-1 could involve a number of impact causing activities. This step is intended to conceptualize and quantify, if possible, potential indirect impacts that would occur because of the proposed project. The general types of project impact-causing activities include the following (NCHRP Report 466):

- **Modification of regime effects** – Approximately 690 ac of wildlife habitat, 39 ac of forested wetlands, and 15.5 ac of non-forested wetland habitat may be impacted as a result of the construction of the proposed project.
- **Land transformation and construction** – The proposed project consists of the construction of new toll lanes of Segments H and I-1 of the Grand Parkway facility. An estimated 1,933 ac of proposed ROW would be required for the proposed action.

- **Processing** – Storage of materials would occur off-site. It is anticipated, based on usual practices, that the contractor, when selected, would negotiate the location for the contractor's field office and storage site. If the contractor chooses to use undeveloped land or another site for material storage, impacts to natural resources may increase.
- **Land alteration** – Land alteration as a result of the proposed project would largely be limited to the areas of proposed ROW and areas that could be affected by encroachment-alteration activities (e.g. changes in travel patterns and access). Areas of vegetation disturbed during construction activities would be reseeded/revegetated with native vegetation after construction is completed.
- **Resource renewal** – The total number of large individual trees that may be removed and total acreage of riparian woodland affected may change during final design. TxDOT would minimize the loss by preserving as many trees as possible.
- **Changes in traffic** – The proposed project is on a new location, and is planned as part of the regional tolling network. The proposed project is expected to reduce congestion by improving traffic operations along existing roadways. The proposed project would also result in roadway network enhancements which can result in land use changes, and improved mobility and access. All such actions can result in changes of traffic patterns, and thus have the potential to indirectly impact air quality in the area.
- **Waste emplacement and treatment** – Soil excavated from the proposed project limits would likely be stockpiled for use on another project or sold for other uses, depending on the results of soil testing. The contractor, when selected, may choose to provide portable sanitary facilities for employees at the field office. No other sanitary waste discharge is anticipated.
- **Chemical treatment** – No use of fertilizer is anticipated during revegetation. Periodic applications of herbicide may occur during the maintenance phase of the proposed project.
- **Access alteration** – Access alteration from a new location facility may be the largest contributor to indirect impacts to land use. Proposed changes in access are discussed in **Chapter 4**. Major roadway and railroad crossings in the proposed project corridor would be bridged to avoid impacts to through traffic. Final overpass, interchange, and road closure locations would be determined during the design phase of the project.

5.6 Step 5: Identify potentially Substantial Indirect Effects for Analysis

Step 5 examines the probability for substantial indirect impacts associated with the proposed project. The objective of this step is to compare project impact-causing actions with the list of goals and notable features to explore potential cause-effect relationships and establish which effects are potentially substantial and merit subsequent detailed analysis (or conversely, which effects are not potentially substantial and require no further assessment). Based upon the information provided in the previous steps, the indirect effects may be identified. This step is essentially a screening step; only those impacts which may be substantial require further analysis. This step should clearly define which effects may be and are not substantial, and the environmental document should discuss how and why the determination was made. The context of the

AOI intensity of the impact should be considered when determining if an impact may be substantial. Each type of indirect effect should be considered for relevance to the project. Types of indirect effects include: (a) encroachment alteration effects; (b) induced growth effects; and (c) effects related to induced growth.

Indirect effects are commonly related to land use changes and may be positive or negative. For example, when a transportation project is constructed, the enhanced access to the project area may attract new development or accelerate already planned development in the area, which can be perceived as a positive change in the community. The development may occur in the form of residential developments or in the form of restaurants, gas stations, and other commercial establishments. This "induced development" would be an indirect impact of the proposed project. Generally, it would be reasonable to expect that projects on new locations or larger scale projects (e.g. upgrading an existing facility to a controlled access freeway) would have more potential to cause indirect effects than smaller scale projects or projects being constructed in previously developed areas.

5.6.1 Encroachment-Alteration Effects

Ecological Effects

Project biologists have determined that ecological encroachment-alteration effects including the loss of vegetation would be a potential indirect impact from proposed roadway improvements. The vegetative communities considered for direct and indirect impacts consist of agricultural wetlands, agricultural land, forest, forest wetlands, non-forested wetlands, and riparian zones. Because of potential loss of vegetation and modifications to former agricultural land resulting from the Preferred Alternative, vegetative communities were studied further.

Potential impacts to Waters of the U.S., including wetlands, from development indirectly related to the project include placement of fill and degradation of function through encroachment and as a result of increased runoff. Within the AOI there are 81,650 ac of streams and wetlands, as defined by the National Wetland Inventory and the topographical maps utilized for this analysis (USFWS 2004). The indirect effects to waters of the U.S., including wetlands were studied further.

Potential indirect effects on floodplains from roadway projects include increases in stormwater runoff due to changes in land use and increased development that may be accelerated by improved mobility and managed congestion on the transportation system on land surrounding the proposed facility. The indirect effects to floodplains as a result of the Preferred Alternative were studied further.

The AOI is part of the EPA designated eight-county marginal nonattainment area for 2008 ozone NAAQS. The AOI is currently in attainment for all other National Ambient Air Quality Standards (NAAQS) pollutants. Please refer to **Section 4.4.1** for the air quality assessment for the proposed project. Based on the results of Steps 1 through 4 that evaluated the possible project-related actions that can indirectly impact air, the proposed project would not be anticipated to cause indirect air quality impacts in the AOI. No change in attainment status is anticipated within the study area as a result of emissions associated with the proposed project. In order for the region to achieve ozone attainment, a variety of point, non-point, and mobile source emission reduction strategies must be implemented for the entire HGB area as outlined in the SIP. Indirect air quality impacts from MSATs are unquantifiable due to existing limitations to determine pollutant emissions, dispersion, and impacts to human health. Emissions would likely be lower than present levels in future years as a result of the EPA's national control regulations (i.e., new light-duty and heavy-duty on-road fuel and vehicle rules and the use of low sulfur diesel fuel). Even with an increase in VMT and possible temporary emission increases related to construction activities, the EPA's vehicle and fuel regulations, coupled with fleet turnover, will cause substantial reductions of on-road emissions over time, including CO, MSATs, and the ozone precursors VOC and NOx. As the proposed project is not anticipated to result in indirect air quality impacts, further discussion in Steps 6-7 below is not necessary.

Socio-economic Effects

Encroachment-alteration effects to socio-economic resources were identified as potentially substantial due to the improved access and mobility that would occur as a direct result of the new location facility. Two broad forms of socio-economic impacts include: 1) changes in travel patterns and access, and 2) direct relocation of homes and businesses. These direct impacts may lead to indirect effects on neighborhood cohesion, neighborhood stability, travel patterns, changes in the local economy, changes in access to specific services, recreation patterns at public facilities, pedestrian dependency and mobility, perceived quality of the natural environment, and perceived visual and aesthetic impacts, among others. Changes in access can include driveway changes, relocations of ramps, introduction of raised medians, alterations of intersections that restrict access to local streets, or the introduction of bicycle and pedestrian facilities. These may result in changes of travel patterns throughout an area. Additionally, changes in travel patterns and access could result in substantial impacts to public services and facilities; these issues were studied further.

5.6.2 Induced Growth Effects

The proposed Grand Parkway Segments H and I-1 project has been a planned transportation corridor in Chambers, Harris, Liberty, and Montgomery counties for decades. Current and future land uses have been developed around the initial planning locations of the proposed roadway and assume its full build-out. It should be recognized that the proposed project is needed to address the region's inadequate system linkage, reduced mobility, compromised safety, and lack of infrastructure to support population growth. The Grand Parkway Segments H and I-1 project is a new location project and as such is expected to influence land use and potentially result in substantial indirect impacts.

An *Indirect Land Use Impacts Assessment* provided in **Appendix O** analyzes the potential for indirect land use impacts related to the construction of the Grand Parkway Segments H and I-1. The *Indirect Land Use Impacts Assessment* was conducted in accordance with NCHRP Report 25-25, Task 22: *Forecasting Indirect Land Use Effects of Transportation Projects*. The indirect land use impacts outlined in the analysis possess a "strong" to "very strong" potential for land use change. Existing comprehensive plans and associated zoning would likely not change as the proposed project is a planned transportation corridor that would benefit from coordinated design, infrastructure, and compatibility of land uses set forth by the cities of Mont Belvieu and Dayton. However, future comprehensive plans or other land use regulations set forth by other municipalities within the AOI may be influenced by the proposed Grand Parkway Segments H and I-1 as the lack of land use regulation in portions of the AOI creates the potential for such influence.

Examples of indirect impacts that could potentially occur as a result of the proposed Grand Parkway Segments H and I-1 project would be the influx of businesses that depend upon proximity to highways with frontage roads and increased business patronage due to improved access from highway improvements. Similarly, residential development could be enhanced due to improved access provided by the improvements. Existing residents would also benefit from the convenience of these additional businesses.

Examples of indirect land use impacts that may occur with anticipation of the construction of proposed Grand Parkway Segments H and I-1 are located throughout the AOI. According to the expert panel surveyed in 2008-2009, a range of 10,000 acres up to 30,000 acres (up to 60 percent of approximately 50,100 acres of planned development) may be indirectly influenced by the proposed project. Some example developments which would benefit from the proposed construction of Grand Parkway Segments H and I-1 are the Aperion Communities master planned community north of Mont Belvieu and the John P.

Dalton residential subdivision just west of Dayton. Other "reasonably foreseeable" developments located within the AOI likely to be influenced by the proposed construction of the Grand Parkway Segments H and I-1 are included in **Table 5-10**.

Developments considered "reasonably foreseeable" include projects that have been approved by the local government development process (e.g. a plat has been filed), possess appropriate funding, etc. These reasonably foreseeable projects were determined from 2007-2008 stakeholder meetings and research of platted developments and have been taken into consideration through Steps 5-7 of the indirect impacts analysis (**Exhibit 5-2**). These reasonably foreseeable projects, which are primarily residential developments, are located within the AOI. It should be noted that the quantifications associated with the AOI in the following discussions represent the resources located within the footprint of the AOI. The reasonably foreseeable projects are not anticipated to affect the entire footprint of the AOI. Due to data limitations, quantification of the impacts is limited to the footprint of the AOI to provide a conservative measurement.

Table 5-10: Reasonably Foreseeable Developments

Development	Approximate Size (acres)	Relationship with Alternative	Stage of Development*
City of Dayton			
Fordland Estates	40.97	3.5 miles east of 2, 3, 7, 8	Developing
John P. Dalton	677.37	2.5 miles east of 2, 3, 7, 8	Future
Oakwood	28.97	1.75 miles east of 2, 3, 7, 8	Developing
The Meadows	7.96	3 miles east of 2, 3, 7, 8	Developing
Gus Prevot Subdivision	148.39	0.5 mile west of 2, 3, 7, 8	Future
City of Old River Winfree			
Indian Ridge	276.69	3 miles east of 2-11	Developing
City of Plum Grove			
HF Houston Green Land LP (residential/	8,725.87	2-11	Future
City of Roman Forest			
Residential Subdivision	111.77	2-6	Future
City of Mont Belvieu			
Aperion Communities	17,560.86	2-5, 7-10	Future
Unincorporated			
Oaks of Trinity	184.93	5 miles east of 2, 3, 7, 8	Developing
West Dayton Manor	78.49	0.75 mile west of 4, 5, 9, 10	Developing
Cedar Springs	463.63	300 ft west of 3, 5, 8, 10	Planned
Southwood	83.54	3.5 miles east of 2, 4, 7, 9	Planned
Auroras LLP	1,050.00	2.5 miles east of 2, 3, 7, 8	Future
Alders parcel	247.44	2 miles northeast of 2, 3, 7, 8	Future
Alders parcel	185.13	3.5 miles northeast of 2, 3, 7, 8	Future
BCD Services	206.72	400 ft east of 6, 11	Future
Kings Colony	395.86	2-6	Planned
Ramiro Cano #1	78.66	6, 11	Future
Pecan Grove	31.25	0.5 mile west of 4, 5, 9, 10	Future
Country Place	107.82	0.5 mile west of 4, 5, 9, 10	Future
Total	**30,692.32**		

Source: Study Team, 2008
* The terms "planned" and "future" are equivalent to platted (according to the H-GAC) and future planned projects, respectively.

Based on the results of the expert panel survey conducted in 2008-2009, it was determined that areas with the greatest potential for induced development are located at major intersections and adjacent to existing municipalities. Specifically, the expert panel predicted that the corridor would likely see an increase in commercial and industrial land uses due to the proximity to the Port of Houston and the Bayport Container Facility. The expert panel survey results predicted that approximately 1,000 acres (ac) at the intersection of the Grand Parkway Segments H and I-1 and I-10 (E) would likely be developed for retail and commercial

uses. Approximately 5,000 ac at each intersection of the Grand Parkway Segments H and I-1 with SH 146 and FM 1960 would likely be developed for residential uses, and approximately 1,000 ac of commercial and retail development would occur at each intersection of Grand Parkway Segments H and I-1 with FM 1960, US 90, FM 1413, and SH 146. An additional 1,500 ac of industrial development is predicted within outlying parcels in the central portion of the AOI for each of the alternatives. This estimate of induced development is shown on **Table 5-12**, with factoring for existing development in the intersection areas and constraints that may limit the potential for development, such as rail lines or waterways.

Scenario A of the *Envision Houston Region* report includes the current growth forecast and development for the region, based on the H-GAC's 2035 population forecast, and assumes the complete build-out of the planned regional toll system. Under this alternative, development follows tollway extensions along the circumferential pattern of the planned Grand Parkway system. The total acreage of these sources combined with existing development is approximately 270,000 ac for the year 2035.

The results of the 2008-2009 expert panel survey were combined with (1) information obtained during the 2007-2008 stakeholder meetings, and (2) data provided in the *Envision Houston Region* report to project the future reasonable and foreseeable development within the AOI of approximately 50,100 acres. The estimated 50,100 acres of future reasonable and foreseeable development includes the acreage of induced development associated with the Preferred Alternative which totals approximately 25,944 acres (discussed further in Step 6). The location of anticipated reasonable and foreseeable development and induced development is illustrated on **Exhibit 5- 2**. Because planned development and induced development have great potential to emerge within the AOI, induced growth effects were studied further.

5.6.3 Effects Related to Induced Growth

Induced growth may result in substantial ecological effects, based on the reasons previously provided. Habitat fragmentation and human activity is expected to continue throughout the AOI. Additional development could further reduce the amount of wildlife habitat available and also impact water quality. Soils and farmlands, archeological resources, as well as non-archeological resources could also be affected by induced growth. **Appendix O: Indirect Land Use Impacts Assessment** identifies and analyzes the potential for land use impacts related to the Preferred Alternative. The analysis of indirect land use impacts describes how land use would be different under two alternatives: one with the proposed transportation improvement, and one without it. Information gathered during the 2007-2008 stakeholder

meetings and the results of the expert panel survey conducted in 2008-2009 were also heavily relied upon for further analysis. Because induced growth could result in substantial impacts to wildlife habitat/threatened and endangered species, water quality, soils and farmlands, archeological resources, and non-archeological resources, these resources were studied further.

5.7 Step 6: Analyze Indirect Effects and Evaluate the Results

The objective of this step is to assess the effects identified in the previous step by determining magnitude, probability of occurrence, timing and duration, and degree to which the effect can be controlled or mitigated to determine if those effects have the potential to be substantial. Indirect effects identified in Step 5 have been analyzed herein, and indirect effects to resources within the AOI have been quantified to the extent practicable in Step 6. Where it is not possible to quantify indirect effects, they are discussed qualitatively.

Resource specific indirect impacts were evaluated within an identified AOI (the 15-minute travel shed shown in **Exhibit 5-1**) and are discussed in the following sections. Where possible, the project team quantitatively determined the potential induced or indirect growth impact of the Preferred Alternative compared to the No-Build Alternative based on mapping prepared as a result of the stakeholder and expert panel coordination described above in **Section 5.1.1** and in **Chapter 8 (Agency and Public Coordination)**.

5.7.1 Encroachment-Alteration Effects

5.7.1.1 Ecological Effects

<u>Vegetative Communities</u>

Loss of vegetation is a potential indirect impact from the proposed construction of the Preferred Alternative. As stated previously, the vegetative communities considered for direct and indirect impacts consist of agricultural wetlands, agricultural land, forest, forest wetlands, non-forested wetlands, and riparian zones. No ecological notable features (Lake Houston, Lake Houston Wilderness Area, salt domes) would be indirectly impacted by the Preferred Alternative. The loss of vegetation is not anticipated to extend beyond the construction limits and would not further encroach upon the ecological notable features. However, continued fragmentation of habitat could occur along the boundaries of the Preferred Alternative resulting from future construction of residential and commercial properties.

Waters of the U.S., including Wetlands

Regarding waters of the U.S., including wetlands, any potential direct impacts would be mitigated via local water quality rules and regulations, including state and federal laws. Because the proposed project would not alter the hydric regime or reduce diversity within the ecosystem, potential indirect effects as a result of encroachment alteration impacts are not anticipated.

Floodplains

Potential indirect effects on floodplains from roadway projects include increases in stormwater runoff due to changes in land use and increased development that may be accelerated by improved mobility and managed congestion on the transportation system to land surrounding the proposed facility.

Floodplains pose a constraint to development of transportation, commercial, and residential projects. This constraint relates to the regulation of these floodplains through county and local ordinances. While these ordinances do not prohibit development within the floodplain, they limit and regulate development to eliminate or reduce potential damage from future floods. Executive Order 11988 (1977), Floodplain Management, and county and local ordinances would minimize floodplain encroachment, to the extent allowable within the regulations, thereby preserving some of a floodplain's natural values. These values include retention of riparian vegetative buffers which preserve wildlife habitat and provide natural filtration for improved water quality.

5.7.1.2 Socio-Economic Effects

Changes in Travel Patterns and Access

In terms of traffic operations, construction of the Preferred Alternative would address existing issues related to system linkage, mobility, safety, and lack of infrastructure to support population growth. Construction of the Preferred Alternative is anticipated to provide system linkage, improve mobility, enhance safety, and provide infrastructure to support forecasted population growth. Populations residing within the AOI would experience some degree of adverse impact due to increased noise, and visual intrusion. However, these populations would benefit from the indirect effects of north-south mobility, improved local and regional access, and improved safety. Traffic diversion (or redistribution) to the existing local roadway network within the AOI as a result of tolling avoidance is not anticipated because as discussed in Chapter 1, the existing transportation system does not provide north-south connectivity for suburban communities and industries located within and near the Grand Parkway Segments H and I-1 study area. It is anticipated that

travelers would either utilize the tolled Preferred Alternative (if constructed) or continue to travel along the minor arterials and collector roadways currently utilized. Other detailed socio-economic indirect effects are discussed below.

Other Socio-economic Indirect Effects

With respect to encroachment-alteration effects to socio-economic resources, indirect impacts would be driven by changes in travel patterns and access associated with the proposed Grand Parkway project. The potential indirect impacts resulting from implementation of the proposed improvements would include improved vehicular access to employment opportunities, markets, goods or services, residential uses, and public facilities due to increased vehicular mobility. Other factors, such as real estate market conditions, local government development codes and plans, city financing opportunities (for various public facility improvements), anticipated growth, public facility and amenities siting (schools, health care facilities, greenspace, etc.), changes in energy costs, and other local and regional roadway improvements play a role in nearby land development investment decisions. However, real estate investment decisions are typically made with regard to factors such as transportation access and mobility. Although not the sole factor in inducing these development projects, the proposed project may have introduced a potential acceleration in these land development decisions.

Other socio-economic indirect impacts that could result from the implementation of the proposed project include expedited and localized economic growth due mainly to increases in land rents, market capture, and related development pressures associated with increased visibility and improved north-south mobility and access in the northeast region of the greater metropolitan area. It is anticipated that the proposed improvements would have a beneficial effect on overall socio-economic conditions within the AOI.

Environmental Justice

The environmental justice community, as a subset of the communities located within the AOI, would experience indirect impacts due to tolling that mirror those of the general population. No disproportional impacts are anticipated to affect environmental justice communities. Impacts relating to the economic impacts of tolling on environmental justice populations are considered a direct impact and have been addressed in **Chapter 4 (Environmental Consequences)**. As stated in **Chapter 4**, low-income populations who elect or can occasionally afford to pay access tolls would be impacted by toll rates, toll collection, and other matters associated with user fees. In addition, the economic impact of tolling the

mainlanes would be higher for low-income users because the cost of paying tolls would represent a higher percentage of household income than for non-low-income users. However, when considering the totality of significant individual or cumulative human health or environmental impacts, there appears to be an overall benefit provided to minority and/or low-income populations, as well as the entire community. The benefits associated with the proposed Grand Parkway Segments H and I-1 project would improve system linkage, mobility, and enhance safety. It would also provide infrastructure to support population growth. Regional indirect effects of toll facilities and managed lanes are assessed in **Section 5.9**.

Potential adverse effects would include displacements of low-income or minority persons, or groups of persons, and additional noise and visual impacts. Beneficial effects could also occur to these populations. For example, induced land use development could create additional job opportunities and increased access to job opportunities through enhanced transportation infrastructure. Indirect impacts pertaining to public facilities and services access, traffic operations, and traffic noise would be experienced by the environmental justice population to the same extent and in the same manner (whether positive or negative) as experienced by the non-environmental justice population. Because indirect effects to environmental justice communities of concern can be both adverse and beneficial, and because proactive public involvement and coordination with local planning officials can help avoid disproportionate impacts, potential indirect effects of Grand Parkway Segments H and I-1 on environmental justice communities of concern are not considered to be substantial. The proposed project may have a beneficial indirect impact on the overall socio-economic conditions within the AOI.

Visual and Aesthetic Impacts

As a result of construction of any of the Preferred Alternative, and with the implementation of lighting, both potential positive and negative indirect impacts could result. The design of the proposed project would be in keeping with the TxDOT Houston District's Green Ribbon Project. When proper corridor lighting is applied to roadway design, the increased visibility would provide social and economic benefits to the public, including the following:

- Reduction of nighttime accidents; and
- Aid of police protection to the community.

Roadway lighting also has some negative side effects that would be associated with the environmental impacts of lighting design. Negative side effects include the following:

- Confusion or visual distraction;
- Lighting structures can create roadside hazards and
- General public annoyance.

These items would be taken into consideration when designing the roadway lighting system of the proposed corridor. A properly designed lighting system would minimize negative light pollution aspects and would increase the social and economic benefits to the public. The lighting, signage, landscape, and roadway designs would be used to enhance the aesthetics of the proposed AOI, not destroy it. Other indirect visual and aesthetic effects may be related to induced development. These impacts may include a change in the viewshed or ambient light within the AOI. Outside of zoned areas, this effect would not be regulated. However, indirect visual and aesthetic impacts to the AOI are anticipated to be minor.

Economic Impacts

The estimated economic impacts resulting only from the highway construction expenditures on the Segments H and I-1 reasonable alternatives in Montgomery, Harris, Liberty, and Chambers counties are presented in this section.

Methodology

The economic analysis presented in this section discusses potential direct and indirect impacts that would occur as a result of the construction of Segments H and I-1. The analysis used a computer-based modeling program called REMI.

As dollars are spent and re-spent within each county economy, this translates into direct, indirect, and induced impacts to value-added, total output, employment, and indirect business taxes. Direct impacts are impacts that affect only the specific industry in which expenditures are spent. Direct impacts resulting from construction expenditures would occur only within the construction industry. Indirect and induced impacts, commonly referred to as multiplier impacts, occur in all other applicable industries within the user defined impact area. Construction industry purchases of goods and services from other industries and the purchases by those industries, in turn, of goods and services from other industries create indirect impacts. Induced impacts are the result of the purchases by employees from labor income received from the directly and indirectly impacted industries. Total economic impacts are the cumulative direct, indirect, and induced impacts.

Travel Efficiencies and Tolling Impacts

Changes in travel demand characteristics stemming from the Grand Parkway result in travel-time, vehicle-operating, and safety cost changes accruing to households and business within the defined study area, and thus results in economic impacts.

Grand Parkway is expected to increase vehicle miles travelled in the regional study area. This would increase vehicle-operating costs and thus negative economic impacts, as those direct costs, are attributed to the sectors in the economic model (as appropriate, depending on the trip purpose) and run through the economic multipliers. Although network vehicle miles travelled are expected to increase with the implementation of the Grand Parkway, resulting in vehicle operation cost increases, the vehicle hours travelled are expected to decline, leading to travel time savings. Accidents, as a function of vehicle miles travelled and the accident rates per mile, are also expected to decline in aggregate across the analysis horizon, as traffic shifts from the overall network to the Grand Parkway highway (with the highway configuration having notably reduced accident rates than the overall network). Consequently, the accident reduction leads to societal accident costs savings, which are translated into positive economic impacts. Imposition of tolling on the local population is an out-of-pocket cost to household and businesses and generally by itself results in negative economic impacts.

Combining the results of the various travel demand characteristic related economic impacts yields net positive results across the entire analysis horizon, although the impacts are negative in a few years following the opening of the Grand Parkway facility, but within a few years revert to net positive impacts that escalate rather quickly thereafter. Reasoning for the pattern of impacts, beginning in the negative and then crossing into the positive and escalating thereafter, is driven by the negative impacts attributable to the vehicle operating cost increases and tolling impositions that are not sufficiently offset initially by accident and travel time savings. Furthermore, because the travel time savings escalate at a higher rate than the annual changes in the other travel demand characteristic related components, the aggregate savings turn positive, together with the resulting total economic impacts around 2025.

Combining all the components, the economic impacts resulting from travel efficiencies and tolling implementation on the Grand Parkway is estimated to amount to $1.44 billion in economic value-added and 10,030 job years over the analysis horizon spanning 2019 through 2039 for the regional study area, and $1.52 billion and 11,120, respectively for the entire State of Texas.

Summary of Economic Impacts

This analysis examined two main sources of potential economic impacts arising from the Grand Parkway investment: expenditures and travel efficiencies based. The travel efficiency benefits arise as a result of (dis)savings accruing to users of the facility such as travel time savings, vehicle operating costs savings and accident savings, while the expenditures-based impacts are a function of the magnitude of the outlays on the facility and the input-output structure of the regional economy.

Liberty County is expected to be impacted, in terms of the economic indicators, the most of the four aggregated counties because the largest percentage of total highway construction expenditures would occur within Liberty County. Liberty County is followed by Chambers, Montgomery, and Harris counties, respectively, in terms of the magnitude of the expected economic impacts.

Based on the REMI model economic analysis, the proposed Grand Parkway corridor is expected to bring employment and economic activity to the Houston regional and statewide economies. The combined (of the different impact categories), cumulative (over the entire 2016-2039 analysis horizon) total employment impact is projected to amount to almost 21,100 job-years in the Houston Region and 24,500 Statewide. Corresponding economic activity (Gross Regional Product) impacts are projected to measure $2.1 billion and $2.4 billion in increased value added for the Houston Region, and Statewide, respectively.

The primary economic benefits of the proposed project are improved accessibility and improved traffic congestion management. The proposed project would provide a route for truck traffic from the Port of Houston to other industrial areas within the project area without traveling through the congested freeways and local roadways in the city. This would result in substantial time and cost savings for travelers and result in some congestion relief on the freeways within Houston. Reduced congestion would result in increased safety, which would be an added economic benefit.

5.7.2 Induced Growth Effects

Table 5-10 provided in **Section 5.6.2** summarizes reasonably foreseeable development within the AOI gathered from the data sources noted in the previous **Sections 5.1.1 and 5.2**. The total planned development, which includes reasonably foreseeable development listed in **Table 5-10**, digitized growth projections from the *Envision Houston* report, and induced development based on the results of the expert panel survey, totals 50,100 ac within the AOI. Based on the results of the 2008-2009 expert panel survey, and after geographic analysis of the areas identified for potential induced growth, the study team

determined that approximately 25,944 acres (approximately 52 percent of planned development) in the AOI is dependent on the Grand Parkway Segments H and I-1 (**Table 5-12**).

As shown in **Table 5-11**, approximately 31 percent of the total land in the AOI is already developed, and approximately 7 percent of the AOI is either planned for development independently of the project or would potentially develop as a result of construction of Grand Parkway Segments H and I-1. Therefore, approximately 38 percent of the AOI is already developed or planned for development, leaving approximately 57 percent or 437,830[1] ac of open land available for development.

Table 5-11: Land Development within the AOI

Type of Land Development	Acres	Square Miles	Percentage
Developed Land	239,370	374	31
Planned/Induced Development	50,100*	78	7
Potential Developable/Open Land**	437,830 ***	684	57
Total land in the AOI	**770,300**	**1,204**	**100**

Source: Study Team, 2008
*Note: Total acreage based on sum of induced development based on results of expert panel survey and reasonably foreseeable development.
**Note: Several creeks, streams, and a river run through a large portion of the potential developable land. Adjacent areas located within the 100-year floodplain would pose a challenge for development in these areas
*** Potential developable land is an estimated sum, based on the total land available within the AOI, minus areas previously developed and planned for development, parkland, and land containing mapped Waters of the U.S.

As noted from the 2008-2009 expert panel survey, the most reasonable area of development indirectly caused by construction of the Preferred Alternative would be within the AOI along the length of the proposed Segments H and I-1. **Table 5-12** shows an estimate of induced developmental effects for the No-Build, the alternatives studied, and the Preferred Alternative based on the results of the expert panel survey conducted in 2008-2009, the *Envision Houston Region* report growth projections, and meetings with stakeholders held throughout the planning process beginning in 2007-2008. This data is a summary per resource based on acreages presented in **Table 5-10**, the *Envision Houston* report, and anticipated induced development acreages provided by the expert panel survey conducted in 2008-2009, adjusted to account for constraints and existing development present at the major intersections.

[1] Potential developable land is an estimated sum, based on the total land available within the AOI, minus areas previously developed and planned for development, parkland, and land containing mapped Waters of the U.S.

Table 5-12: Potential Indirect Land Use and Resource Impacts Within the AOI*

Alternative	Description	Total Acres of AOI	Potential Acres of Induced Development within AOI	Acres of Parkland within Induced Development	Acres of 100-yr Floodplains within Induced Development	Acres of Forests within Induced Development	Acres of Prime Farmland within Induced Development	Acres of T&E Habitat within Induced Development	Acres of Waters of the U.S. within Induced Development	Acres of Wetlands within Induced Development
1 (No-Build)	No-Build	--	--	--	--	--	--	--	--	--
2	A-2, B-1, C-2	770,300	24,912	0	2,072	2,597	14,129	7	0	2,870
3	A-2, B-1, C-3	770,300	24,912	0	2,072	2,597	14,129	7	0	2,870
4	A-2, B-2, C-2	770,300	26,413	0	2,072	2,615	14,432	7	0	3,015
5	A-2, B-2, C-3	770,300	26,413	0	2,072	2,615	14,432	7	0	3,015
6	A-2, B-5, C-6	770,300	27,502	0	3,167	2,634	14,277	7	0	3,671
7	A-4, B-1, C-2	770,300	24,442	0	2,006	2,518	14,091	7	0	2,852
8	A-4, B-1, C-3	770,300	24,442	0	2,006	2,518	14,091	7	0	2,870
9	A-4, B-2, C-2	770,300	25,944	0	2,006	2,536	14,394	7	0	2,997
10	A-4, B-2, C-3	770,300	25,944	0	2,006	2,536	14,394	7	0	2,997
10R**	A-4, B-2, C-3	770,300	25,944	0	2,006	2,536	14,394	7	0	2,997
11	A-4, B-5, C-6	770,300	27,033	0	3,102	2,555	14,239	7	0	3,653

* Calculations reflect specific land uses that were assessed for indirect impacts.
** Preferred Alternative
Study Team, 2012

The general estimate of the total acres of undeveloped land within the AOI and the areas of potential induced development does not take into consideration the potential for existing physical and natural barriers to induced development, such as railroad tracks, and/or hazardous material sites in the southern corridors. Salt domes (notable features), a superfund site, and the industrialized nature of the AOI may limit development. Floodplains, as well as the Lake Houston Wilderness Park along the northern corridor following FM 1485, would also be deterrents to development in these areas.

Based on input received from the entities with planning jurisdiction and other stakeholders, it is anticipated that only a portion of these areas along each alternative has the potential to develop even in the absence of the proposed project. In addition, while the Preferred Alternative may influence the rate of development based on H-GAC growth models for the year 2035 which include the proposed Grand Parkway facility, areas that currently are experiencing low growth rates would continue to remain relatively unchanged (e.g. portions of Liberty County). However, increased access through Liberty County may indirectly impact economic development by increasing commercial and industrial development associated with recent Port of Houston expansion projects.

5.7.3 Effects Related to Induced Growth

Vegetative Communities

The direct impacts to vegetation for the Preferred Alternative is approximately 1,700 ac, including land in agricultural use, forest, riparian zones, and non-forested wetlands. Areas of potential indirect land use impacts to undeveloped land which contains the remaining vegetative communities are estimated to be approximately 25,944 ac with the construction of the Preferred Alternative (**Table 5-12**). Of the 25,944 ac of vegetation potentially impacted by induced development, it is estimated that indirect impacts to mature woody vegetation (forest) would be 2,536 ac for the Preferred Alternative within the AOI (**Table 5-12**). The No-Build Alternative would not indirectly impact vegetative communities along the corridor. Construction of the new corridor may indirectly impact vegetation communities due to future development; however, indirect impacts to vegetative resources are not expected to be substantial when compared to the acreage of vegetation available within the entire AOI.

Waters of the U.S., including Wetlands

Within the AOI there are 41,665 ac of waters and 120,141 ac wetlands, as defined by the National Wetland Inventory and the topographical maps utilized for this analysis. The potential direct impact to wetlands and

Waters of the U.S. for the Preferred Alternative is estimated to be approximately 327.4 ac of wetlands and 22.9 ac of potential Waters of the U.S. The potential indirect impacts to Waters of the U.S. and wetlands due to induced development within the AOI is anticipated to be zero acreage of Waters of the U.S. and 2,997 ac of wetlands for the Preferred Alternative (**Table 5-12**). Not all of these streams or wetlands would be considered jurisdictional by the USACE and subject to protection under Section 404 of the CWA. Regardless of whether the forecasted development would be public or private, these developments would have to comply with Sections 404 and 401 of the CWA, which regulates the filling of and encroachment on these resources. The USACE administers Section 404 of the CWA and operates under "no net loss" policy for wetlands, requiring avoidance and minimization of impacts, and compensatory mitigation for unavoidable impacts. Compensatory mitigation may include mitigation banking under specific criteria defined and approved by EPA and the USACE. Because of the mitigation required, indirect impacts to Waters of the U.S. including wetlands would be considered minor.

Floodplains

Within the AOI, there are 179,507 ac of 100 year floodplains, 19,813 ac of which are within current and future development under the No-Build Alternative. The anticipated direct impact to floodplains under the Preferred Alternative is approximately 159 ac. The potential indirect impacts to floodplains are approximately 2,006 ac under the Preferred Alternative, based on the expert panel survey estimates of potential developed areas (**Table 5-12**). However, indirect impacts to floodplains would be considered minor because the areas located within the 100-year floodplain are subject to local regulations and would pose a challenge for development. Therefore, the indirect effects to floodplains are anticipated to be minimal.

Wildlife

Potential indirect effects on wildlife habitat from roadway projects include impacts from induced development. Approximately 437,830 ac of potential wildlife habitat is located with the AOI. Of the available habitat, approximately 25,944 ac of vegetation, including land in agricultural use, may be indirectly impacted (**Table 5-12**). Existing wildlife habitat within the AOI is either protected from development by a park or floodplain designation (e.g. the Lake Houston Wilderness Area, which is a notable feature), or is interspersed with existing development and pasturelands. The proposed project would not alter the hydric regime or reduce diversity within the ecosystem.

Loss of wildlife habitat or habitat fragmentation would be a potential indirect impact from proposed roadway improvements. Specifically, wildlife habitat could be indirectly impacted by the proposed project if the roadway improvements influence an increase in development in the AOI. Under the No-Build Alternative, a total of approximately 270,000 ac are already developed and planned for development independently of the Grand Parkway. The direct impact to wildlife habitat under the Preferred Alternative is estimated to be approximately 665 ac. Areas of potential indirect land use impacts to undeveloped land are estimated to be approximately an additional 25,944 ac with the construction of the Preferred Alternative (**Table 5-12**). This portion of undeveloped land that would be indirectly impacted contains wildlife habitat consisting of forested wetlands, non-forested wetlands, farmland, and forest. As noted in **Chapter 4 (Environmental Consequences)**, the existing habitat has largely been fragmented by development, the timber industry, and agricultural practices. Activities within the AOI may have the potential to impact foraging, breeding, or roosting activities of some species, and some terrestrial species may relocate due to changes in available habitat. However, species within the AOI are largely found throughout the region, and substantial impacts to individual species are not anticipated. Therefore, additional indirect impacts to wildlife species or their habitats are not expected to be substantial.

Threatened and Endangered Species

To determine the potential indirect impacts to threatened and endangered species, known occurrences of federal- and state-listed species provided by the Texas Natural Diversity Database (TxNDD) were compared with the Grand Parkway Segments H and I-1 study area (TPWD, 2012). In addition, potential habitat for the bald eagle, red-cockaded woodpecker, and Texas prairie dawn are within the AOI. The TPWD review gave the potential threatened and endangered species habitat as one combined GIS file, and did not distinguish individual species or habitat locations.

Under the No-Build Alternative, an approximate total of 270,000 ac of land is already developed and planned for development within the AOI. Preferred habitat located within these areas designated for future development could be negatively impacted where federal oversight would not be required (such as with private residential and commercial development). However, developers are required to coordinate with the USFWS on all activities involving threatened and endangered species.

Approximately 35,150 ac were identified by the TPWD TxNDD as potential threatened or endangered species habitat within the AOI for the bald eagle, Texas prairie dawn, red-cockaded woodpecker, and the

Rafinesque's big-eared bat. The TxNDD review for habitat documented that approximately 11,680 ac are included within parks, which are protected from development. Approximately 10,860 ac of the potential threatened and endangered species habitat documented within the AOI occurs within the 100-year floodplain. Therefore, development in these areas may be limited and is currently regulated. Approximately 7 ac of these areas designated as potential habitat for threatened or endangered species are located within the areas denoted by the expert panel as potentially developed areas under the Preferred Alternative.

It is expected that any undeveloped areas, both planned and unplanned, could be developed under the No-Build Alternative, and continued loss of habitat may occur if these areas are not developed in compliance with the Endangered Species Act. It is impossible to determine the degree to which future development would comply with the Endangered Species Act. However, based on the land use analysis **(Chapter 4, Environmental Consequences)** and current federal and state laws and regulations, it is expected that the development of properties containing threatened or endangered species preferred habitat within the AOI would not be affected by the Preferred Alternative of the Grand Parkway Segments H and I-1 project. Therefore, indirect impacts are not anticipated from the proposed Grand Parkway Segments H and I-1 project on the bald eagle, red-cockaded woodpecker, or Texas prairie dawn within the AOI.

Water Quality

Potential impacts to Waters of the U.S. from development indirectly related to the project include placement of fill and degradation of function through encroachment and as a result of increased runoff. Within the AOI there are 41,665 ac of waters and 120,141 ac wetlands, as defined by the National Wetland Inventory and the topographical maps utilized for this analysis. Any potential direct impacts would be mitigated via local water quality rules and regulations, including state and federal laws. The Coastal Water Authority Canal system (a notable feature and potential Waters of the U.S.) is partially located within the path of planned and induced development. As previously stated, conversion of farmland is anticipated to continue with the forecasted development trend. Significant impacts to the Coastal Water Authority Canal system are not anticipated given the regulatory review process associated with Waters of the U.S.; however, the true degree of impact to the canal system as a whole resulting from future private development cannot be determined at this time.

Development induced by the Preferred Alternative could result in some adverse effects to water resources through degradation of surface water and groundwater. Development effects that contribute to water quality degradation include increased impermeable surface and increased non-point source pollution (e.g. from fertilizers, pesticides, sediments, and vehicle residues). The indirect impacts of this development could include increased stormwater runoff velocities and pollutant loads leading to impacts to surface waters and, subsequently, groundwater.

Within the direct impact's study area of the Preferred Alternative, two stream segments are listed on the 2010 303(d) List: Cedar Bayou Above Tidal (Segment 0902) and Cedar Bayou Tidal (Segment 0901). Water quality protection is mandated by numerous federal, state, and local ordinances within the AOI. Water quality in the State of Texas is protected by Sections 401 and 402 of the Clean Water Act (CWA) and the Texas Water Code.

Section 401 Water Quality Certification of Federal Actions, such as permits for work in jurisdictional waters, requires that specific Best Management Practices (BMPs) be used to address erosion, sedimentation, and post-construction total suspended solids control. Substantial differences in impacts to water quality are not anticipated for the Preferred Alternative compared to the No-Build Alternative. Substantial indirect impacts to the water quality of Lake Houston (a notable feature) are not anticipated; however, impacts could occur as a result of planned or induced development.

No public or private groundwater wells would be impacted by development under the No-Build Alternative. The Preferred Alternative would require groundwater pollution prevention measures to minimize potential impacts to up to seven well capture zones. Indirect impacts to groundwater wells and capture zones are anticipated to be minor in the context of the regional development as a whole.

Soils and Farmlands

The AOI contains approximately 348,650 ac of prime farmland soils. Within areas estimated to be indirectly impacted by construction of the Preferred Alternative, the approximate area of farmland soils is approximately 14,394 ac (**Table 5-12**). However, the potential indirect impacts to prime farmland soils related to the reasonably foreseeable development is anticipated to be minimal compared to the total acreage of prime farmland soils found within the AOI. As documented in **Chapter 4 (Environmental Consequences)**, the Preferred Alternative would directly impact approximately 960 ac of prime farmland

soils. However, this acreage is considered to be a minor impact, and scored below 160 on the Natural Resources Conservation Service (NRCS) Form CPA-106. Actual indirect farmland conversion due to increased development associated with reasonably foreseeable projects is also anticipated to be considered a minor impact based on NRCS ratings; therefore, no substantial indirect impacts to prime farmland soils are anticipated with the proposed project. The No-Build Alternative would not indirectly impact farmland soils; however, conversion of farmland soils in the central area would continue with the current development trend.

Archeological Resources

Land use changes have the potential to impact archeological resources through site clearing, grading, or excavation during development. Some of the development may fall under federal or state regulatory resource protection review, and therefore, archeological sites could be protected, preserved, and mitigated. Within the AOI, numerous archeological sites may exist, especially within the land available for development adjacent to creeks. Direct impacts to known archeological sites are not anticipated as a result of construction of the Preferred Alternative. Indirect impacts to archeological sites could result from construction of the Preferred Alternative; however, it cannot be determined whether this development would result in substantial impacts to these sites because the quantity, location, and integrity of individual resources are unknown.

Non-Archeological Historic Resources

For the purpose of this analysis, non-archeological historic resources include those buildings, structures, objects, and non-archeological districts that are listed or eligible for listing in the National Register of Historic Places (NRHP). Indirect impacts to non-archeological historic resources could occur if the proposed improvements were to result in changes to land use and spur development that would replace these resources. Therefore, any indirect impacts to land use changes attributed to the proposed improvements of Grand Parkway Segments H and I-1 have the potential to have an indirect impact to historic resources. As with archeological sites, some of the induced development related to the Preferred Alternative may fall under federal or state regulatory resource protection review; therefore, these historic properties would be protected or preserved. However, most of the development induced by the Preferred Alternative would be (private) residential and commercial development, and would not fall under the regulatory review process; therefore, historic-age properties potentially affected by such development

would not have protection under federal or state laws. Components of the Dayton Canal system (which includes the NRHP-eligible Dayton Main Canal and Big Ditch) are notable features which are located within the path of planned and induced development. As previously stated, conversion of farmland is anticipated to continue with the forecasted development trend. Significant impacts to the Dayton Main Canal and Big Ditch are not anticipated given the regulatory review process associated with the NRHP; however, the true degree of impact to the Dayton Canal system as a whole resulting from future private development cannot be determined at this time.

5.8 Step 7: Assess Consequences and Consider/Develop Mitigation (When Appropriate)

In summary, construction of the Preferred Alternative would result in indirect impacts to various ecological and socio-economic resources throughout the AOI. The severity of the anticipated indirect impacts ranges from minor to less than significant depending on the resource. For example, indirect impacts to Waters of the U.S., including wetlands; floodplains; water quality; soils and farmland are anticipated to be minor. Indirect impacts to vegetation and wildlife are not anticipated to be substantial compared to the breadth of those resources found within the AOI. Beneficial indirect impacts are anticipated in terms of enhanced travel patterns, increased accessibility and traffic congestion management, economic efficiency benefits related to travel, and increased employment and economic activity throughout the greater Houston region. The potential exists for some populations within the AOI to bear minor adverse effects associated with visual, traffic noise, and access impacts.

The potential for any of the AOI's notable features to be significantly or negatively impacted is unlikely as a result of the construction of the Preferred Alternative. Lake Houston and the Lake Houston Wilderness Park are protected resources that would serve as development deterrents in that portion of the AOI. The industrialized nature of the various salt dome locations would likely limit or discourage any future development induced by the Preferred Alternative. The Dayton Canal system and the Coastal Water Authority Canal system are not anticipated to be significantly impacted given the regulatory review process associated with these resources.

Based on the results of the information obtained during stakeholder meetings held in 2007-2008, the **Indirect Land Use Impacts Assessment** (**Appendix O**) initially conducted in 2008, and the results of the 2008-2009 expert panel surveys, it is evident that the proposed Grand Parkway Segments H and I-1

presents a strong potential for land use changes and has influenced development decisions within the AOI. Mitigation of the potential 25,944 acres of induced development within the AOI considered for this assessment would rest with the agencies that have the authority to implement such controls. This authority rests with the municipal governments and to a lesser extent, the county governments. Examples of municipal government regulations include land development code tree ordinances. The responsibility of transportation providers such as the Grand Parkway Association, TxDOT, local and regional transit agencies, and the local governments would be to implement a transportation system to complement the land use or development controls currently in place.

5.9 Indirect Regional Effects of Toll Facilities and Managed Lanes

Regional Perspective

The freeway and toll road system is a major component of the Houston-Galveston regional transportation system. Currently, the freeway/toll road system represents nearly 19 percent of regional lane miles, but carries more than 48 percent of VMT. Although growth in vehicle travel may be mitigated by transit expansion, improved operation of major arterial streets and growth of teleworking and e-business options, regional and State economic growth would require continued expansion of the region's freeway/toll road network.

METRO is the region's largest transit provider. Its service area encompasses approximately 1,300 square miles. The agency has 100 miles of barrier-separated HOV lanes operating on six freeways that carry 73,000 carpool and vanpool passengers daily.

Inherent to the region's freeways are the high costs of maintenance and improvements. Although they generate few operational costs once constructed, building, maintaining, and expanding freeway facilities is very expensive. Over the last few years, the idea of user-fee based roadways has been growing in acceptance and popularity, and recently the Texas Transportation Commission adopted a favorable toll road policy to promote the study of additional toll roads throughout the State.

The Houston-Galveston region is a national leader in using toll roads as a method of financing facilities and improving mobility for more than two decades. Currently, there are four toll roads in operation - the Hardy, Sam Houston Parkway, Westpark, and Fort Bend Parkway Toll Roads. As seen in **Table 5-13**, the system of toll roads and "managed" (HOT) lanes is planned to grow from approximately 947 lane miles today to

over 2,902 lane miles by 2035. In addition to increasing system capacity, the development of managed lanes would provide travel priority for transit buses, carpools, and vanpools on an expanded number of roadways, thereby greatly increasing their attractiveness to commuters and reducing congestion.

Table 5-13: Transportation System Expansion (Lane Miles)

Year	Freeway	Toll Roads	HOT Lanes	Arterial	Total Lane Miles
2009 Network	3,669	658	289	19,955	24,571
2035 RTP	4,339	2,049	853	25,614	32,855

Source: H-GAC, Regional Cumulative and Indirect Effects of Toll Facilities, October 2013.

Managed lanes use pricing as a means to manage demand. In essence, during peak periods managed lanes carry vehicles with a certain minimum number of occupants for no or low toll amounts with SOV paying a higher toll. This "management" allows for fine tuning of HOV lane eligibility because tolls can be varied to find the appropriate price to generate only sufficient additional demand to utilize any spare capacity. This use of capacity would not slow travel time because the pricing component ensures that the federal requirements regarding HOT lanes with speed limits greater than 50 mph must maintain a speed of 45 mph 90 percent of the time during peak periods is upheld.

Figure 1 in **Appendix P** shows the toll and managed lane improvements to the roadway system contained in the fiscally constrained RTP for the year 2035.

As regional and population and employment continue to grow, transit will become an increasingly important tool for improving mobility. Transit is forecasted to significantly increase from its current 485,000 daily passenger boarding's, to over 725,000 daily passenger boarding's by 2035. This significant increase will be attributed to:

- Expansion of transit services (increased bus and rail transit services);
- New transit modes (commuter rail transit and signature express bus service);
- Transit connectivity to multiple employment centers; and
- Coordination of transit services among regional public transportation providers.

The 2035 METRO Long Range Plan (**Figure 5-1**) is an iterative process incorporating the 2025 METRO Solutions Plan and future mobility needs identified in regional planning efforts. METRO's 2035 Long Range

Plan recommends significant expansion of the current transit system and includes a network of integrated high capacity transit facilities on major travel corridors. This plan also identifies significant service expansions beyond the METRO service area. New improvements scheduled for implementation through the year 2035 include high occupancy tolls, a new intermodal terminal, park-n-ride facilities, and several new high capacity transit corridors throughout the region. Additional key elements of the METRO Solutions plan include:

- 89 miles of fixed light rail transit (LRT);
- 84 miles of commuter rail transit (CRT); and
- 40 miles of signature bus service.

Figure 5-1 shows the future corridor and capital facilities projects in the 2035 METRO Long Range Plan.

Figure 5-1: Proposed 2035 Future Corridor and Capital Facilities Projects

Source: H-GAC, 2013

Demographics

The following information and projections provide an overview of H-GAC demographics at the regional level. The 2000 population of the Houston-Galveston region is over 4.5 million people, which includes eight counties and covers more than 7,000 square miles. Several counties in the region are listed among the top ten for growth in the nation having experienced double-digit population growth for over a decade.

Significant investments have been made to the regional transportation system, such as the expansion of our major highways and our toll road systems. The region is anticipated to grow by more than 3 million new residents by 2035. **Table 5-14**, below, shows the projected demographic changes expected in the region by 2035.

Table 5-14: Projected Demographic Changes in H-GAC Region 2000-2035

H-GAC Region	2000	2035	Percent Change
Population	4,669,571	8,835,000	89.20
Households	1,639,401	3,302,013	101.40
Percent Minority	52.10	68.97	16.87
Percent Non-Minority	47.80	31.02	-16.87
Percent Zero-Auto Households	8.28	14.10	5.82

Source: U.S. Census Bureau, 2000.

As can be seen in **Table 5-15**, significant changes in the distribution of household income are also projected to occur in the H-GAC region between 2000 and 2035. This analysis divided household income into five groups: 0 to $15,000; $15,000 to $30,000; $30,000 to $50,000; $50,000 to $75,000; and $75,000 and above. The income figures are presented in 1995 base year dollars since the travel demand model is estimated based on the 1995 household survey. The year 2000 household income distribution has the least percentage of households in the lowest income quintile ($0 to $15,000) and the highest percentage of households in the highest income quintile ($75,000 and above).

The projection for year 2035 shows this distribution trend reversing. By 2035 the highest income quintile would have the lowest household income percentage share. While the percentage of households within the middle quintile is projected to increase by 2035, the largest projected increase is in the lowest quintile, increasing by 3.79 percent. These projections indicate that overall wealth, as indicated by income, would decrease in the future. This shift in the percentage of the populations within income quintiles indicates a potential change and possible increase in future EJ zones.

Table 5-15: Percent of Households in the H-GAC Region within Income Categories

Household Income (1995 Dollars)	2000 (Percent)	2035 (Percent)	Percent Change
$0 to $15,000	14.31	18.07	3.79
$15,000 to $30,000	18.32	21.60	3.28
$30,000 to $50,000	22.27	24.41	2.14
$50,000 to $75,000	18.91	19.03	0.12
$75,000 and above	26.19	16.89	-9.30

Source: U.S. Census Bureau, 2000.

Conclusion

The expanding regional roadway network, including tolled facilities and managed lanes, along with the expanding transit network could have indirect and cumulative impacts. However, the impacts are not isolated to one location and would be better considered at the regional level. As a result, the consideration of the regional tolled roadway network is included in the cumulative impacts portion of this document (**Section 6.4**).

CHAPTER 6: CUMULATIVE IMPACTS
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CHAPTER 6
CUMULATIVE IMPACTS

This chapter examines the cumulative impacts of the proposed Grand Parkway Segments H and I-1. The Council on Environmental Quality (CEQ) has established regulations for implementing provisions of the National Environmental Policy Act (NEPA). The CEQ regulations direct agencies to assess the potential for project-related direct, indirect, and cumulative impacts. This analysis follows the requirements and process outlined in 23 Code of Federal Regulations (CFR) 771, the Federal Highway Administration (FHWA) Technical Advisory 6640.8A, the Transportation Research Board's (TRB) National Cooperative Highway Research Program (NCHRP) *Report 466: Desk Reference for Estimating the Indirect Effect of Proposed Transportation Projects* (TRB, 2002), *Considering Cumulative Effects Under the National Environmental Policy* Act (CEQ, 1997), *Questions and Answers Regarding the Consideration of Past Actions in Cumulative Effects Analysis* (FHWA, 2003), CEQ's memorandum *Guidance on the Consideration of Past Actions in Cumulative Effects Analysis* (CEQ, 2005), the Texas Department of Transportation's (TxDOT) *Guidance on Preparing Indirect and Cumulative Impact Analyses* (TxDOT, 2006), and *Revised Guidance on Preparing Indirect and Cumulative Impact Analyses* (TxDOT, 2010).

A FHWA and TxDOT indirect and cumulative impacts (ICI) workshop was held in October 2008 that resulted in additional ICI guidance which influenced the preparation of this Final Environmental Impact Statement (FEIS). This evaluation of cumulative impacts follows the guidance from the 2008 workshop and the eight steps in TxDOT's *Revised Guidance on Preparing Indirect and Cumulative Impact Analyses* (September 2010).

6.1 TYPES OF IMPACTS: DIRECT, INDIRECT, AND CUMULATIVE

As shown in **Table 6-1**, there are three types of impacts that may be caused by a roadway project: direct, indirect, and cumulative. Direct impacts are those impacts which are caused by the action and occur at the same time and place (40 CFR § 1508.8). Indirect impacts are those impacts which are caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable (40 CFR § 1508.8). CEQ regulations define a cumulative impact as an impact which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions (40 CFR § 1508.7).

Table 6-1: Distinction Between Types of Impact

Type of Impact	Direct	Indirect	Cumulative
Nature of Impact	Typical/Inevitable/Predictable	Reasonably Foreseeable/Probable	Reasonably Foreseeable/Probable
Cause of Impact	Project	Project's Indirect Impacts	Project's Direct and Indirect Impacts and Impacts of Other Activities
Timing of Impact	Project Construction and Implementation	At Some Future Time Other Than Direct Impact	At Time of Project Construction, in the Future or in the Past
Location of Impact	At the Project Location	Within Boundaries of System Affected by the Project	Within Boundaries of System Affected by the Project

Source: NCHRP Report 466, 2002

Direct impacts are discussed and identified in **Chapter 4 (Environmental Consequences)** and indirect impacts are discussed in **Chapter 5 (Indirect Impacts)**. This chapter focuses on an analysis of cumulative impacts that were considered with the proposed project.

6.2 METHODOLOGY

Relatively minor individual impacts may collectively result in substantial cumulative impacts, and project-related direct and indirect impacts must be analyzed in the context of non-project-related impacts that may affect the same resources. Cumulative impacts are the incremental impacts that the project's direct or indirect impacts have on a resource in the context of the myriad of other past, present, and future impacts on that resource from related or unrelated activities. This analysis of cumulative impacts relies heavily on both existing land use impacts and the anticipated land use changes anticipated to occur in the project area and the impacts these changes would have on the resources considered in this analysis.

The cumulative impacts analysis allows the decision maker to evaluate the incremental impacts of any one of the proposed reasonable alternatives in light of the overall health and abundance of selected resources. In essence, a cumulative impacts evaluation creates a model of the predicted condition of each resource that is independent of the proposed project, and then analyzes the expected direct and indirect impacts or other past, current, or planned projects in the same area of the project within that context to determine if there is a cumulative effect. The evaluation process for each resource considered may be expressed in shorthand form as follows:

BASELINE CONDITION + PROJECT IMPACTS + FUTURE EFFECTS = CUMULATIVE IMPACTS
(historical and current) (direct and indirect) (expected projects)

The evaluation of cumulative impacts follows the eight steps in TxDOT's *Revised Guidance on Preparing Indirect and Cumulative Impact Analyses* (September 2010). To conduct the cumulative impact analysis it was essential to build on information derived on the direct and indirect impacts analyses. Unlike direct impacts, quantifying indirect and cumulative impacts may be difficult, since a large part of the analysis requires an eye to the future and what may happen in the study area. This eight-step approach was utilized to assess the potential cumulative impacts of the past, present, and reasonably foreseeable actions on the resources in the proposed study area. The eight-step methodology from TxDOT's *Revised Guidance* was utilized to assess the potential cumulative impacts of the past, present, and reasonably foreseeable actions to the resources in the project area and is depicted in **Table 6-2**.

Table 6-2: TxDOT Eight-Step Approach to the Cumulative Impacts Analysis

Step No.	Step
1	Identify the resources to consider in the analysis.
2	Define the study area for each affected resource.
3	Describe the current health and historical context for each resource.
4	Identify direct and indirect impacts that may contribute to a cumulative impact.
5	Identify other reasonably foreseeable actions that may affect resources.
6	Assess potential cumulative impacts to each resource.
7	Report the results.
8	Assess and discuss mitigation issues for all adverse impacts.

Source: Revised Guidance on Preparing Indirect and Cumulative Impact Analyses. TxDOT, September 2010

Steps 1 through 6 will be applied to each resource. Once each resource is analyzed, Steps 7 and 8 will follow and address all identified resources. The methodology used to prepare this evaluation is also in accordance with guidance from the CEQ, *Considering Cumulative Effects under the National Environmental Policy Act* (1997).

Identify Resources (Step 1)

Step 1: All of the resource categories considered in this FEIS were candidates for analysis with regard to indirect and cumulative impacts. The initial step of the cumulative impacts analysis uses information from the evaluation of direct and indirect impacts in the selection of environmental resources that should be evaluated for cumulative impacts. TxDOT's *Revised Guidance* states: "If a project will not cause direct or indirect impacts on a resource, it will not contribute to a cumulative impact on the resource. The cumulative impact analysis should focus only on: (1) those resources substantially impacted by the project; and (2) resources currently in poor or declining health or at risk even if the project impacts are relatively small (less

than significant)." Similarly, the CEQ guidance recommends narrowing the focus of the cumulative impacts analysis to important issues of national, regional, or local significance. This narrowing of focus would help produce a thoughtful analysis of the relevant issues of importance. Thus, the cumulative impacts analysis should focus only on the resources that are substantially affected by the proposed project by direct and/or indirect impacts. The extent to which a resource is affected is a function of the existing abundance and condition of the resource and would include resources that are currently in poor or declining health or that are at risk even if the proposed project impacts would not be substantial.

As recommended by the CEQ guidance, specific indicators of each resource's condition are identified and shown in **Table 6-3**. The use of indicators of a resource's health, abundance, and/or integrity are helpful tools in formulating quantitative or qualitative metrics for characterizing overall impacts to resources. These indicators are also key aspects of each resource that have already been evaluated in terms of the project's direct and indirect impacts associated with the Preferred Alternative and facilitate greater consistency and objectivity in the analysis of cumulative impacts.

Table 6-3: Resources Considered for the Cumulative Impacts Analysis

Resource Category/Issue		Summary of Existing Resource Condition and Potential Impacts			Additional Concerns Raised During Project Development	Permitting or Mitigation Necessary?	Cumulative Impact "Triggers"	
		Existing Condition/ Current Health of Resource	Preferred Alternative Direct Impacts	Preferred Alternative Indirect Impacts			Would the resource be substantially impacted by the project?	Is the resource currently in poor or declining health or at risk even if anticipated impacts are less than substantial?
Land Use		Changing – Historically, a highly disturbed study area due to farming, timbering, petro-chemical industrial activities. The existing land use continues to change due to increasing development. Changing land use from undeveloped to developed could contribute to the decline in the health of natural resources.	Conversion of 1,933 acres (ac) of undeveloped land to developed land.	Conversion of approximately 25,944 ac within the indirect impacts area of influence (AOI) as a result of the induced development anticipated as a result of the Preferred Alternative. Induced development in the study area would be consistent with all state and local government plans and policies.	Concerns over impacts to this resource were raised during the scoping for this project.	No	Yes	Yes
Socio-economic	Community Impacts	Changing – Rural lifestyle is being replaced by expanding Houston metropolitan area. Land would continue to be converted to residential and commercial uses as area population increases.	A total of 98 potential displacements are anticipated from construction of the Preferred Alternative. These displacements include 77 residential properties, 1 church, 19 commercial properties, and 2 utility displacements.	In the study area, rural areas are expected to continue to transition slowly to a suburban setting. New development provides potential for new jobs and increased economic utility.	Individual concerns over loss of community connectivity and rural lifestyle.	No	No	No
	Environmental Justice	The EJ population of the Metropolitan Planning Organization (MPO) area is growing. Impacts to the community are stable. The passage of Title VI of the Civil Rights Act of 1964 ensures that "No person in the United States shall, on the ground of race, color, or national origin be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any program or activity receiving federal financial assistance."	Although low-income, minority, and LEP populations are present within the study area, it is not anticipated that they would experience disproportionately high and adverse human health or environmental impacts. The origin-destination analysis indicated the majority of trips anticipated to utilize the Preferred Alternative would not originate from areas identified with high concentrations of environmental justice populations. Non-toll options exist for those who elect or can only afford on an occasional basis to pay tolls to access the tolled mainlanes.	Induced land development could create additional job opportunities and increased access to job opportunities through enhanced transportation infrastructure. Indirect impacts pertaining to public facilities and services, traffic operations, and traffic noise would be experienced by the environmental justice population to the same extent and in the same manner (whether positive or negative) as experienced by the non-environmental justice population.	Environmental justice was not identified as an issue of concern.	No	No	Yes
Pedestrians and Bicyclists		Based on review of the 2013-2016 Transportation Improvement Plan (TIP) Bicycle and Pedestrian Project section, no pedestrian or bicyclist improvements are planned for Grand Parkway Segments H and I-1 study area.	Grand Parkway Segments H and I-1 would accommodate access to "Proposed Shared-Use Path/Trails" as identified in Houston-Galveston Area Council (H-GAC)'s Regional Bikeway Plan. These include a shared-use path/trail along Farm to Market Road (FM) 2100. These "Proposed Shared-Use Path/Trails" would begin near the intersection of FM 2100 with Huffman-Cleveland Road on the western edge of the study area, approximately 3 miles west of the Preferred Alternative, and head south. The Preferred Alternative would not adversely impact any existing bicycle or pedestrian network. No new bicycle or pedestrian facilities are proposed for the controlled access portion of the facility. The restriction of bicycle and pedestrian use of a controlled-access facility is permitted under Texas Transportation Code 545.0651.	The Preferred Alternative would not indirectly impact existing pedestrian or bicyclist facilities. In the event that a bicycle or pedestrian facility is in place prior to the construction of the proposed project, the facility would be reconstructed to maintain continuity and function.	Pedestrians and bicyclists were not identified as an issue of concern.	No	No	No
Visual and Aesthetic Qualities		Changing – Transition from a rural to suburban/developed landscape.	The proposed project would be predominately at-grade with vegetated shoulders, right-of-way, and medians. The roadway and landscape design would be consistent with the TxDOT Houston District's Green Ribbon Project.	Both positive and negative indirect impacts could result. A properly designed lighting system would minimize negative light pollution aspects and would increase the social and economic benefits to the public. Other indirect visual and aesthetic effects may be related to induced development. These impacts may include a change in viewshed or ambient light within the AOI. Indirect visual and aesthetic impacts within the AOI are anticipated to be minor.	Impacts to visual or aesthetic quality are not a substantial environmental concern associated with the proposed project.	No	No	No

Resource Category/Issue		Summary of Existing Resource Condition and Potential Impacts			Additional Concerns Raised During Project Development	Permitting or Mitigation Necessary?	Cumulative Impact "Triggers"	
		Existing Condition/ Current Health of Resource	Preferred Alternative Direct Impacts	Preferred Alternative Indirect Impacts			Would the resource be substantially impacted by the project?	Is the resource currently in poor or declining health or at risk even if anticipated impacts are less than substantial?
Soils and Farmlands		Farmland resources are declining - Land use would continue to be converted within the study area due to growth.	The Preferred Alternative may impact up to 960 ac of prime farmland soils. Completion of the formal CPA-106 NRCS form indicates no substantial direct impacts from any of the alternatives associated with the conversion of farmland soils.	There is a potential for 14,394 ac of farmlands to be converted under the Preferred Alternative. However, completion of the CPA-106 NRCS form indicates formal coordination with the NRCS is not necessary.	Coordination with the NRCS was not required by the completion of CPA-106. However, coordination will occur for approval of CPA-106 scoring.	No	No	No - While the area continues to see a change in land use, the NRCS has not determined this to be a substantial decline.
Air Quality	CO and Ozone	Currently in poor condition. The MPO Houston-Galveston-Brazoria (HGB) eight-county area is currently in attainment for CO. However, it is classified to be in marginal nonattainment for the eight-hour ozone National Ambient Air Quality Standards (NAAQS). Texas has made significant progress over the past 15 years in addressing ozone in the HGB eight-county area. These decreases are expected to continue despite a rapid growth in the area's economy and population.	Decrease in congestion on existing roadways systems would likely benefit air quality. According to studies conducted by H-GAC and the Texas Commission on Environmental Quality (TCEQ), and based on ambient air monitors managed by TCEQ and approved by the Environmental Protection Agency (EPA), the one-hour and eight-hour ozone concentrations for the HGB eight-county area from 1991 to 2005 have decreased 23 and 13 percent, respectively, over the 15 year period between 1991 and 2005. These decreases occurred despite a 36% increase in area population. Based on previous analyses of similar projects, it is unlikely that the CO standard would be exceeded as a result of the Preferred Alternative. The Houston-Galveston-Brazoria (HGB) eight-county region is included in the area's financially constrained 2035 RTP Update, as revised, and the 2013-2016 TIP, which were found to conform to the SIP by FHWA/FTA on January 25, 2011 and November 1, 2012, respectively.	No change in attainment status is anticipated within the study area as a result of emissions associated with the proposed project. The proposed project is not anticipated to result in indirect impacts to air quality. Indirect air quality impacts from MSAT are unquantifiable due to existing limitations to determine pollutant emissions, dispersion, and impacts to human health. Emissions would likely be lower than present levels in future years as a result of the EPA's national control regulations. Even with an increase in vehicle miles traveled and possible temporary emission increases related to construction activities, the EPA's vehicle and fuel regulations, coupled with fleet turnover, will cause substantial reductions of on-road emissions over time, including CO, MSAT, and the ozone precursors VOC and NOx.	Concerns over region air quality were raised during public meetings and meetings with the H-GAC.	Yes, transportation conformity rules apply. The project must be included in a conforming financially constrained RTP and corresponding TIP.	No	Yes
	Mobile Source Air Toxics (MSAT)	Based on an FHWA analysis using EPA's MOVES2010b model, even if vehicle-miles travelled (VMT) increases by 102% as assumed from 2010 to 2050, a combined reduction of 83% in the total annual emissions for the priority MSAT is projected for the same time period.	The localized level of MSAT emissions for the Build Alternative could be higher relative to the No-Build Alternative.		The general public, resource agencies, and/or the Study Team's technical experts identified concerns related to air quality, specifically MSAT.	No		
Water Quality		Overall water quality is improving nationwide since the implementation of the CWA in 1972. Watersheds within the Resource Study Area (RSA) contain streams listed on the 2010 303(d) List of Impaired Waters. West Fork San Jacinto River: 2 Segments Impaired; East Fork San Jacinto: No Segments Impaired; Lower Trinity: 1 Segment Impaired; North Galveston Bay: 4 Segments Impaired; Buffalo-San Jacinto: 60 Segments Impaired; Spring: 13 Segments Impaired; Cedar Bayou Above Tidal (Segment ID: 0902), and Cedar Bayou Tidal (Segment ID: 0901) are within the project corridor.	Direct project impacts to resources that would affect water quality include impacts to wetlands and riparian areas as well as direct crossings of water bodies. Two stream segments within the study area are listed on the 2010 303(d) list. They are Cedar Bayou Above Tidal (Segment 0902) and Cedar Bayou Tidal (Segment 0901). Project construction would result in temporary increase in sedimentation and turbidity. Construction impacts would be minimized through the incorporation of appropriate Best Management Practices (BMPs) for erosion control.	Approximately 25,944 ac of undeveloped land would be converted to residential and commercial use as a result of the Preferred Alternative. This induced development could result in adverse effects to water resources through degradation of surface water and groundwater. The Preferred Alternative would require groundwater pollution prevention measures to minimize potential impacts to up to seven well capture zones. Indirect impacts to groundwater wells and capture zones are anticipated to be minor in the context of regional development as a whole.	Water quality was identified by technical experts as a major environmental concern associated with the proposed project.	Yes. Refer to Chapter 7 for mitigation proposed for direct impacts.	No	Yes

Resource Category/Issue	Summary of Existing Resource Condition and Potential Impacts			Additional Concerns Raised During Project Development	Permitting or Mitigation Necessary?	Cumulative Impact "Triggers"	
	Existing Condition/ Current Health of Resource	Preferred Alternative Direct Impacts	Preferred Alternative Indirect Impacts			Would the resource be substantially impacted by the project?	Is the resource currently in poor or declining health or at risk even if anticipated impacts are less than substantial?
Waters of the U.S., including Wetlands and Vegetative Communities	Stable - continued changes in land use due to development are expected to convert more wetlands to non-wetlands. However, the U.S. Army Corps of Engineers (USACE)'s "no net loss" policy has continued to keep the losses of jurisdictional wetlands at a stable number. Declining - Vegetative communities will continue to be converted to developed uses as land use changes occur.	The Preferred Alternative would potentially impact approximately 327 ac of wetlands and 22.9 ac of Waters of the U.S.	The potential indirect impacts to Waters of the U.S. and wetlands due to induced development within the AOI is anticipated to be zero acreage of Waters of the U.S. and approximately 2,997 ac of wetlands.	Water resources were identified by technical experts as a major environmental concern associated with the proposed project.	Yes	Yes	Yes
Wildlife	Stable - Most wildlife species in the RSA are broadly distributed across southeastern Texas. While impacts to individuals may occur, population impacts are not anticipated. Changes in land use due to suburban growth are expected to convert more of the available wildlife habitat to other uses.	Direct impacts associated with the Preferred Alternative could include an increase in wildlife mortality associated with vehicle collisions. This does not include threatened and endangered species and EFH. The Preferred Alternative would impact up to approximately 665 ac of wildlife habitat. The primary impacts to wildlife species inhabiting the project area are loss of habitat and habitat fragmentation.	Indirect impacts to wildlife include loss of habitat and/or habitat fragmentation– the land use analysis determined that the Preferred Alternative would indirectly impact approximately 25,944 ac of undeveloped land. This portion of undeveloped land that would be indirectly impacted contains wildlife habitat consisting of forested wetlands, non-forested wetlands, farmland, and forest. Existing habitat has largely been fragmented by development, the timber industry, and agricultural practices. Species within the AOI are largely found throughout the region; substantial impacts are not anticipated as a result of indirect impacts.	Concerns related to habitat loss and habitat fragmentation were received.	No	No	No
Threatened and Endangered Species	Stable - The Endangered Species Act is intended to protect these species. No adverse effects or takings are permitted.	At the time of this publication, there are no known direct impacts to federally protected species associated with the Preferred Alternative. However, only 22% of the properties have been accessed due to limited right-of-entry. This information will be updated as more information becomes available and access to properties is obtained. On the ground surveys for federally protected species were performed for the Preferred Alternative.	Approximately 7 ac of potential habitat for federally protected species exists within the AOI. Based on the land use analysis (Chapter 4) and current federal and state laws and regulations, it is expected that the development of properties containing threatened or endangered species preferred habitat within the AOI would not be affected by the Preferred Alternative.	Texas Parks and Wildlife Department (TPWD) expressed concern for Texas Prairie Dawn, if habitat was found within the study area.	No	No	No for properties accessed, unknown at this time for properties that have not yet been accessed
Floodplains	Stable - Flooding in the Houston area continues to be an issue. Changes in land use due to suburban growth are expected to result in encroachment of the 100-year floodplain.	Direct impacts, as a result of the Preferred Alternative, include approximately 159 ac of impacts to the 100-year floodplain.	The potential exists for up to 2,006 ac of 100-year floodplains to potentially be impacted by indirect development within the AOI. However, it is unlikely that indirect development would occur in the floodplains. Access points to Grand Parkway Segments H and I-1 have also been located outside of the floodplains to the greatest extent practicable to minimize any potential for future floodplain development.	Individual concerns over floodplains and drainage were raised.	No	No	No
Wild and Scenic Rivers	None present within the project area.	The Preferred Alternative is not situated in the vicinity of any river on the National Inventory of River Segments included in the National Wild and Scenic River System (NPS, 1999); no impacts to wild and scenic rivers would occur.	The study area is outside any wild and scenic rivers; the Preferred Alternative would not have any indirect impacts to wild and scenic rivers resources.	Wild and scenic rivers were not identified as an issue of concern.	No	No	No

Resource Category/Issue	Summary of Existing Resource Condition and Potential Impacts			Additional Concerns Raised During Project Development	Permitting or Mitigation Necessary?	Cumulative Impact "Triggers"	
	Existing Condition/ Current Health of Resource	Preferred Alternative Direct Impacts	Preferred Alternative Indirect Impacts			Would the resource be substantially impacted by the project?	Is the resource currently in poor or declining health or at risk even if anticipated impacts are less than substantial?
Coastal Barriers	None present within the project area.	The proposed Grand Parkway Segments H and I-1 project area is wholly outside any coastal barrier system; the Preferred Alternative would not have any impacts to coastal barrier resources.	The study area is outside any coastal barrier system; the Preferred Alternative would not have any indirect impacts to coastal barrier resources.	The coastal barrier system was not identified as an issue of concern.	No	No	No
Coastal Zone Management	The Coastal Zone is a managed, stable resource.	The proposed Preferred Alternative is not within the CZMP boundary and therefore, is in compliance with the CZMA. Coordination with the CZMA is not required.	The study area falls along the coastal zone management area; however, the Preferred Alternative would not have any indirect impacts to coastal zone management resources.	The coastal zone management area was not identified as an issue of concern.	No	No	No
Essential Fish Habitat	None present within the project area.	The Preferred Alternative does not intersect tidally influenced coastal waters and would have no impact on EFH. Coordination with NMFS is not required.	The study area is outside any tidally influenced coastal waters; the Preferred Alternative would not have any indirect impacts to EFH.	EFH was not identified as an issue of concern.	No	No	No
Archeological Resources	Stable - Agency oversight is intended to minimize or avoid impacts to these resources.	As a result of the official archeological records review, no previously recorded sites were identified within the Grand Parkway Segments H and I-1 Preferred Alternative ROW.	There is a possibility for indirect impacts to historic archeological resources in the study area as land is converted to residential and commercial uses. Development in the floodplain would be minimized, thereby protecting the areas with some of the greatest potential for archeological resources.	Neither the general public resource agencies nor the public identified issues of concern for archeological resources.	No	No	No
Non-Archeological Historic Resources	Stable - Agency oversight is intended to minimize or avoid impacts to these resources.	As a result of the historic resources survey, it was determined a total of four resources within the Preferred Alternative's area of potential effects (300 ft) were previously determined or recommended NRHP Eligible. The two resources previously determined NRHP Eligible are associated with the Dayton Canal rice irrigation system; no adverse effects to these resources are anticipated. The two resources recommended NRHP Eligible are a house and garage located at 2669 FM 1485 in Harris County; no direct effects are anticipated to these resources.	Indirect impacts to land use changes attributed to the Preferred Alternative have the potential to indirectly impact historic resources. Some development may fall under federal or state regulatory resource protection review; however, the true degree of impact to historic resources resulting from future private development cannot be determined at this time.	The public agencies identified the canals in and around Dayton as an area of potential concern.	The Historic Resources Survey Report is under coordination with the SHPO. No adverse effects are anticipated.	No	No

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As documented in **Chapter 4 (Environmental Consequences)** and **Chapter 5 (Indirect Impacts)**, it was determined that the Preferred Alternative would not have considerable direct or indirect impacts on the following resources: social and economic resources, pedestrians and bicyclists, visual and aesthetic qualities, soils and farmlands, wildlife, threatened and endangered species, floodplains, wild and scenic rivers, coastal barriers, coastal zone management, essential fish habitat, archeological resources, non-archeological historic resources, hazardous materials, visual and aesthetics, parkland, or energy resources. Therefore, these resources were not carried forward through the cumulative impacts analysis. As **Table 6-3** indicates, the following resources were determined to be resources that warrant cumulative impacts analyses: land use; environmental justice populations; air quality (CO, ozone, and MSAT); water quality; and waters of the U.S., including wetlands.

Define Resource Study Areas (RSAs) (Step 2)

Step 2: Cumulative impacts are considered within spatial and temporal boundaries. Each resource has its own RSA to best assess the impacts to that individual impact. The scope of this analysis seeks to evaluate the direct and indirect impacts and other potential impacts from other past, present, or future projects in the area as far away from the proposed project as the impacts are expected to be realized on each of the resources studied. The physical boundary of these impacts is the RSA.

Because the resources/issues vary widely, the appropriate geographical context for evaluating cumulative impacts depends upon a myriad of factors. The setting of spatial limits for resource indicators was established using TxDOT and CEQ criteria, and considered factors such as each resource's physical characteristics, biological relationships, and affected institutional jurisdictions. The RSA defined for the examination of each indicator of resource condition and potential impacts is also noted in **Table 6-4**.

The temporal boundary set for each resource is 1970 through 2035. The beginning timeframe of 1970 was considered to be the most appropriate for the area because the region experienced unprecedented growth in 1970 due to the opening of the George Bush Intercontinental Airport in 1969. The future date of the temporal boundary is set at 2035, based on the Houston-Galveston Area Council's (H-GAC) 2035 Regional Transportation Plan (RTP) Update. The H-GAC's 2035 RTP Update was created by community leaders to address regional mobility, air quality, and safety under the current growth projections for the eight-county area over the next two decades.

Any development, such as planned communities, cities, and industrial areas that existed and/or were developed prior to 1970 was not calculated in the cumulative impacts analysis. However, general land use trends are noted under the land use discussion. Present actions are those actions that have occurred generally between 2000 and 2013. The years 2013-2035 represent future actions which correlate with the H-GAC's 2035 RTP Update.

Describe Resources, Identify Impacts, Assess Cumulative Effects, Report Results, and Assess Mitigation (Steps 3-8)

Step 3: Examination of the current health and historical context of each resource is necessary to establish a baseline for determining the impacts of the proposed action and other reasonably foreseeable actions on the resource. For the resource categories of special interest identified from the direct and indirect impacts analyses, each resource's abundance and quality at the present time, defined as the publishing date of the FEIS, was evaluated considering the impacts of historical activities, the resource's response to change, and the continuing stresses imposed on the resource and its capacity to withstand these stresses. Collectively, these factors capture the influences that have shaped and are shaping the amount and quality of each resource, and which would continue to shape each given resource in the future.

The discussion describes the historical and current condition of each resource within the context of its RSA. A summary of existing conditions is included in **Table 6-3**, where it serves as a point of reference for summaries of impacts from the proposed project and from other projects within each resource's RSA. Demographic and land use information was obtained from local government planning offices, meetings with stakeholders, and websites. Vegetation was generally characterized through interpretation of high resolution aerial photography for the year 2008 from the H-GAC. USFWS National Wetland Inventory (NWI) maps were utilized for information regarding potential Waters of the U.S., including wetlands. Information on the various resources studied was digitized, and spatial data was developed through the use of Geographic Information Systems (GIS) software.

Table 6-4 provides a summary of the RSAs and the health of those resources considered during the cumulative impacts analyses.

Table 6-4: Summary of Resource Study Areas (Step 2) and Health of Resources (Step 3) for the Cumulative Impacts Analysis

Resource Category	Indicators of Resource Condition and Potential Impacts	Resource Study Area (RSA)	Health of Resource
Land Resources	Land use	Transportation projects have the potential to influence traffic patterns or land development. The land use RSA was defined by the adjacent 15-minute travel shed (same as the indirect impacts AOI). Outside the boundaries of the land use RSA, it is not anticipated that the improvements to Grand Parkway Segments H and I-1 would influence traffic patterns or land development, as areas outside of the defined RSA are better served by other roadways, and the land use in those areas would be impacted by these other facilities.	Historically disturbed RSA and changing.
Environmental Justice	Impacts on Environmental Justice populations	Toll facilities have the potential to impact low-income populations as a higher percentage of their income would be required to utilize these facilities than that of non-low-income populations. The H-GAC 8-county region was defined to be the RSA for environmental justice because the regional toll system (of which Grand Parkway Segments H and I-1 would be part of) is located within this region.	The EJ population of the MPO area is growing based on a comparison of 2000, 2010, and 2035 population data. Impacts to the community are stable. Title VI of the Civil Rights Act of 1964 states "No person in the United States shall, on the grounds of race, color, or national origin be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any program or activity receiving federal financial assistance."
Air Quality	8-Hour Ozone Standard: ability of the region to meet this air quality standard. Carbon Monoxide: carbon monoxide concentrations along the ROW under worst meteorological conditions MSAT: trend of emissions over time	Air quality impacts from mobile sources are evaluated and managed on a regional basis primarily through the MPO, in coordination with the EPA, TCEQ, TxDOT, and FHWA. The non-attainment areas represent the management unit for mobile source pollutants as regulated by federal, state, and local government agencies. Evaluating air quality in relation to cumulative impacts requires looking at the following three distinct RSAs: Houston-Galveston-Brazoria eight-county nonattainment area for ozone and MSAT, and proposed ROW line for CO. The RSA for CO was based on the proposed ROW line, which represents the location with highest potential for CO concentrations.	Air Quality: poor, the Houston-Galveston-Brazoria eight-county region is classified as a marginal nonattainment area for ozone. MSAT: emissions are anticipated to decrease over time.

Resource Category	Indicators of Resource Condition and Potential Impacts	Resource Study Area (RSA)	Health of Resource
Water Resources	Water Quality	The RSA for water quality was based on potential impacts to watersheds in the immediate area of the proposed ROW. These watersheds include: West Fork San Jacinto, East Fork San Jacinto, Lower Trinity, North Galveston Bay, Buffalo-San Jacinto, and Spring	Overall water quality is improving nationwide since the implementation of the CWA in 1972. However, watersheds within the RSA contain stream segments listed on the 2010 303(d) List of Impaired Waters. Low dissolved oxygen is the primary water quality concern for each listed stream segment.
	Waters of the U.S., including Wetlands	The RSA for Waters of the U.S., including wetlands, was based on potential impacts to wetlands and waters in the immediate area of the proposed ROW. These associated watersheds include: West Fork San Jacinto, East Fork San Jacinto, Lower Trinity, North Galveston Bay, Buffalo-San Jacinto, and Spring	The USACE's "no net loss" policy has continued to keep the losses of jurisdictional wetlands at a stable number.

Source: Study Team, 2012

Step 4: The analysis of cumulative impacts must consider the direct and indirect impacts of the proposed action within the RSAs. Identification of the direct and indirect impacts of the proposed action would also assist in determining the project's contribution to the cumulative impact on the resource. The direct and indirect impacts expected from the proposed project were discussed in detail in the FEIS in **Chapter 4 (Environmental Consequences)** and **Chapter 5 (Indirect Impacts)**, respectively. The results of the study of direct and indirect impacts to resources included in this cumulative effects analysis are summarized in **Table 6-3**.

Step 5: CEQ regulations indicate that cumulative impacts analyses must include an assessment of impacts of other past, present, and/or reasonably foreseeable future actions affecting the resources studied (40 CFR Section 1508.7). This portion of the cumulative impacts analysis sought out other transportation projects and planned large-scale public or private developments in the watersheds. The identification of other past, present, and reasonably foreseeable future actions for the watershed RSA was based on a review of proposed and ongoing development projects that are associated with H-GAC plans, local municipality plans, local school district plans, master plan communities, and county economic development studies. In addition, a panel of experts on land use planning and development in the region were surveyed. H-GAC personnel, as well as local and county planning personnel, were consulted during the indirect impacts analysis of the proposed project. Past, current, short term, and long term transportation projects were determined from the H-GAC's 2035 RTP Update, the H-GAC's *Envision Houston Region* report,

surveys and interviews with city and county planning offices, TxDOT databases, and engineering documents.

In addition to site-specific development plans, the anticipated impacts from the eventual development of the watershed RSA as reflected in comprehensive land use plans was considered in reviewing future impacts to biological and water resources. Qualitative inferences as to potential impacts on the resources studied are drawn from the description of each project or plan. Individual projects would not be identified for the O_3 nonattainment area because air quality is regulated and managed on a regional level, with expected development projects with substantial air emissions included in air pollution budgets, dispersion modeling, and air quality state implementation plans.

Steps 6, 7, and 8: The information contained in **Tables 6-3** and **6-4** represents the starting point for assessing (**Step 6**) and reporting (**Step 7**) cumulative impacts in this subsection. Cumulative impacts were evaluated using the following factors: the historical context of each resource, current condition and trend, future land use and zoning plans, and the pertinent regulations and standards associated with each resource. These factors capture the influences that have shaped and are shaping the amount and quality of each resource, and which would continue to shape the resources into the future. Several key assumptions that are implicit in the approach to predicting the future condition of resources include:

- All reasonably foreseeable actions would be completed as currently planned;
- The relationships between the resources, ecosystems, and human communities that have been identified from historical experience would continue into the future; and
- The sponsors of government and private projects would abide by relevant federal, state, and local laws designed to protect each resource, and regulatory agencies would perform their duties in accordance with legal requirements and internal guidelines.

Of particular importance is the assumption concerning compliance with relevant environmental laws designed to ensure the sustainability of resources. Over the past several decades, federal, state, and local lawmaking bodies have enacted statutes, regulations, and ordinances designed to preserve and enhance the abundance and quality of natural resources by requiring project sponsors to avoid, minimize, and mitigate the environmental impacts of their projects or actions. The cumulative impacts analysis focuses on the net effects on each resource that remain after full compliance with the regulatory requirements at all levels. To this point in this analysis, the approach has been to identify and report the potential unmitigated impacts to each of the resources, but net cumulative impacts must consider the long-term impacts in light of

mitigation that would likely be applied. The discussion of cumulative impacts for each resource studied would first outline the key regulatory measures government leaders and agencies have implemented to manage and sustain the resource for long-term use, then evaluates expected net cumulative impacts for each of the resources analyzed. This discussion of key mitigation measures affecting the expected potential cumulative impacts is an integral part (**Step 8**) of the cumulative impacts analysis. More detailed discussions of specific regulatory measures to control adverse impacts to various resources would be contained in discussions of direct impacts to specific resources in **Chapter 7 (Mitigation and Permitting)** of this FEIS document.

6.3 CUMULATIVE IMPACTS ANALYSIS PER RESOURCE

A discussion and application of the cumulative impacts analysis for each selected resource follows. The remainder of the cumulative impacts analysis consolidates the remaining steps from TxDOT *Guidance* so that the analytical steps may be grouped within the discussion about each resource (December 2006). Steps 1 through 6 were applied to each resource. Once each resource is analyzed in Steps 1 through 6, Steps 7 and 8 follow and address all identified resources, only if a substantial cumulative impact is identified.

Cumulative impacts are analyzed in terms of the specific resource being affected based on direct and indirect impacts. The resources considered in the following cumulative impacts analyses are:

- **Land Use** – RSA is defined by a 15-minute travel shed (**Exhibit 6-1**);
- **Environmental Justice** - RSA is defined by the H-GAC eight-county region (**Exhibit 6-2**);
- **Air Quality/MSAT** – RSA for Ozone is defined by the Houston-Galveston-Brazoria eight-county marginal ozone non-attainment area; the RSA for MSATs is defined by the H-GAC eight-county region; and the CO RSA is defined by the proposed project ROW (**Exhibit 6-2**); and
- **Water Resources (Water Quality and Waters of the U.S., including Wetlands)** – RSA is defined by six watersheds (**Exhibit 6-3**).

6.3.1 Land Use

6.3.1.1 Step 1: Resource Identification - Land Use

Based on a review of historical aerial photographs, the portions of the project area and the RSA considered for this analysis have experienced and continue to experience conversion from undeveloped land uses to residential and commercial uses in the Montgomery, Harris, and Chambers counties while the majority of

the project area in Liberty County has experienced a slower growth rate. These land use changes drive any impacts to the other resource categories in this analysis. There is a direct impact to existing land uses as a result of the proposed action.

6.3.1.2 Step 2: Resource Study Area - Land Use

The RSA defined to determine cumulative impacts to land use as a result of the construction of Grand Parkway Segments H and I-1 is the same as the area of influence (AOI) utilized in the indirect impacts analysis (**Exhibit 6-1)**. As explained in **Chapter 5**, the AOI was defined by the 15-minute travel shed. Outside the bounds of the land use RSA, it is not anticipated that the improvements to Grand Parkway Segments H and I-1 would influence traffic patterns or land development, as areas outside of the defined RSA are better served by other roadways, and the land use in those areas would be impacted by these other facilities. The land use RSA encompasses approximately 1,204 square miles (mi^2), or approximately 770,300 acres (ac), of Harris, Montgomery, Liberty, San Jacinto, and Chambers counties.

As previously stated, the temporal boundaries for the cumulative impacts analysis are the years 1970 to 2035. Historical actions are those actions which occurred between 1970 and 2000; present actions occurred between 2000 and 2013. The years 2013 to 2035 represent future actions, which correlate with the H-GAC's 2035 RTP Update.

6.3.1.3 Step 3: Resource Health and Historical Context - Land Use

<u>Health</u>

The central corridor of Grand Parkway Segments H and I-1 would be located in an area of Liberty County that has been experiencing relatively little growth. Most of the growth in the greater Houston metropolitan area has been to the north, west, and south of the proposed project. For example, between 1990 and 2000, the Harris County population growth represented 62.1 percent of the eight-county metropolitan statistical area growth while Fort Bend County represented 13.7 percent, and Montgomery County represented an additional 12.9 percent. These three counties accounted for 88.7 percent of the metropolitan area growth between 1990 and 2000. Population estimates suggest that these three counties accounted for 86 percent of the population in the eight-county area between 2000 and 2005. Liberty County accounted for only 1.9 percent of the metropolitan area growth between 1990 and 2000, and an estimated 1.2 percent between 2000 and 2005.

Most of the historically developed land is within and adjacent to the northern portion of the RSA. Kingwood, a master planned community of approximately 60,000 residents which is a part of the City of Houston, falls within the RSA. North of Kingwood and within the RSA are the communities of Porter, New Caney, Woodbranch, Patton Village, and Roman Forest. A 4,919 ac Section 4(f) property (the Lake Houston Wilderness Park) is also located within the RSA. The Lake Houston Wilderness Park is operated by the City of Houston Parks and Recreation Department.

Most of the RSA is currently forested or in agricultural production. A number of primarily residential developments stretch between the east shore of Lake Houston and Farm to Market Road (FM) 2100. The largest of these is The Commons of Lake Houston, a large lot subdivision. Incorporated communities in or near the RSA are Crosby (1,714), Dayton (5,709), and Mont Belvieu (2,324).

Mont Belvieu sits on top of the 1 mi diameter Barbers Hill salt dome. The Barbers Hill dome is the largest Liquid Petroleum Gas storage complex in the United States, providing 36 percent of the nation's storage capacity. The more than 126 active solution-mined caverns store from 75 to 300 million barrels of light hydrocarbon products.

Montgomery County

Approximately 278 mi^2, or 23.1 percent of the RSA is in Montgomery County. Montgomery County cities within the RSA include Patton Village, Roman Forest, and New Caney. The current development within the Montgomery County portion of the RSA is primarily residential and is focused along FM 1485 and U.S. Highway (US) 59 (N). Much of the development in Montgomery County has traditionally been on larger rural lots that are greater than one-half acre in size; however, the trend has been toward more dense residential development on lots smaller than one-half acre in size. Much of the Montgomery County portion of the RSA is currently developed or platted, with the remaining areas consisting of rural pasture and cropland.

Harris County

Approximately 347 mi^2, or 28.8 percent of the RSA is in Harris County. The RSA falls within the limits of the incorporated cities in northern Harris County. Harris County cities within the RSA include Kingwood and Crosby. The Harris County portion of the RSA, particularly between US 59 (N)/I-69 and FM 1960, has typically developed with large, predominantly residential developments. Commercial uses consisting of

retail shopping centers, restaurants, and gas stations are concentrated at the intersections of major arterial roadways, and along the freeway corridors in the area. There is little undeveloped land remaining in this area.

Liberty County

Approximately 403 mi^2, or 33.5 percent of the RSA is in Liberty County. Liberty County is considered to be a largely rural county, though the developed uses in the Liberty County portion of the RSA are residential and commercial. The predominant land use in this county includes oil fields, crop and pasture land. The City of Dayton is the largest incorporated area in the county.

Chambers County

Approximately 167 mi^2, or 13.9 percent of the RSA is in Chambers County. The RSA includes the incorporated cities of Mont Belvieu and Baytown. The predominant developed uses north of I-10 in the Chambers County portion of the RSA are residential and industrial. South of I-10, the predominant use is residential.

San Jacinto County

Approximately 9 mi^2 or 0.7 percent of the RSA is in San Jacinto County. The predominant land uses in this county includes oil fields, crops, and pasture land. San Jacinto County is outside of the H-GAC's MPO area; therefore, data regarding growth projections for San Jacinto County is not available at this time.

Historic Context

The opening of the Bush Intercontinental Airport in 1969 was followed by a boom in residential development in the areas of southern Montgomery County and northeast Harris County, within the land use RSA. Along with the construction of these homes came the ancillary retail and public services.

Development within the Harris and Montgomery county portions of the RSA has occurred within large subdivisions dominated by single family residential uses. Historical aerials dating back to 1970 were obtained and used to determine how much growth has occurred over the past 30 years. Within the past 30 years, larger master planned subdivisions have developed, particularly outside of Beltway 8. One development, Kingwood, has provided a mix of single family, multi-family, and commercial uses. There has been little effective large area or regional land planning within the RSA. The result is automobile dependent development with limited travel mode options.

6.3.1.4 Step 4: Direct and Indirect Impacts - Land Use

Direct Impacts

The proposed action would directly convert approximately 1,933 ac of land (less than 0.3 percent of the RSA) from its current use to transportation uses. More detail on the types of uses to be converted may be found in **Chapter 4 (Environmental Consequences)** of this document.

Indirect Impacts

Land indirectly converted to developed uses as a result of the Preferred Alternative is estimated to be 25,944 ac (**Table 5-12**); this would account for approximately 3 percent of the total land in the RSA. Likewise, other indirect impacts (noise, runoff, erosion, etc.) are anticipated to also be minor. These conclusions were reached following meetings with local officials and during the stakeholder meetings held in conjunction with the improvements to Segments H and I-1. These included meetings with officials from Harris, Chambers, Liberty, and Montgomery counties, the H-GAC, local school districts and the cities of Baytown, Mont Belvieu, and Dayton. As noted in **Chapter 5 (Indirect Impacts)**, an expert panel was also surveyed in 2008-2009 to determine the extent of induced development within the study area. The expert panel survey results predicted that approximately 1,000 ac at the intersection of the Grand Parkway Segments H and I-1 and I-10 (E) would likely be developed for retail and commercial uses. Approximately 5,000 ac at each intersection of the Grand Parkway Segments H and I-1 with SH 146 and FM 1960 would likely be developed for residential uses; and approximately 1,000 ac of commercial and retail development would occur at each intersection of Grand Parkway Segments H and I-1 with FM 1960, US 90, FM 1413, and SH 146. An additional 1,500 ac of industrial development is predicted within outlying parcels in the central portion of the AOI for each of the alternatives.

6.3.1.5 Step 5: Reasonably Foreseeable Actions - Land Use

Land Development

Several sources were utilized to determine reasonably foreseeable land use and transportation changes that are anticipated to occur in the RSA. These sources included the H-GAC's 2035 projections, meetings with local and county officials, school boards, city planners, and an expert panel survey. **Table 5-10** in **Chapter 5** lists reasonably foreseeable projects which were identified during the 2007-2008 stakeholder meetings and research of platted developments. The H-GAC also provided the *Envision Houston Region* report with its 2008-2009 expert panel survey response. Scenario A of this report includes the current

growth forecast and development for the region, based on the H-GAC's 2035 population forecast, and assumes the complete build-out of the planned regional toll system.

Transportation 2035 H-GAC Projects

There are added capacity and new location projects on various corridors identified in the H-GAC's 2035 RTP Update and located within the land use RSA. Projects listed on the H-GAC's Plan are considered reasonably foreseeable transportation projects for the purposes of this analysis.

Major Thoroughfare Plan Projects

Within the land use RSA, the City of Houston plan identifies improvements to many area roadways. These roadways are shown in **Table 6-5**. All of these roadways currently exist and are only proposed to be upgraded according to the 2012 City of Houston Major Thoroughfare and Freeway Plan, with the exception of the proposed Grand Parkway and the proposed SH 35 facilities.

Table 6-5: City of Houston Major Thoroughfare and Freeway Plan

Roadway Name	Roadway Name	Roadway Name
1st St	Genoa Red Bluff Rd	Preston
75th St	Grand Mission Blvd	Proposed SH 35
Addicks Clodine Rd	Grant Rd	Purple Sage Rd
Aerospace Ave	Gray	Queenston Blvd
Airline Dr	Green River Dr	Quitman
Airport Blvd	Greenbriar Dr	Ralston Rd
Airtex	Greenhouse Rd	Ranchester Dr
Airtex Dr	Greens	Rancho Bella
Alabama St	Greens Crossing Blvd	Rankin Rd
Aldine Bender Rd	Greens Pkwy	Rayford Rd
Aldine Mail Rd	Greens Rd	Reed Rd
Aldine Westfield Rd	Greenspoint Dr	Renwick
Alief Clodine Rd	Griggs	Research Forest Dr
Allen Genoa Rd	Grisby	Reveille
Allen Pkwy	Groeschke Rd	Rice Blvd
Allendale Rd	Grogams Mill Rd	Ricewood Dr
Allum Rd	Gulf Bank	Richey Rd
Almeda Genoa Rd	Gulf Bank Rd	Richmond Ave
Almeda Rd	Gulfton	Riley Fuzzel Rd
Altoona St	Haley Rd	Roberts Cemetery Rd
Anagnost Rd	Hamblen Rd	Roberts Rd
Anderson Rd	Hamilton	Rochen Rd

Roadway Name	Roadway Name	Roadway Name
Antoine Dr	Hammerly	Rockwell Blvd
Astoria Blvd	Hanna Nash	Roesner Rd
Atasca Oaks Blvd	Hardy	Rogerdale Rd
Atascocita Rd	Hardy Airport Connector	Roman Forest Blvd
Badtke Rd	Hardy Toll Rd	Rosslyn Rd
Bagby St	Hare Cook Rd	Runneburg
Baker Rd	Harlem Rd	Rusk
Bammel N Houston Rd	Harrisburg Blvd	Rutherglenn Dr
Barker Clodine Rd	Harwin Dr	S 75th St
Barker Cypress Rd	Hebert Rd	S Barker Cypress Rd
Barryknoll Ln	Hegar Rd	S Braeswood Blvd
Bartlett Rd	Heights Blvd	S Bw 8 E
Bauer Hockley Rd	Heiner	S Bw 8 W
Bauer Rd	Hempstead Hwy	S Dairy Ashford
Bay Area Blvd	Hermann Dr	S Diamondhead Blvd
Bay Hill Blvd	Highland Knolls Dr	S Fry Rd
Beamer Rd	Hillcroft	S Gessner Dr
Beaumont Hwy	Hillcroft St	S Greenhouse Rd
Beaumont Pl	Hiram Clarke Rd	S Heights Blvd
Beckendorff Rd	Hirsch Rd	S Hwy 59
Becker Rd	Hogan	S I-45
Beechnut St	Holcombe Blvd	S I-610 E
Belknap Rd	Holderrieth	S I-610 W
Bellaire Blvd	Hollister	S Jensen Dr
Bellfort Rd	Hollister Dr	S Katy Fort Bend Rd
Bennington St	Hollister St	S Kirkwood Rd
Bentley Rd	Holly Hall	S Lake Houston Pkwy
Berry Rd	Holmes Rd	S Lockwood Dr
Bertner Ave	Holt	S Macgregor Way
Betka Rd	Holzwarth Rd	S Main St
Binford Rd	Homestead Rd	S MAIN-HOLMES S
Bingle Rd	Hopfe Rd	S Mason
Binz St	Hopper Rd	S Mason Rd
Birnam Wood Blvd	House Hahl Rd	S Peek Rd
Bissonnet St	Houston Ave	S Pinemont Dr
Blackhawk Blvd	Houston Rd	S Post Oak Blvd
Blalock Rd	Howard Dr	S Post Oak Ln
BLINKA RD	Huffman Cleveland Rd	S Post Oak Rd

Roadway Name	Roadway Name	Roadway Name
Blodgett St	Huffmeister Rd	S Rice Ave
Blue Ridge Rd	Hufsmith Kohrville Rd	S Richey
Bob White Dr	Hufsmith Kuykendahl Rd	S SH 6
Boone Rd	Hughes Ranch Rd	S Shaver St
Botkins Rd	Hughes Rd	S Sheldon Rd
Boudreaux Rd	Humble Pkwy	S Shepherd Dr
Boundary	Humble Westfield Rd	S Ssgt Macario Garcia Dr
Brandt Rd	Idleloch Dr	S US 59/I-69
Brazos St	I-10	S Victory Dr
Breen Dr	I-45 N	S Voss Rd
Briar Forest Dr	I-45 S	S Wayside
Briarpark Dr	I-45 N	S Wayside Dr
Brittmoore Rd	I-45 S	Sabo Rd
Broadway St	I-610	Saddle Creek Farms Dr
Broyles	Imperial Valley Dr	Sage Rd
Buffalo Speedway	Independence Blvd	Sampson
Bunker Hill Dr	Indian Hills Rd	San Felipe St
Bunker Hill Rd	Irvington Blvd	San Jacinto St
Burke Rd	Jacinto Port Blvd	Saums Rd
Burnett St	Jack Rd	Sawdust Rd
Burney Rd	Jackson Field	Sawmill Rd
Burton Cemetery Rd	James Muse Parkway	Sawyer
C E King Pkwy	Jarvis Rd	SB 59 S TO SB 288
Calhoun Rd	Jensen Dr	Scarsdale Blvd
Calumet	John Cooper Rd	Schiel Rd
Calvert Rd	John F Kennedy Blvd	Schlipf Rd
Cambridge St	John Ralston Rd	School Rd
Cameron Rd	Jones Rd	Schroeder
Campbell Rd	Juergen Rd	Schroeder Rd
Canal St	Jutland	Schurmier Rd
Cane Island Pkwy	K Z Rd	Scott St
Capitol St	Katy Flewellen Rd	Sendero Blvd
Cardiff Rd	Katy Fort Bend Rd	Settegast Ranch Rd
Carver Rd	Katy Gaston Rd	SH 225
Castle Rd	Katy Hockley Cut Off Rd	SH 249
Cavalcade	Katy Hockley Rd	SH 288
Cebra St	Katy Rd	SH 288 US 59/I-69 RAMP
Central Bridgeland	Keller	SH 290
Challenger 7 Pkwy	Kelley	SH 35

Roadway Name	Roadway Name	Roadway Name
Champion Forest Dr	Kempwood Dr	SH 6
Champion Forest Rd	Kenswick Dr	Sharp Rd
Chasewood Dr	Kermier Rd	Shaver St
Chimney Rock Rd	Kickapoo Rd	Shaw Rd
Cinco Ranch Blvd	Kieth Harrow Blvd	Sheldon Rd
Clara Rd	Kings Forest Rd	Shepherd Dr
Clay Rd	Kings Park Way	Silber
Clear Lake City Blvd	Kingsland Blvd	Skinner Rd
Clearwood	Kingspoint	Smalley Rd
Clinton Dr	Kingwood Dr	Snowden
Clinton Federal	Kirby Dr	Solon
Clodine Rd	Kirkpatrick Blvd	Sorters Rd
Clodine Reddick Rd	Kitzman Rd	South Wayside
College	Kleckley Dr	Southmore Blvd
College Park Dr	Kluge Rd	Space Center Blvd
Collingsworth	Kress	Spears Rd
Colonial Pkwy	Krezdorn	Spring Cypress Rd
Colorado Rd	Kuykendahl Rd	Spring Green Blvd
Commonwealth	La Porte Fwy	Spring Stuebner Rd
Community Dr	Lake Houston Pkwy	Spring West Dr
Cook Rd	Lake Olympia	Springer
Corbitt St	Lake Woodlands Dr	Springwoods Village Pkwy
Corporate Dr	Lakemont Dr	Spur 527
Cottingham Rd	Lakewood Dr	Ssgt Macario Garcia Dr
Court Rd	Langley	Stagewood Dr
CR 602	Lathrop	Stedman
CR 612	Lauder Rd	Stella Link
CR 622	Laura Koppe Rd	Stockdick
Crawford St	Lawndale	Stockdick School Rd
Creekbend Dr	Lazy Ln	Stokes Rd
Creekside Forest Dr	League Line	Stroker Rd
Creekside Green Dr	Lee Rd	Studemont
Creekside Park Blvd	Leeland St	Studewood
Crenshaw Rd	Lexington Blvd	Stuebner Airline Rd
Crestmont St	Ley Rd	Sunset Blvd
Crestvale	Liberty Rd	Synott Rd
Crockett St	Little York Rd	T C Jester Blvd
Crosby Fwy	Lockwood Dr	Tanner

Roadway Name	Roadway Name	Roadway Name
Crossover Rd	Lockwood Rd	Taylor St
Crosstimbers	Long Dr	Teal Bend Blvd
Crystal Lake Ln	Long Point Rd	Telephone Rd
Cullen Blvd	Longenbaugh Dr	Telge Rd
Cumberland Ridge Dr	Longenbaugh Rd	Teller Blvd
Cunningham Rd	Loop 494	Texas
Cutten Rd	Lorraine St	Texas Spur 5 Hwy
Cypress N Houston Rd	Lou Edd Rd	Tide St
Cypress Rosehill Rd	Louetta Rd	Tidwell Rd
Cypresswood Dr	Lyons	Timber Forest Blvd
Dacoma 290 HOV Ramp	Macedonia Rd	Timber Forest Dr
Dacoma St	Magnolia Rd	Tomball Pkwy
Dairy Ashford	Mahaffey Rd	Town Park Dr
Dallas Rd	Main	Townsen
Dallas St	Main St	Trammel Fresno Rd
Decker Prairie Rosehill Rd	Malcomson	Treaschwig Rd
Deer Run Ln	Manchester St	Treichel Rd
Deer Trail Dr	Mangum	Tuckerton Rd
Delldale	Margerstadt Rd	University Blvd
Deussen Pkwy	Market St	Unnamed
Dixie Dr	Martin Luther King Blvd	Upper Lake Dr
Dixie Farm Rd	Mason	US 290
Dowling St	Mason Rd	US 59/I-69
Dunlavy	Mathis Rd	US 59/I-69 Spur 527 Ramp
Durham Dr	Maxey Rd	US 90
E 11th St	Mayer Rd	US HWY 90 Bus Hwy
E 20th St	Mccarty	Uvalde Rd
E Airtex	Mcclellan Rd	Valley Ranch Bend Dr
E Anderson Rd	Mccrary Rd	Valley Ranch Crossing Dr
E BW 8	Mcgowen St	Valley Ranch Pkwy
E Bw 8 N	Mchard Rd	Van Hut Ln
E BW 8 S	Mckinney St	Veterans Memorial Dr
E Crosstimbers	Mckinnon Rd	Via Dora Dr
E Cypresswood Dr	Melendy	Vickery Dr
E Edgebrook Dr	Memorial Dr	Vickery St
E FM 1960	Mercury	Victory Dr
E FM 1960 BYPASS	Mesa Dr	Voss Rd
E Hardy Rd	Metro ROW	W 11th St

Roadway Name	Roadway Name	Roadway Name
E Hillcroft St	Middlebrook Dr	W 18th St
E Houston Rd	Miller Rd No 2	W 20th St
E I-10	Miller Rd No 3	W 34th St
E I-610 N	Miller Wilson Rd	W 43rd St
E I-610 S	Mills Branch Dr	W 6th St
E Lake Houston Pkwy	Mills Rd	W Airport Blvd
E Little York Rd	Mitchell Rd	W Alabama St
E Louetta Rd	Monroe Rd	W Bay Area Blvd
E Mossy Oaks Rd	Montrose Blvd	W Bellfort St
E Navigation Blvd	Mop	W Bw 8 N
E Orem Dr	Morton Rd	W Bw 8 S
E Parker Rd	Mound Rd	W Cavalcade
E Richey Rd	Mount Houston Rd	W Crosstimbers
E T C Jester Blvd	Mueschke Rd	W Cypress Hill Cir
E Tidwell Rd	Murrell Rd	W Dallas St
E West Rd	Mykawa	W El Dorado Blvd
Echo Ln	N Braeswood Blvd	W FM 1960
Ed Ln	N Bridgelands Lake Pkwy	W FM 1960 BYP
Edgebrook Dr	N Bw 8 E	W FM 1960 Rd
Edloe St	N Bw 8 W	W Fuqua St
Egypt Ln	N Calumet	W Gray
El Camino Real	N Crawford St	W Greens Rd
El Dorado Blvd	N Dairy Ashford	W Gulf Bank
Elan Blvd	N Diamondhead Blvd	W Gulf Bank Rd
Eldridge Pkwy	N Durham Dr	W Hardy Rd
Elgin St	N Eldridge Pkwy	W Hillcroft St
Elgin- Texas Spur 5	N Gessner Dr	W Holcombe Blvd
Ella Blvd	N Houston Rosslyn Rd	W I-10
Ellington Bypass	N I-45	W I-610 N
Elysian St	N I-610	W I-610 S
Elysian Viaduct	N I-610 E	W Lake Houston Pkwy
Enclave Pkwy	N I-610 W	W Little York Rd
Ennis St	N Kirkwood Rd	W Memorial-Woodway W
Enos	N La Branch St	W Montgomery Rd
Ernestes Rd	N Lake Houston Pkwy	W Mossy Oaks Rd
Ernestine St	N Macgregor Way	W Mount Houston Rd
Fairbanks N Houston Rd	N Main	W Orem Dr
Fairfield Place Dr	N Main St	W Parker Rd

Roadway Name	Roadway Name	Roadway Name
Falcon Landing Blvd	N Mccarty	W Patton St
Fall Creek Bend	N Post Oak Ln	W Rankin Rd
Fallbrook Dr	N Post Oak Rd	W Rayford Rd
Falling Creek Dr	N Sampson	W Richey Rd
Falvel Rd	N SH 6	W Sam Houston Pkwy N
Fannin	N Shaver St	W Stroker Rd
Farmer Rd	N Shepherd Dr	W Sycamore St
Farnham St	N US 59/I-69	W T C Jester Blvd
Federal Clinton	N Wayside	W Tidwell Rd
Federal Rd	N Westgreen Blvd	Waco
Fidelity St	N Wilcrest Dr	Waller Spring Creek
Fields St	N York	Waller Tomball Rd
Fields Store Rd	N. MAIN	Wallisville Rd
First St	Nasa Pkwy	Warren Ranch Rd
Flukinger Rd	Navigation Blvd	Washington Ave
FM 1093	NB 610 E /EB 225 TO Broadway	Watonga Blvd
FM 1314	NB 610 W TO WB 290	Watson
FM 1463	Newcastle	Waugh
FM 1464	Nichols Rd	Waughcrest St
FM 1485	Nichols Sawmill Rd	Wayside
FM 1488	Normandy	Weaver Rd
FM 1736	Normandy St	Weeds Rd
FM 1959	North by Northwest	Weeping Willow
FM 1960	North Long Meadow Farms	Weslayan St
FM 2100	Northborough Dr	West Rd
FM 2351	Northgate Crossing Blvd	Westcott
FM 2855	Northpark Dr	Westgreen Blvd
FM 2920	Northpointe Blvd	Westheimer Pkwy
FM 2978	Northwest Fwy	Westheimer Place Dr
FM 359	Oak Leaf Dr	Westheimer Rd
FM 362	Oates Rd	Westmoor Dr
FM 521	Old Airline Dr	Westmoor Rd
FM 528	Old Atascocita Rd	Westpark Tollroad
FM 529	Old Bechkendorf Rd	Westview
FM 723	Old Humble Rd	Westwood Rd
Foley Rd	Old Katy Rd	Wheatley St
Fondren Rd	Old Main St Loop Rd	Wheeler
Ford Rd	Old Richmond Rd	White Oak Dr

Roadway Name	Roadway Name	Roadway Name
Fort Bend Tollway	Oold Riley Fuzzel Rd	Wilcrest Dr
Fountain View Dr	Old Spanish Trl	Will Clayton Pkwy
Fox Run Blvd	Old Spring Cypress Rd	Willardville Rd
Franklin St	Old Waller Tomball Rd	Willowbend Blvd
Franz Rd	Orem Dr	Willowbrook Dr
Freeman Rd	Owens Rd	Willowick
Freeport Blvd	Park Place Blvd	Wilshire Dr
Frey Rd	Park Row	Wilson Rd
Fry Rd	Parker Rd	Winfield
Fulshear Gaston Rd	Patterson Rd	Winfield Rd
Fulton St	Patton St	Winkler Dr
Fuqua St	Pearland Pkwy	Wirt Rd
Furman Rd	Pecore	Wolf Trot
Gaines Rd	Peek Rd	Woodforest Blvd
Galaxy Blvd	Peek Ridge Rd	Woodland Hills Dr
Galveston Rd	Penick Rd	Woodlands Pkwy
Garland Dr	Perry Rd	Woodridge Dr
Garrett Rd	Pin Oak Rd	Woods Rd
Gaston Rd	Pinelakes Blvd	Woodway Dr
Gears Loop	Pineloch Dr	Yale
Gears Rd	Pinemont Dr	Yellowstone Blvd
Gellhorn	Pitts Rd	York St
Genoa Red Bluff Rd	Polk	Yorktown St

Source: City of Houston Major Thoroughfare Plan, 2012

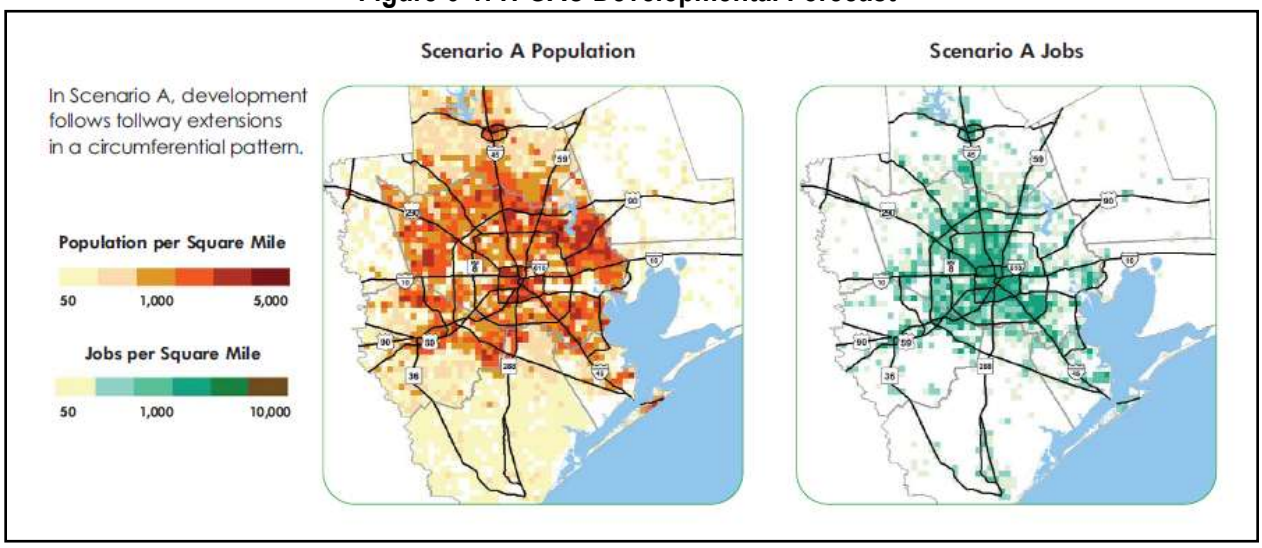
Development Forecasts

The H-GAC 2035 population trends projections were reviewed for information on forecasts for development in the RSA. The H-GAC relies on past trends, current conditions, and anticipated growth influences to determine their projections. The H-GAC projections are to the year 2035 for Harris, Montgomery, Liberty, and Chambers counties. Forecast data was not available for San Jacinto County as this county is outside of the MPO jurisdiction. The H-GAC forecast is for continued growth in the counties already seeing increasing development trends, and steady growth in areas currently experiencing less development, continuing to the year 2035. Two large multi-modal rail yards are currently planned in Liberty County. These rail yards are planned for the area southwest of Dayton between SH 146 and US 90. Details concerning the size of these proposed rail yards were not available at the date of this study. In addition to

the reasonable foreseeable land use changes, these two facilities would potentially impact transportation planning in the region.

The *Envision Houston Region* report, published by the H-GAC, was provided during the expert panel survey conducted during 2008-2009. The *Envision Houston Region* report is the result of an innovative public outreach effort designed to promote dialogue between the public and policymakers regarding future growth and development of the eight-county Houston-Galveston region. The data provided by the *Envision Houston Region* report was used to project future growth within the region. Scenario A, as defined in the report, defines the current growth forecast and development pattern for the eight-county Gulf Coast region based on H-GAC's 2035 demographic forecasts. Scenario A includes the build out of the Grand Parkway toll road system. The report stated that "in Scenario A, mixed-use development is concentrated along the highway system. Low-density housing developments fill the areas between major roadways, resulting in floodplain development, more acreage consumption, more vehicle miles, and less transit use." This scenario, illustrated in **Figure 6-1**, assumes no change to current land use plans or planning controls.

Figure 6-1: H-GAC Developmental Forecast



Source: H-GAC *Envision Houston Region* report. http://2035plan.org/docs/final/Appendix%20A-Envision%20Houston%20Region%20Flyer.pdf Accessed April 2009

For comparison, Scenarios B and C consisted of the workshop participants' visions of ideal planned growth for the Houston region. Scenarios B and C required developmental regulations and incentives not currently in place; therefore, they were not considered as likely to occur as Scenario A by the project team.

Scenario A used a growth pattern in this study resulting from current and planned growth in the region, and

combined with the expert panel survey, data from the stakeholder meetings, and other data noted above to determine all of the reasonably foreseeable actions within the land use RSA. The projected cumulative development within the land use RSA is shown on **Exhibit 6-1**.

6.3.1.6 Step 6: Cumulative Impacts Assessment - Land Use

Potential cumulative impacts considered and discussed include land use and development impacts associated with commercial and residential growth as related to the access of the Preferred Alternative in combination with the effects of the other reasonably foreseeable actions. Cumulative impacts on land use resulting from indirect effects of the Preferred Alternative, in combination with the previously described reasonably foreseeable land development and transportation projects, would decrease the amount of open spaces and increase the north-south traffic volumes within the land use RSA.

Not considering construction of the Grand Parkway Segments H and I-1, the land use RSA is steadily developing generally north and south of the proposed project's corridor; however, growth is slow throughout the majority of the central portion of the project corridor. Construction of the Preferred Alternative is anticipated to influence planned development, as well as induce development within the land use RSA. The area is also developing with respect to the MPO's roadway plan – a plan developed to address forecasted growth. The proposed Grand Parkway projects are a small percentage of the total proposed roadway projects planned to address the future transportation needs of the region in the 2035 plan. The MPO plan also lists several transportation related improvements to serve the RSA.

6.3.1.7 Step 7: Results– Land Use

The combined effect of existing development (239,370 ac), the Preferred Alternative (conversion of approximately 1,933 ac to proposed ROW), and planned/reasonably foreseeable/induced development (approximately 50,100 ac, of which 25,944 ac is anticipated to be induced by the Preferred Alternative) could result in approximately 291,477 total acres of cumulative impacts to the land use RSA. Because of the various land use changes planned for the land use RSA, the likelihood of development as a cumulative effect is very high. The proposed project's contribution to the cumulative effect is relatively low, as approximately 9.6 percent (27,951 ac) of the 291,477 total ac of cumulative impacts can be directly and indirectly attributed to the Preferred Alternative. The anticipated cumulative land use effects (291,477 ac) represents approximately 38 percent of the land use RSA.

6.3.1.8 Step 8: Mitigation – Land Use

Mitigation for the development within the RSA considered for this analysis would rest with agencies that have the authority to implement such controls. This authority rests with municipal governments and to a lesser extent, county governments. The responsibility of transportation providers such as TxDOT, local and regional transit agencies, and local governments would be to implement a transportation system to complement the land use or development controls implemented. Grand Parkway Segments H and I-1, as well as any other links in the transportation network, would complement the land use and transportation changes in the area, but it cannot be considered the sole reason for the forecasted land use changes to occur. Therefore, no mitigation is proposed.

6.3.2 Environmental Justice

6.3.2.1 Step 1: Resource Identification – Environmental Justice

The thresholds used to identify areas with high concentrations of low-income and/or minority populations in the RSA were set based on the definitions of low-income and minority established in the FHWA Order 6640.23 and by the CEQ, Environmental Justice Guidance under NEPA documentation.

The proposed toll facility has the potential to directly impact low-income populations (refer to **Chapter 4 (Environmental Consequences)** and **Exhibit 3-2**), as a higher percentage of their income would be required to utilize the facility than that of non-low-income populations. Further, low-income populations would not benefit from improved system linkage that would be afforded those motorists who have the ability to pay for the proposed toll facility.

6.3.2.2 Step 2: Resource Study Area – Environmental Justice

The RSA for socio-economic conditions is the H-GAC (MPO) boundary (**Exhibit 6-2**). The regional toll system (of which Grand Parkway Segments H and I-1 would be an element) is located within this MPO area. Quantitative U.S. Census Bureau data (*Census 2000 and 2010*) and H-GAC 2035 population forecast data was evaluated to determine the demographic trends for the RSA. The temporal boundaries for the cumulative impacts analysis are the years 1970 to 2035. Historical actions are those actions which occurred between 1970 and 2000; present actions are those actions which have occurred between 2000 and 2010. The years 2010 through 2035 represent future actions. The year 2035 was chosen to correlate with the H-GAC's 2035 RTP Update.

6.3.2.3 Step 3: Resource Health and Historical Context – Environmental Justice

Executive Order (EO) 12898 was intended to ensure that federal departments and agencies identify and address disproportionately high and adverse human health and environmental impacts of their policies, programs, and activities on minority populations and low-income populations. It reinforced Title VI of the Civil Rights Act of 1964. It reminded all government agencies receiving federal funding that they are required to address discrimination as well as the consequences of their decisions or actions that might result in disproportionately high and adverse environmental and health impacts on minority and low-income communities.

Subsequent to EO 12898, U.S. Department of Transportation (USDOT) Order 5610.2 was published in the *Federal Register* in 1997. It describes the process for incorporating environmental justice principles into all USDOT programs, policies, and activities. The following year FHWA Order 6640.23 was issued establishing policies and procedures for FHWA to use in complying with EO 12898 and USDOT Order 5610.2.

From a historical demographic perspective, extensive growth has occurred within the environmental justice RSA since 1970. The H-GAC's eight-county region grew approximately 106.7 percent between 1970 and 2000 according to the U.S. Census Bureau's 1970 and 2000 decennial census, from 2,259,847 to 4,669,571 persons. Within the 1970 to 2000 timeframe, population growth by county ranged from approximately 47.3 percent (Galveston County) to 493.7 percent (Montgomery County). In 1979 and 1989, the median household income of the State of Texas was $27,997 (in 1989 CPI-U adjusted dollars) and $27,016 (in 1989 dollars), respectively. The median household income by county within the H-GAC's eight-county region ranged from $28,153 (Liberty County) to $42,882 (Fort Bend County) in 1979 [in 1989 CPI-U adjusted dollars]. In 1989, the median household income for the H-GAC region ranged by county from $22,334 (Waller County) to $42,809 (Fort Bend County) [in 1989 dollars]. A comparison of racial and ethnic profiles by county is not readily available for the H-GAC region for the 1970 through 2000 timeframe.

A comparative breakdown of environmental justice populations for each of the counties located within the H-GAC's eight-county region for the years 2000 and 2010 was reviewed. The total environmental justice population percentage for the RSA is anticipated to increase between 2000 and 2035 based on the demographic trend observed between 2000 and 2010, as shown in **Table 6-6**.

Table 6-6: H-GAC MPO Environmental Justice Population Comparison (2000 and 2010) and 2035 Population Forecast

County	2000			2010			Total 2035 Population Forecast
	Total Population	Percentage Minority Population (%)	Percentage Family Low-Income Population (%)	Total Population	Percentage Minority Population (%)	Percentage Family Low-Income Population (%)	
Brazoria	241,767	33.6	8	319,379	49.1	10.6	469,304
Chambers	26,031	21.2	8.3	35,522	32.7	10.5	52,617
Fort Bend	354,452	52.4	5.4	606,953	65.8	8	935,102
Galveston	250,158	35.8	10.1	295,747	42.8	12.8	404,471
Harris	3,400,578	56.9	12	4,180,894	69.9	16.8	5,769,193
Liberty	70,154	24.4	11.1	76,206	33.5	15.4	119,810
Montgomery	293,768	17.7	7.1	471,734	31.2	10.9	857,637
Waller	32,663	49.2	11.4	44,013	58.4	21.1	75,618
H-GAC MPO TOTAL	4,669,571	51	10.8	6,030,448.00	85.6	13.3	8,683,752

Source: U.S. Census Bureau (*Census 2000* and *2010*) and H-GAC 2035 Population Forecast

Of the counties located within the RSA, Harris County contained the largest concentration of minority and low-income populations in 2010. Harris County contains a minority population of approximately 69.9 percent and a low-income population (those living below the 2010 $22,050 poverty guideline for a family of four) of approximately 16.8 percent. As documented in the *2010 Census*, the remaining RSA counties contain minority populations which range from approximately 31.2 to 65.8 percent and low-income populations ranging from approximately 8 to 21.1 percent.

6.3.2.4 Step 4: Direct and Indirect Impacts – Environmental Justice

Direct Impacts

No substantial direct impacts to environmental justice populations would result from tolling Grand Parkway Segments H and I-1. The Preferred Alternative is anticipated to result in traffic noise impacts. There would be one residential displacement within an environmental justice community (CT 7009.00 BG 1 CB 1019). Tolling costs would be comparable to existing Harris, Montgomery, and Chambers county toll roads. The project impacts would not be isolated within a limited number of census tracts, but would be incurred by all users, including minority and low-income users of the Grand Parkway Segments H and I-1 facility. Although the impacts would not be substantial, it should be noted that low-income populations would be impacted by toll rates, toll collection, and other matters associated with user fees. No substantial indirect impacts are anticipated.

Should a low-income person be unable to pay the toll, this may result in a difference of time travel associated with utilizing non-toll alternatives. In addition, the economic impact of tolling would be higher for low-income users since the cost of paying tolls would represent a higher percentage of household income than for non-low-income users. Potential benefits of the new location roadway would include improved system linkage and access, improved mobility, and increased economic vitality to the area.

Indirect Impacts

The environmental justice community, as a subset of the communities located within the AOI, would experience indirect impacts due to tolling that mirror those of the general population. No disproportional impacts are anticipated to affect environmental justice communities. Potential adverse effects would include displacements of low-income or minority persons, or groups of persons, and additional noise and visual impacts. Beneficial effects could also occur to these populations. For example, induced land use development could create additional job opportunities and increased access to job opportunities through enhanced transportation infrastructure. Indirect impacts pertaining to public facilities and services access, traffic operations, and traffic noise would be experienced by the environmental justice population to the same extent and in the same manner (whether positive or negative) as experienced by the non-environmental justice population. Because indirect effects to environmental justice communities of concern can be both adverse and beneficial, and because proactive public involvement and coordination with local planning officials can help avoid disproportionate impacts, potential indirect effects of Grand Parkway Segments H and I-1 on environmental justice communities of concern are not considered to be substantial. The proposed project may have a beneficial indirect impact on the overall socio-economic conditions within the AOI.

6.3.2.5 Step 5: Reasonably Foreseeable Actions – Environmental Justice

Existing toll facilities that factor into the cumulative impacts of the proposed toll system include the Sam Houston Tollway, the Westpark Tollway, and the Hardy Toll Road. Linkage to these toll facilities would be available to users of Segments H and I-1 as well as the non-tolled alternatives associated with those existing toll facilities. Other reasonably foreseeable toll projects in the immediate area include the completion of Segments G and I-2 of the Grand Parkway.

6.3.2.6 Step 6: Cumulative Impacts Assessment – Environmental Justice

Historically, TxDOT has financed highway projects on a "pay-as-you-go" basis, using motor fuel taxes and other revenue deposited in the state highway fund. However, population increases and traffic demand have outpaced the efficiency of this traditional finance mechanism. As funding mechanisms evolve, the trend towards utilization of toll facilities in this region would through time create "user impacts" as access to highway systems becomes an issue to the economically disadvantaged.

As acknowledged in the environmental justice assessment **(Chapter 4 (Environmental Consequences))**, the economic impact of tolling would be higher for low-income residents since the cost of paying tolls would represent a higher percentage of household income than for non-low-income households. Further, low-income residents would not directly benefit from system linkage that the Segments H and I-1 are proposed to provide if they are unable to use the roadway due to the cost of paying tolls. Grand Parkway Segments H and I-1, as an element of the system of toll roads now being developed for the greater Houston metropolitan area, would contribute to a cumulative impact on low-income users of the system.

System Level Analysis

A system level analysis for Level of Service (LOS) impacts associated with Segments H and I-1 is provided in **Chapter 2 (Alternatives Analysis)**. According to the analysis, vehicle hours of total delay (signalized delays and congestion delays) decrease when Segments H and I-1 are added to the system. Additionally, the model indicates the LOS for arterial streets in the cities have a slight improvement. As stated earlier, non-toll alternatives would be available to all travelers, including low-income populations, via frontage roads (if available along FM 1485) and local arterials. The use of these alternative non-toll routes may result in a difference in travel time due to a lower speed limit and signalization.

The Grand Parkway as an element of the system of toll roads now being developed for the H-GAC area would contribute to a cumulative impact on low-income users of the system. Although it is likely that a user may routinely travel one or more elements of the toll system en-route to and from various destination points throughout the city, it is unlikely that the user would travel the entire length of those elements. Further, given the lay-out and orientation of the regional system, it is not likely that a driver would routinely travel the entire length of the entire Houston-area toll system during the course of normal activities.

6.3.2.7 Step 7: Results– Environmental Justice

The combined effect of the historical growth patterns within the environmental justice RSA, forecasted growth of population, induced development associated with the proposed project described in **Chapter 5**, reasonably foreseeable developments, and improvements to other transportation facilities previously discussed results in a market attractive for continued residential and commercial development. As stated in Step 5, the anticipated increase of tolled mainlanes in the regional transportation network is indicative of an emerging regional tolling network.

Access to the mainlanes of the emerging regional tolling network would be limited to those who elect or can only on occasional basis afford to pay the toll. Additionally, as detailed in **Section 4.2.1.2**, the cash payment option for HCTRA's EZ TAG is not currently available. Because (at this time) cash accounts are not accepted to maintain an EZ Tag, individuals without a bank account or credit card would face limitations with using the regional tolling network. However if other forms of prepaid tolling transponder accounts are accepted, such as TxDOT's TxTag or NTTA's TollTag, users without a bank account would be able to utilize the regional tolling network by maintaining cash payments. The difference in travel times between the tolled mainlanes and the non-tolled alternatives would be the highest during peak periods of travel when traffic congestion would be the greatest.

The economic impact of tolling would be higher for the low-income individuals because the cost of paying tolls would represent a higher percentage of household income than for non-low-income households. Not maintaining a prepaid toll transponder account would impact any user, including low-income users, because the cost of paying the accumulated toll charges without an account would represent a higher toll rate than toll charges affiliated with a prepaid account.

It is reasonable to assume that there would be a cumulative impact on environmental justice populations upon build-out of the toll system due to the economic impacts of tolling and the difference in travel time should non-toll alternatives be utilized by low-income populations. However, given the lay-out and orientation of the regional system and examination of the traffic data associated with the origin-destination analysis, it is not anticipated that users (including low-income users) would be affected by travelling the entire length of the entire system during the course of normal activities.

6.3.2.8 Step 8: Mitigation – Environmental Justice

Mitigation: Regulatory Controls

The proposed tolling of Segments H and I-1 would not exclude any person on the ground of race, color, or national origin from participation in the project, be denied the benefits of the project, or be subject to discrimination under the proposed project; therefore, according to Title VI of the Civil Rights Act of 1964 and EO 12898 regulation, mitigation associated with environmental justice is not currently proposed. Through the excess toll revenue generated from the proposed toll project, other transportation projects could be programmed to benefit the regional community including environmental justice populations.

6.3.3 Air Quality

6.3.3.1 Step 1: Resource Identification – Air Quality

The proposed project area falls within the eight-county Houston-Galveston-Brazoria nonattainment area which is currently classified as a marginal nonattainment area for the eight-hour ozone NAAQS. All projects in the H-GAC's 2013-2016 Transportation Improvement Program (TIP) that are proposed for federal or state funds were initiated in a manner consistent with federal guidelines in Section 450, of Title 23 CFR and Section 613.200, Subpart B, of Title 49 CFR. Air quality is among the considerations addressed in the programming of the TIP.

Ozone and Carbon Monoxide

In order to protect human health and the environment, the Clean Air Act (CAA) of 1970 mandated the establishment of the NAAQS and regulations to reduce air pollutants. When the pollutant level within an area exceeds the NAAQS, U.S. Environmental Protection Agency (EPA) designates the area as "nonattainment" for the pollutant.

MSAT

In addition to NAAQS, EPA also regulates air toxics. Most air toxics originate from human-made sources, including on-road mobile sources, non-road mobile sources (e.g., airplanes), area sources (e.g., dry cleaners), and stationary sources (e.g., factories or refineries).

6.3.3.2 Step 2: Resource Study Area – Air Quality

The RSA for evaluating air quality associated with the NAAQS and transportation conformity was designated as the eight-county Houston-Galveston-Brazoria non-attainment area for the eight-hour ozone standard, which includes Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, and

Waller counties as depicted in **Exhibit 6-2.** This area represents the management unit for mobile source pollutants as regulated by federal, state, and local government agencies. The NAAQS criteria pollutants include ozone, carbon monoxide, particulate matter, nitrogen dioxide, sulfur dioxide, and lead. Unlike the other resources evaluated, air quality impacts from mobile sources are evaluated and managed on a regional basis primarily through the H-GAC, in coordination with the EPA, TCEQ, TxDOT, and FHWA. Evaluating Air Quality in relation to cumulative impacts requires looking at three distinct RSAs, as described below:

- **Ozone** – The RSA for evaluating the ozone NAAQS was designated as the Houston-Galveston-Brazoria eight-hour ozone nonattainment area, which includes: Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, Waller counties. The NAAQS criteria pollutants include ozone, carbon monoxide, particulate matter, nitrogen dioxide, sulfur dioxide, and lead.
- **Carbon Monoxide** – The RSA for carbon monoxide was based on the ROW line, which represents the locations with the highest potential for carbon monoxide concentrations. However, the nature of the proposed project does not warrant a Traffic Air Quality Analysis. Therefore, carbon monoxide levels resulting from this project would not be expected to exceed the NAAQS for carbon monoxide and negatively impact air quality in this area.
- **Mobile Source Air Toxics (MSAT)** – The RSA for MSAT is encompassed by the boundaries of Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, Waller counties. Unlike the other resources evaluated, air quality impacts from MSAT have been evaluated qualitatively in this proposed project by TxDOT and FHWA. MSAT are regulated by EPA on a national basis through requirements for fuels and vehicle technology. The MSAT analysis conducted for the proposed project qualitatively evaluated emission changes based upon the proposed project and national trends.

6.3.3.3 Step 3: Resource Health and Historical Context – Air Quality

The EPA establishes limits on atmospheric pollutant concentrations through enactment of the NAAQS for six principal, or criteria pollutants. The EPA designated eight counties in the Houston-Galveston-Brazoria area as nonattainment for ozone. The region is currently in attainment for all other criteria pollutants. Although there have been year-to-year fluctuations, the ozone trend continues to show improvement. The trend of improving air quality in the region is attributable in part to the effective integration of highway and alternative modes of transportation, cleaner fuels, improved emission control technologies, and H-GAC regional clean air initiatives.

6.3.3.4 Step 4: Direct and Indirect Impacts – Air Quality

Direct impacts on air quality and MSAT from the project are primarily those associated with the increased capacity, accessibility and the resulting projected increases in VMT. Emission reductions as a result of EPA's new fuel and vehicle standards are anticipated to offset impacts associated with VMT increases.

Indirect impacts on air quality and MSAT are primarily related to any expected development resulting from project's increased accessibility, or capacity to the area. Any increased air pollutant or MSAT emissions resulting from the potential development of the area must meet regulatory emissions limits established by the TCEQ and EPA, as well as obtain appropriate authorization from the TCEQ, and therefore are not expected to result in any degradation of air quality or MSAT levels.

6.3.3.5 Step 5: Reasonably Foreseeable Actions – Air Quality

Increased development and urbanization can result in increased air pollutant or MSAT emissions resulting from these actions. These must meet regulatory emissions limits established by the TCEQ and EPA, as well as obtain appropriate authorization from the TCEQ, and therefore are not expected to result in any degradation of air quality or MSAT levels. Reasonably foreseeable actions that could impact air quality within the RSA include projects within the H-GAC 2035 RTP Update – Appendix E Project Listing (http://www.h-gac.com/taq/plan/documents/2035_update/Appendix%20E%20-%20Compiled%20-%2001-21-11.pdf).

6.3.3.6 Step 6 and Step 7: Cumulative Impacts Assessment and Results – Air Quality

Any increased air pollutant or MSAT emissions resulting from increased capacity, accessibility and development are projected to be more than offset by emissions reductions from EPA's new fuel and vehicle standards or addressed by EPA's and TCEQ's regulatory emissions limits programs. Projected traffic volumes are expected to result in no impacts on air quality; improved mobility and circulation may benefit air quality. Increases in urbanization would likely have a negative impact on air quality. However, planned transportation improvements in the project area as listed in the conforming 2035 RTP Update and 2013-2016 TIP, coupled with EPA's vehicle and fuel regulations and fleet turnover, are anticipated to have a cumulatively beneficial impact on air quality.

The cumulative impact on air quality from the proposed project and other reasonably foreseeable transportation projects is addressed at the regional level by analyzing the air quality impacts of

transportation projects in the 2035 RTP Update and the 2013-2016 TIP. The proposed project and the other reasonably foreseeable transportation projects were included in the 2035 RTP Update and the 2013-2016 TIP, and have been determined to conform to the State Implementation Plan (SIP). When combined, planned transportation improvements, revised EPA fuel and vehicle regulations, and fleet turnover are anticipated to have a cumulatively beneficial impact on air quality.

6.3.3.7 Step 8: Mitigation– Air Quality

The mitigation of future development within the region considered for this study would rest with the agencies with the authority to implement such controls. This authority rests with the municipal governments and to a lesser extent, the county governments. The responsibility of transportation providers such as TxDOT, local and regional transit agencies, and local governments would be to implement a transportation system to complement the land use or development controls implemented. The H-GAC would be responsible for determining the conformity of the RTP and TIP to air quality standards and mitigating air quality on a regional basis.

Mitigation: Regulatory Controls

A variety of federal, state and local regulatory controls as well as local plans and projects have had, and would continue to have, a beneficial impact on overall regional air quality. The CAA, as amended, provides the framework for federal, state, tribal, and local rules and regulations to protect air quality. The CAA required the EPA to establish NAAQS for pollutants considered harmful to public health and the environment. In Texas, the TCEQ is responsible to develop, adopt and implement plans and strategies to protect and restore air quality in cooperation with local, regional, state, and federal stakeholders. TCEQ has the legal authority to implement, maintain, and enforce the NAAQS. Authorization in the Texas CAA allows the TCEQ to do the following: collect information and develop an inventory of emissions; conduct research and investigations; prescribe monitoring requirements; institute enforcement; formulate rules; establish air quality control regions; encourage cooperation with citizens' groups and other agencies and political subdivisions of the state as well as with industries and the federal government; and to establish and operate a system of permits for construction or modification of facilities. Local governments having some of the same powers as the TCEQ can make recommendations to the commission concerning any action of the TCEQ that may affect their territorial jurisdiction, and can execute cooperative agreements with the TCEQ or other local governments. In addition, a city or town may enact and enforce ordinances for the control and abatement of air pollution not inconsistent with the orders of the TCEQ.

The CAA also requires states with areas that fail to meet the NAAQS prescribed for criteria pollutants to develop a SIP. The SIP describes how the state would reduce and maintain air pollution emissions in order to comply with the federal standards. Important components of a SIP include emission inventories, motor vehicle emission budgets, control strategies, and an attainment demonstration. The TCEQ develops the Texas SIP for submittal to the EPA. One SIP is created for each state, but portions of the plan are specifically written to address each of the nonattainment areas. These regulatory controls, as well as other local transportation and development initiatives implemented throughout the Houston-Galveston-Brazoria eight-county area by local governments (and others) provide the framework for growth throughout the area consistent with air quality goals. As part of this framework, all major transportation projects (including the proposed project) are evaluated at the regional level by the H-GAC for conformity with the SIP.

The cumulative impact of reasonably foreseeable future growth and urbanization on air quality within this area would be minimized by enforcement activities of federal and state regulations by the EPA and TCEQ, which would help ensure that growth and urbanization would not prevent attainment with the ozone standard or threaten the maintenance of the other air quality standards.

6.3.4 Water Resources

6.3.4.1 Step 1: Resource Identification –Water Resources

The resource is all of the U.S. Army Corps of Engineers (USACE) jurisdictional waters within the water quality RSA. Particular attention is given to surface water quality conditions, habitat value and functions and values. Declining health trends in surface water quality nationally and concern for special aquatic sites make analysis necessary.

6.3.4.2 Step 2: Resource Study Area – Water Resources

The RSA for water resources (specifically water quality and waters of the U.S., including wetlands) is shown in **Exhibit 6-3** and is comprised of approximately 3.3 million ac. The RSA includes six regional watersheds; a watershed represents a bounded hydrologic system wherein natural resources are interconnected and integrated through a common water course. Conversion of this resource would affect the hydrology and ecology that currently characterizes the watersheds. The six regional watersheds found within the RSA include: Buffalo-San Jacinto, East Fork San Jacinto, Lower Trinity, North Galveston Bay, Spring, and West Fork San Jacinto watersheds; these regional watersheds include sub-watersheds, notably including the San Jacinto River, Luce Bayou, Cedar Bayou, and Jackson Bayou watersheds within

the project area. The San Jacinto River watershed includes Caney Creek, Peach Creek, and the East Fork and West Fork of the San Jacinto River, and their tributaries. Luce Bayou and its tributaries comprise the Luce Bayou watershed. Cedar Bayou watershed is comprised of Cedar Bayou and Old River and their tributaries. Jackson Bayou flows west into Lake Houston. Within the water resources RSA, there are approximately 190,000 ac of waters and 343,000 ac wetlands, as defined by the National Wetland Inventory and the topographical maps utilized for this analysis.

As previously stated, the temporal boundaries for the cumulative impacts analysis are the years 1970 to 2035. Historical actions are those actions which occurred between 1970 and 2000; present actions occurred between 2000 and 2013. The years 2013 to 2035 represent future actions, which correlate with the H-GAC's 2035 RTP Update.

6.3.4.3 Step 3: Resource Health and Historic Context –Water Resources

According to the 2010 Texas 303(d) list, two listed segments are within the RSA. Segment ID: 0902, Cedar Bayou Above Tidal, is listed as impaired from a point 1.4 mile (mi) upstream of I-10 (E) in Chambers/Harris County to a point 4.6 mi upstream of FM 1960 in Liberty County; it is listed as a Category 5c, Rank D because of low dissolved oxygen. Category 5 waters are those which do not meet applicable water quality standards or are threatened for one or more designated uses by one or more pollutants. Category 5c waters are those where additional information would be collected before a Total Maximum Daily Load (TMDL) study is scheduled. Cedar Bayou Tidal (Segment ID: 0901) is listed along its entire length as impaired due to dioxin in catfish and crab tissue (Category 5a, Rank U). The Category 5a designation means that a TMDL study is scheduled, underway or would be scheduled for the waterway in question. The Rank of "U" indicates that a TMDL study is underway. Sixty stream segments are listed as impaired in the Buffalo-San Jacinto watershed. The West Fork San Jacinto watershed has two stream segments listed as Impaired, the East Fork San Jacinto watershed has no impaired segments, the Lower Trinity watershed has one listed segment impaired, the North Galveston Bay watershed has four listed impaired segments, and the Spring watershed has 13 listed impaired segments.

These impairments are a function of historical (and many pre-regulatory) changes to the land around these waterways and introduced stress placed upon them by land use changes. CWA Section 303(d) requires the TCEQ to identify those waters within its boundaries for which the effluent limitations required by Section 301(b)(1)(A) and Section 301(b)(1)(B) are not stringent enough to ensure compliance with applicable

surface water quality standards. If waterways do not meet these standards, a plan must be developed to meet the standards. The TCEQ must establish a priority ranking, taking into account the severity of the pollution and the uses of the streams.

In the water resources RSA, development and urbanization has resulted in channelization, excavation, and filling of many of the area's natural streams and wetlands.

In 1991, Texas adopted state goals for "no net loss" of acreage or aquatic function of wetlands. These goals reflect the regulatory program in the CWA legislation that prohibits the discharge of fill into Waters of the U.S. unless authorized by a permit issued under CWA Section 404. The USACE has authority over such actions and may require the permittee to restore, create, enhance, or preserve nearby aquatic features as compensation to offset unavoidable adverse impacts to the aquatic environment. This means compensatory mitigation is intended to comply with the general goals of the CWA and the specific goal of "no net loss" of aquatic functions. Several regulations, such as Nationwide Permits (NWP) and Individual Permits (IP) issued by the USACE and consistency with the Texas Coastal Management Program, have been enacted on a federal, state, and local level to achieve these goals.

6.3.4.4 Step 4: Direct and Indirect Impacts – Water Resources

Direct Impacts (Water Quality)

Impervious surfaces may be directly increased by as much as 419 ac with the construction of the Preferred Alternative. In addition, although not required by regulation, the project would include features to facilitate the control of possible spills of hazardous materials along the roadway. These features include, but are not limited to, silt fences, check dams, vegetative swales and filter strips, and detention basins. No such features currently exist within the project corridor.

It is not anticipated that the Preferred Alternative or the No-Build Alternative would contaminate or otherwise adversely affect any surface waters including the public water supply, water treatment facilities, or water distribution systems. Rainfall runoff rates would increase slightly due to an increase in impervious cover. The TCEQ requires temporary and permanent Best Management Practices (BMPs) designed to assure that unacceptable impacts to water quality are avoided. These measures include, but are not limited to, silt fences, check dams, vegetative swales and filter strips, and detention basins. Indirect impacts are anticipated to be minor. Aquatic habitat values for ephemeral streams are absent and water

quality impacts would be minimized and mitigated by adherence to federal and state regulatory permits and conditions.

Direct Impacts (Waters of the U.S., including Wetlands)

The proposed project would have direct impacts to approximately 338 ac of wetlands and 22.9 ac of Waters of the U.S. Impervious surfaces may be increased by as much as 419 ac due to direct impacts. In addition, although not required by regulation, the project would include features to facilitate the control of possible spills of hazardous materials along the roadway. No such features currently exist within the project corridor.

It is not anticipated that the Preferred Alternative or the No-Build Alternative would contaminate or otherwise adversely affect any surface waters including public water supply, water treatment facilities, or water distribution systems. Rainfall runoff rates would increase slightly due to an increase in impervious cover. The TCEQ requires temporary and permanent BMPs designed to assure that unacceptable impacts to water quality are avoided. These measures include, but are not limited to, silt fences, check dams, vegetative swales and filter strips, and detention basins. As with all of the reasonable alternatives, much of this "jurisdictional area" is already disturbed (graded, piped, concrete-lined, etc.). Direct impacts to surface waters resulting from any of the reasonable alternatives are anticipated to require an individual permit. Indirect impacts are anticipated to be minor. Aquatic habitat values for ephemeral streams are absent and water quality impacts would be minimized and mitigated by adherence to federal and state regulatory permits and conditions.

Indirect Impacts (Water Quality)

Approximately 25,944 ac of undeveloped land would be converted to residential and commercial use with the build alternative. New development indirectly caused by the project would result in an increase in impervious cover and greater volumes of runoff during storm events. Runoff could contain oil and grease constituents, which could be carried to off-site water bodies. New residential development would also result in new municipal discharges from sewage treatment facilities and storm water runoff from new off-system roadways. Induced development under the Preferred Alternative could result in adverse effects to water resources through degradation of surface water and groundwater, more rapid discharge of stormwater, and additional pollutant loadings of waterways. Indirect impacts to groundwater wells and capture zones are anticipated to be minor in the context of the regional development as a whole. As with

direct impacts, water quality effects from induced development would be minimized and mitigated by adherence to federal and state regulatory permits and conditions.

Indirect Impacts (Waters of the U.S., including Wetlands)

Indirect impacts to Waters of the U.S. and wetlands are anticipated to be approximately 2,997 ac of wetlands and no Waters of the U.S., as a result of the Preferred Alternative. These estimates of indirect impacts are based on the existing resources within the RSA, and in fact, may not be a practical assumption of total impacts, as much of these resources are protected under the current federal regulations and the "no net loss" policy and these resources serve as a constraint to development.

6.3.4.5 Step 5: Reasonably Foreseeable Actions – Water Resources

Envision Houston land development projections (H-GAC 2035), as well as development trends for the region documented during the indirect impacts analysis (**Chapter 5**), indicated approximately 22.2 percent of the water resources RSA is already developed or planned for development, resulting in an approximately 1,270,000 ac increase of impervious surfaces and cumulative impacts to approximately 114,000 ac of Waters of the U.S. and wetlands (or 20 percent of Waters of the U.S. and wetlands within the RSA). These estimates of cumulative impacts are based on the existing resources within the RSA, and in fact, may not be a practical assumption of total impacts, as much of these resources are protected under the current federal regulations and the "no net loss" policy. However, it is imperative that the continued health of the resource is monitored and regulatory programs remain sensitive to the changes that are occurring. The trend for CWA Section 404 Nationwide permits has been a continued lowering of permit and reporting thresholds. Likewise CWA 303 and 305 programs continue to monitor the health of surface waters. USGS studies indicate that Total Suspended Solids (TSS) runoff rates for transportation corridors are lower than those levels generated naturally.

6.3.4.6 Step 6: Cumulative Impacts Assessment – Water Resources

Increased development can and has historically resulted in aquatic habitat fragmentation and displacement. The aquatic habitat value of affected waters is low because the affected waters are ephemeral and only contain water for brief periods after a rainfall event. Therefore, they are dry most of the year. Increased construction would result in disturbance to ground cover, and sediment discharge resulting from the disturbance and increased impermeable area would be likely. Increases in runoff can cause erosion to

enter surface waters. These activities are regulated and subject to stormwater management criteria designed to minimize these impacts.

Cumulative impacts are likely to be related to land use changes in and around the watershed. Cumulative impacts within all watersheds in the RSA may be up to approximately 114,000 ac of Waters of the U.S. and wetlands (or 20 percent of Waters of the U.S. and wetlands within the RSA). These estimates of cumulative impacts are based on the existing resources within the RSA, and in fact, may not be a practical assumption of total impacts as much of these resources are protected under the current federal regulations and the "no net loss" policy, and are often viewed as a constraint to development. Adherence to local, state and federal regulations and standards would minimize these adverse impacts. However, it is imperative that the continued health of the resource is monitored and regulatory programs remain sensitive to the changes that are occurring. The trend for CWA Nationwide permits has been a continued lowering of permit and reporting thresholds. Likewise CWA 303 and 305 programs continue to monitor the health of surface waters. USGS studies indicate that TSS runoff rates for transportation corridors are lower than those levels generated naturally.

6.3.4.7 Step 7: Results– Water Resources

Water Quality

Potential long-term surface water quality impacts for Segments H and I-1 within the project limits include the relocation from runoff of typical traffic pollutants (such as gasoline, oil, and antifreeze, among others) into surface waterways and the potential for isolated spill events.

Water pollution due to erosion and sedimentation during construction could potentially have short-term temporary adverse impacts on receiving waters. The impacts of this project are anticipated to be minimal. The net effect of all development reasonably foreseeable within the RSA in the next 20 years may require a reassessment of CWA 401 goals and sedimentation and erosion guidelines. Stormwater runoff from the completed facility could also introduce pollutants into surface water, which could result in long-term adverse effects on surface water quality. There have been no documented water quality problems associated with the existing roadways operating in the area and no serious problems are anticipated by this proposed project. USGS studies seem to indicate that TSS from highway corridor runoff is less than TSS from undeveloped areas, inferring that BMPs and water pollution abatement procedures improve the quality of water from a suspended-solid perspective beyond natural conditions. Contaminants from highway use are

a concern, but implementation of stormwater quality requirements of Section 401 of the CWA would minimize potential impacts.

The potential for erosion within the ROW increases during the construction phase of the roadway development. Vegetation clearing and grading accelerates erosion and sedimentation processes. Eroded sediment may redeposit downstream, resulting in disruption of the aquatic ecosystem and degraded water quality.

Waters of the U.S., including Wetlands

The Preferred Alternative would have approximately 338 ac of wetlands and 22.9 of impacts to Waters of the U.S. All potential impacts to Waters of the U.S. are regulated by the USACE and would be minimized or mitigated. There would be up to 2,997 ac of indirect impacts to Waters of the U.S., including wetlands. For the past, present, and reasonably foreseeable private development and roadway projects in the project area, it is estimated that up to approximately 114,000 ac (or approximately 20 percent) of the approximate 190,000 ac of waters and 343,000 ac of wetlands within the RSA may be affected.

Additionally, there are added capacity projects on various corridors within the land use RSA identified in H-GAC's 2035 Plan and the City of Houston's Major Thoroughfare and Freeway Plan (**Table 6-5)**. The projects are anticipated to convert approximately 761 ac and 565 ac, respectively, of land from existing uses to transportation uses within the surface water RSA. These projects are in the planning stage, and as such, information regarding the permitting status and any proposed mitigation is incomplete. It is a certainty that some linear projects, such as these, would impact surface waters. Impacts to surface waters are not quantifiable at this time.

6.3.4.8 Step 8: Mitigation – Water Resources

Regulatory controls are an important component of assuring that future impacts to surface waters are minimized. Waters of the U.S. are regulated by the USACE under authority of Section 404 of the CWA. Section 404 of the CWA authorizes the USACE to issue permits for the discharge of dredged or fill material into Waters of the U.S., including wetlands. The intent of this law is to protect the nation's waters from the indiscriminate discharge of material capable of causing pollution, and to restore and maintain their chemical, physical, and biological integrity. Any discharge into Waters of the U.S. must be in accordance with Section 404(b)(1) guidelines developed by the EPA in conjunction with the USACE. In the Section 404

permit process, permit applications are reviewed by the USACE for compliance with Section 401 of the CWA.

There would be only minor indirect impacts to Waters of the U.S., including wetlands. For the past, present, and reasonably foreseeable private development and roadway projects in the project area, it is estimated that up to 114,000 ac of waters and wetlands within the RSA may be affected; however, given the current federal "no net loss" policy, and the constraint these resources are to development, this total cumulative impact number is not likely to occur in the region.

The proposed project's impact to Waters of the U.S. would be avoided or minimized by compliance with the USACE NWP and IP programs and the federal "no net loss" policy. The cumulative impact of reasonably foreseeable future actions to Waters of the U.S. could be minimized by adherence to applicable USACE, USFWS, TPWD, and U.S. Coast Guard (USCG) regulations for projects subject to state and federal jurisdiction. The proposed project would not contribute to substantial cumulative impacts to the area Waters of the U.S.

Due to these potentially adverse impacts, the minimization of erosion and sedimentation processes during highway construction would be included in the design of the highway through the use of strategically located, temporary BMPs which would be maintained throughout the construction phase.

TxDOT would also comply with the TCEQ Texas Pollution Discharge Elimination System (TPDES) general permit for storm water discharges from construction sites. All development in the RSA is required to comply with the TCEQ TPDES general permit. In accordance with TCEQ regulation, a Notice of Intent (NOI) would be filed and a Stormwater Pollution Prevention Plan (SWPPP) would be implemented for the construction site because the project impacts over 5 ac. Any adverse impact caused by storm water runoff would be mitigated through the use of temporary and permanent erosion and sedimentation controls. Temporary controls would be implemented before the beginning of construction and permanent controls would be maintained throughout the construction phase. On-site inspections and regular maintenance would also be performed.

These projects are in the planning stage and as such, information regarding the permitting status and any proposed mitigation is incomplete. It is a certainty that some linear projects, such as these, would impact surface waters. Impacts to surface waters are not quantifiable at this time.

It is important to stress with regard to this project that all impacts to jurisdictional waters associated with this project would be permitted and mitigated in compliance with all applicable regulatory standards.

6.4 Cumulative Regional Effects of Tolled Facilities and Managed Lanes

Overview

As the MPO for the Houston-Galveston Region, the H-GAC is charged with enabling and creating a regional perspective for transportation and mobility. In its mission to provide effective regional transportation strategies, the MPO examines potential impacts to natural, cultural, and socioeconomic resources including Title VI (environmental justice) communities, air and water quality, land use, and vegetation implications at the planning and project development phases for individual transportation projects.

In order to maintain mobility in the region, the 2035 RTP Update provides major strategies, which utilized together would preserve needed regional mobility. The 2035 RTP Update recognizes that although the region cannot build itself out of congestion, adding system capacity cannot be avoided and is thus an important strategy for improving mobility. Adding capacity to the roadway network is costly, and with dwindling funding, strategies such as tolled facilities have become an increasingly attractive option as a means of adding capacity to the network. The Houston-Galveston region is now one of the few regions in the country that has or is on the verge of having a regional tolled roadway network. The H-GAC conducted analyses on the regional indirect and cumulative effects of tolled facilities and managed lanes and in April, 2009 prepared a report titled Regional Toll Analysis Summary for Inclusion in Houston Area Toll Road Environmental Documents). This report was updated (lastly) in October 2013 and the report is titled Regional Cumulative and Indirect Effects of Toll Facilities (**Appendix P**). The analysis focuses on a regional tolled roadway network and its indirect and cumulative impacts on the above mentioned resources.

Cumulative impacts may result from individually minor, but collectively significant actions taking place over time. H-GAC plans for regional changes over a long time horizon, 30 years, thus providing a means to assess cumulative impacts to a region. Indirect effects are typically observed after the action occurs. Consideration of both the indirect and cumulative effects of a regional tolled roadway network is essential to the analysis of tolled facilities, as the existence of this type of network can cause long term changes in air and water quality, vegetation, and land use patterns. Air and water quality are most affected by the

increase the number of vehicles and non-permeable surface area, respectively. Furthermore, as the regional tolled roadway network increases, the potential for changes in land use also increase. Land use changes often result because the regional tolled roadway network and proposed additions are located outside of the core urban area where development is not yet clearly defined or existing.

Indirect and cumulative impacts from a regional tolled roadway network may also be evident in EJ populations, as these populations are most sensitive to a tolled roadway network in relation to access. Restricting access based on pricing has the potential to create disproportionate adverse effects. The analysis focuses on quantifying the benefits and/or disbenefits to the identified EJ populations based on accessibility and travel time.

It is also likely that a tolled roadway network would also have an impact on the regional economy as freight and transportation are vital to the health of the economy in the Houston-Galveston region. The analysis concludes that a regional tolled roadway network is not expected to have any significant adverse cumulative or indirect impacts.

Air Quality

The CAAA of 1990 require transportation plans, programs, and projects in nonattainment areas, which are funded or approved by the FHWA or FTA, to conform to the SIP. This ensures that transportation plans, programs, and projects do not produce new air quality violations, worsen existing violations, or delay timely attainment of the NAAQS.

Under the CAA, the EPA established criterion called the NAAQS to determine the health threat of criteria pollutants generally located within Consolidated Metropolitan Statistical Areas (CMSAs). If a CMSA has a health threat, it is designated as a 'nonattainment' area until compliance is achieved. The HGB region is classified as a nonattainment area for the 2008 8-hour ozone standard, and it has been further classified as "marginal".

Transportation conformity is an analytical methodology that establishes the connection between projected on-road emissions from the 2035 RTP Update Transportation Plan (Plan) and the known reductions in the motor vehicle emission budget from the SIP. Through the process of transportation conformity, the 2035 RTP Update uses the SIP on-road mobile strategies and air quality targets to demonstrate if the 2035 RTP

Update complies with the federal air quality requirements. Vehicle emissions resulting from the implementation of transportation projects in the 2035 RTP Update cannot exceed emission budgets established by the SIP. The Houston-Galveston region must demonstrate that the 2013-2016 TIP and the long-range plan (2035 RTP Update) result in less VOC and NOx than established and approved by EPA for each analysis year. The USDOT (FHWA and FTA) determined that the 2035 RTP Update and the 2013-2016 TIP conformed to the requirements of the SIP for the Houston-Galveston ozone nonattainment area on January 25, 2011 and November 1, 2012, respectively.

Level of Mobility (LOM) was developed to illustrate the degree of congestion on roadways within the region. The H-GAC analyzed the relative distribution of morning peak period congestion levels for the current and future regional roadway network as a percentage of VMT in each LOM category (**Appendix P**, Page 7, Figure 2). There will be an increase in regional congestion levels if the forecasted growth occurs. The most significant changes would be at the low end of the range (tolerable congestion levels) and high end (severe) congestion levels, between the current system performance and a future scenario without the 2035 RTP Update project (the No Build). The proposed 2035 RTP Update Regional Roadway Network would reduce the percentage of severely congested VMT in the morning peak period, from approximately 50 percent to less than 30 percent compared to the 2035 No Build Scenario.

Air Quality Findings

The introduction of additional priced facilities into the existing roadway network would not cause any cumulative impacts to air quality. Moreover, a regional priced roadway system provides additional travel capacity to the roadway network, which allows a greater flow of traffic throughout the region decreasing the amount of cars traveling at lower speeds or idling conditions. This would result in less fuel combustion and lower emissions including MSATs, CO, and Ozone. EPA's vehicle and fuel regulations, coupled with fleet turnover, are expected to result in significant reductions of on-road emissions, including MSATs, CO and ozone precursors.

Water Quality

The Houston-Galveston region has an abundance of water resources including rivers, lakes, and bays, among others. The TCEQ, along with the Clean Rivers Program and numerous local agencies, are responsible for monitoring all major bodies of water and reporting those conditions in a biennial Texas

Water Quality Inventory report. Section 303(d) of this report details those waterbodies TCEQ has identified as impaired because of water contamination.

The 303(d) list identifies several major water systems as impaired with pollutants and bacteria in the Houston-Galveston Transportation Management Area (TMA). A majority of the waterways located in the Trinity-San Jacinto Coastal Basin, San Jacinto River Basin, San Jacinto-Brazos Coastal Basin, Brazos-Colorado Coastal Basin, including bays and estuaries that flow to the Gulf of Mexico, are impaired and included in the 303(d) list. The construction of the proposed priced facility system would cross and impact the above mentioned waterbodies at multiple locations and could cause water quality impacts. The increase of impervious square footage from adding capacity to the roadway network greatly increases non-point source pollution and the potential to cause further impairment to the region's waterways.

The TCEQ regulates water quality through SWP3, MS4, and BMPs. All construction of the priced facilities in the 2035 RTP Update would follow these water quality regulations that would aid in preventing further pollution to these impaired waters and to waters that are not impaired. Additionally, any land use development that would occur from the construction of these facilities would follow TCEQ's regulations for water quality through SWP3 and MS4.

Water Quality Findings

Although overall impacts cannot be avoided, the above mentioned mitigation techniques would ensure that the regional priced facilities would not have significant cumulative impacts to water quality.

Vegetation

Prairie, Wetland, Bottomland Forest, Upland Forest, and Riparian Corridor ecosystems are all located in the Houston region. Each of these resources provides vital functions such as flood protection, air quality, water quality and wildlife habitat. Vegetation aids in the health of water quality by filtering nutrients and trapping sedimentation before it has an opportunity to enter surface water resources. In much the same way, vegetation can filter air pollutants which can improve air quality. Also, shade produced by vegetation can reduce the demand for energy, further decreasing the production of associated air pollution. Protection of these natural resources that contribute to our region's quality of life is an important priority when planning for our region's future growth and transportation requirements, a desire that was strongly echoed at the Envision Houston Region workshops and forums. The H-GAC launched the Envision Houston Region

initiative in 2005 to facilitate citizen involvement in the process of analyzing how future population growth could affect land use and transportation plans across the region and to identify innovative approaches to meet transportation challenges associated with rapid growth.

As growth and development are part of our region's future, it is not feasible that every environmental parcel would be able to be conserved. However, it is feasible that the region identifies and works to conserve those areas that are most significant ecologically. The H-GAC identified areas of concern that are distinct environmental resources within the H-GAC region for special consideration in the transportation planning process. The results are intended to be used for long-range planning purposes and screening to identify areas in which future transportation projects or development may potentially impact these sensitive resources. In addition, the identified environmental resources are areas in which mitigation efforts may be focused.

In some instances, disturbing natural resources may be unavoidable for regionally significant projects or projects located on facilities that are multiple-lane, limited access facilities, such as highways and tollways. Due to their scale, regionally significant projects potentially have a larger impact on the environment than a local project and therefore are closely examined. Currently, projects within the 2035 RTP Update are individually subject to environmental requirements but have no mechanism for cumulatively identifying or mitigating environmental impacts. At the project level, the TxDOT Houston District can mitigate for loss of vegetation with the TPWD, and wetlands mitigation would occur through the permitting process under the jurisdiction of the USACE. Locally, cities can also curb vegetation loss by implementing measures to protect vegetation areas.

Vegetation Findings

Impacts to vegetation would undoubtedly occur from the priced facility system. However, these impacts are best evaluated and mitigated at the project level; region-wide impacts on vegetation would be minimal from toll network facilities.

Land Use

While we can increase system capacity, manage demand, and improve the efficiency of the existing system, the strategy with potentially the most effect upon improving mobility and quality of life is the strategy of connecting transportation and land use. Land use has a direct impact on the ability of the

region's transportation system and agencies to deliver a variety of travel choices. The 2035 RTP Update has shown that sustained major investments in roadway capacity would only moderate, and would not eliminate the level of future traffic congestion; however, significant mobility gains are possible through better coordinated land use and transportation planning.

The Envision Houston Region process was initiated by H-GAC and its partners to engage residents in a discussion of the region's future growth and development. The process focused on land use and transportation alternatives. Citizen input from workshops was used to develop growth scenarios representing two different types of alternative development patterns. The objective was to provide information on the projected impacts of the alternatives and to highlight the difference between the two growth scenarios developed from the workshops and the Base Case or traditional growth scenario. **Table 6-7** below shows the statistics produced through the analysis of each scenario. Brief descriptions of each scenario are below:

- Scenario A: (fiscally constrained 2035 RTP Update network): denotes the current growth and development pattern for the Houston region, based on H-GAC's 2035 demographic forecasts. It is characterized by low-density housing development in currently undeveloped portions of the region with mixed-use development along major roadways. Jobs are concentrated in the central business district, and several other employment centers are scattered throughout the region.

- Scenario B: indicates the workshop participants' ideal growth pattern, adjusted to the regional forecast of household and job growth. This scenario is characterized by development along major roadways, in a radial pattern, creating centers at major intersections.

- Scenario C: signifies the workshop participants' ideal growth pattern, adjusted to the forecast of household and job growth by county. This scenario clusters mixed-use development in satellite cities and along major roadways in a radial pattern. Satellite employment centers emerge throughout the region.

Table 6-7: Alternative Growth Scenarios

Data of Interest	Scenario A	Scenario B	Scenario C
Transit Boardings	758,000	+10%*	+20%*
Vehicle Miles Traveled	248M	-7%*	-7%*
Vehicle Hours Traveled	7M	-16%*	-15%*
NOx Emissions	46.58	46.43	43.74
VOC Emissions	50.72	48.65	47.65

Source: H-GAC, Regional cumulative and Indirect Effects of Toll Facilities, October 2013.
*Denotes change over Scenario A

These results reinforce the public's intuitive notions about coordinated transportation and land use planning. The H-GAC has identified a three-pronged land use and transportation coordination strategy that is called the "3C's" strategy. The "3C's" strategy calls for the creation of bicycle and pedestrian friendly ***centers***; establishment of better ***connections*** between the centers, and designs based on the ***context*** of the surrounding land uses.

In order to integrate the 3C's concepts into regional transportation planning, the H-GAC has identified the following five strategies:

- Coordinate transit and roadway planning to connect existing and planned centers with the region's multi-modal transportation network;
- Promote roadway designs appropriate for the context of the surrounding community to ensure safe, convenient travel choices for all user modes;
- Coordinate transportation improvements and private sector development efforts to promote projects that combine sustainable mobility and economic benefits;
- Help fund local planning studies to assist in the development of centers; and
- Provide funding support for infrastructure projects that enhance connections within and between centers.

In addition to expanding the regional transit system, transit ridership and efficiency can be improved by coordinating transit and land use. Development along transit lines that increases density and integrates transit with development can make transit more accessible and decrease the need for single-occupancy vehicle trips. Recommended strategies include:

- Promote community design that provides convenient access to transit systems;
- Promote transit-oriented development investments around regional transit facilities; and
- Enhance access opportunities for the transportation disadvantaged.

These land use/transportation coordination tools are tools that can be used in the H-GAC region to reduce the need for additional infrastructure, including utilities, transportation, water, and tolled facilities for the region. Without sustainable land use, the additional cost of new infrastructure items will increase beyond the current estimated costs.

The current future roadway network outlined in the fiscally constrained 2035 RTP Update (Scenario A) is in support of the predicted land use changes and growth in the region. To meet the demand of the expansive growth and changes in land use from development, the aim of the 2035 regional roadway network is to supply the transportation portion of infrastructure requirements for the expanding growth and development. Current and future predicted available funds from the federal government for transportation alone will not be able meet the demands for the transportation infrastructure needed to support the predicted changes. Toll roads and managed lanes are methods that the 2035 RTP Update employs to ensure the transportation demands from future growth are met based on limited transportation funds.

Land Use Findings

The proposed 2035 toll network may affect land use within the MPO boundaries by creating land development opportunities. However, the toll network is only one factor in creating favorable land development conditions; other prerequisites for growth in the region include demand for new development, favorable local and regional economic conditions, adequate utilities, and supportive local land development policies. The proposed 2035 toll network as currently envisioned may, with the right conditions, help influence the additional planned regional land use conversion, redevelopment, and growth.

<u>Economic</u>

In 2006, H-GAC completed an extensive financial survey that included local governments and agencies with significant expenditures on the transportation network and services. The result is a more complete understanding of how much, by whom, and where transportation dollars are being spent. The results indicate a significant undercounting in previous plans (based on preliminary results) of the contribution by local governments on transportation investments. However, for the purposes of fiscal constraint, this undercounting is neither surprising nor alarming because a large portion of local transportation investment is done on local street networks that are not included in the 2035 RTP Update because they are not considered to be of regional significance. Fiscal constraint is demonstrated for the regionally significant transportation projects.

This financial summary is different from those in past Plans in that it conforms to new federal regulations requiring the expression of future costs and revenues in year-of-expenditure dollar values, that is, the effects of inflation must be included. The rate of inflation from 1996-2005 has been, on average, 2.53 percent. Another innovation is expressing the costs of projects in terms of their total costs, including the costs of ROW, realignment of utilities, and engineering costs, all of which are paid for from statewide accounts, including federal and State dollars that are directly apportioned to the Houston-Galveston area.

Expenditures

Expenditures on the transportation network include building new and improving existing roadways and transit lines (added capacity), operating the network and maintaining it in good repair (operations and maintenance), reconstructing existing facilities when they have reached the end of their useful life (system preservation), financing costs associated with debt incurred for transportation projects (financing), and wages and salaries paid to various staff of the roadway and transit agencies (administration). Total Estimated Expenditures 2035: $158.9 Billion (Appendix P, Page 12, Graphic-Expenditures by Category).

For the next several years the region is expecting to continue the trend of expanding the transportation network through added capacity projects. However, in the 2006, edition of the Texas Metropolitan Mobility Plan prepared by H-GAC, findings indicate that added capacity projects would decrease in spending relative to system preservation costs. Not only would there be a larger network to maintain in the future, but also system preservation efforts are currently under-funded. In the future, more revenues would be needed for system preservation to prevent further deterioration of roadway surfaces.

When examined by mode of travel (roadway, transit, or bicycle), nearly 71 percent of all expenditures are for roadway projects that support the automobile (Appendix P, Page 13, Graphic-Expenditures by Mode). In a region known for its dispersed suburbanized housing, this percentage is not unusual. However, over the last several years transit investments have increased dramatically, and this trend is expected to continue.

Revenues

The estimated total revenue available for the 2035 RTP Update is $168.9 Billion (Appendix P, Page 13, Graphic-Revenue Sources). These revenues come from a variety of federal, State, and local sources. Among the federal sources is the federal gas tax, and programmed funds from the FHWA and FTA. State

sources include the motor fuel tax, vehicle registration fees, pass-through financing agreements, and other State allocations. Local sources include property and sales taxes collected by the cities and counties, toll revenues, bonds, and user fees from transit agencies. As a group, the local sources provide the greatest amount of revenues for the 2035 RTP Update.

It is particularly important to note that the region's reliance on toll receipts to fund the 2035 RTP Update is growing each year. New toll roads, such as the SH 99 (Grand Parkway), as well as managed lanes, are scheduled to come on line in the next 30 years. Although the Harris, Fort Bend, Brazoria, and Montgomery County Toll Road Authorities are not obligated to spend tolling receipts on non-toll transportation projects, in the past they have reinvested all toll-generated revenues into the toll and connecting roadway road systems.

Environmental Justice

Methodology

The H-GAC conducted an evaluation to determine the effects of a regional tolled roadway network on EJ populations. The unit used for the analysis is the traffic analysis zone (TAZ). The TITLE VI/EJ TAZ were selected based on the Census 2000 block groups that contain 51 percent or greater minority and low-income populations. A TAZ is recognized as an EJ zone if 50 percent its area is covered by EJ block groups.

As shown in **Table 6-8**, in the year 2000, approximately 31 percent of the H-GAC regional population has been identified as being within EJ zones, which represents approximately 46 percent of the total number of TAZ in the 8-county region. This equates to 1,383 of the total 3,000 TAZ are considered to be EJ TAZs. As can be seen in Appendix P, Page 17, Figure 3, there are significant EJ communities located throughout the H-GAC region, but the majority of EJ communities are located within Harris County and generally clustered within the Sam Houston Toll Road. Appendix P, Page 17, Figure 3 also shows a subset of the EJ zones that have minority or low-income population that are greater than 51 percent of the total TAZ population.

Table 6-8: Distribution of EJ Communities in H-GAC Region

	Population (2000)	Percent of Total	Number of TAZ	Percent of Total
Total Population within EJ zones	1,634,500	31.3	1,383	46.1
Total Regional Population	5,214,051	100.0	3,000	100.0

Source: H-GAC, Regional Cumulative and Indirect Effects of Toll Facilities, October 2013.

Analysis Approach

The analysis addresses the potential impacts of tolled facilities on accessibility by analyzing their impacts on the travel time choices of the persons residing in EJ zones and Non-EJ zones. The introduction of tolled facilities would generally result in a travel time benefit (i.e., a travel time savings) to those who choose to use the facilities (both EJ and Non-EJ users). It is a user decision whether or not to use one of the proposed new tolled facilities. From an EJ perspective, it appears the issue should be whether the introduction of the proposed tolled facilities is expected to have a significant and/or disproportionate adverse impact on the EJ population. This issue is addressed by analyzing forecasted trips made by the EJ population that are "candidate" trips for the new tolled facilities.

Two networks were used for purposes of the analyses: 2035 RTP Update Build and 2035 RTP Update No Build Managed Road. The full extent of the toll and managed lane system as contained in the fiscally constrained 2035 RTP Update can be seen in Appendix P, Page 18, Figure 4). As shown in Appendix P, Page 19, Figure 5, the No Build network is essentially the fiscally constrained 2035 RTP Update network with the existing plus committed managed lane system; the Katy Freeway HOT lanes are included.

Analysis Assumptions and Limitations

The region's travel demand models do not provide a means for tracking travel at an individual household level, but do provide a means for tracking travel at a zonal level. For purposes of the analyses, the zones are specified as either EJ zones or non-EJ zones based on the socioeconomic characteristics of the zonal populations. Some regional travel models employ a generalized cost assignment procedure for toll analyses. The H-GAC models perform toll analyses at the mode choice level. Hence, the H-GAC travel model uses a multi-class assignment procedure rather than a generalized cost procedure.

The mode choice models are applied by trip purpose. For the mode choice toll analyses, two travel time estimates are developed from each zone to all other zones: 1) the travel time using both toll and non-toll links (commonly referred to as "toll path" travel times), and 2) the travel time using only non-toll links (commonly referred to as the "free path" travel time). In the mode choice model, if the toll path does not

offer a shorter travel time between two zones than the free path travel time, the trip is not considered a "candidate" for the toll facility. If a trip can save travel time using a toll path over a free path then it is considered a "candidate" trip. Of course, not all candidate trips will choose to use a tolled path. The probability of a candidate trip using a tolled path is a function of a number of variables such as the magnitude of the potential travel time savings, the toll costs and the income characteristics of the zones residents. Aspects of this approach are employed in the analyses presented in this report.

In mode choice model applications, there is a single highway network which is used to estimate the travel times for toll paths and free paths. For the regional toll analyses, there are two networks: the "Build" network (i.e., the forecasted roadway network containing the subject toll facilities) and the "No Build" network (i.e., the network containing all the forecasted roadways except the subject toll facilities). Existing and committed toll facilities are contained in both networks. In this analytical setting, simply comparing the toll path versus free path option will not identify the candidate trips for only the new toll facilities being studied. Indeed, such a grouping would include trips using both existing and proposed toll facilities.

To focus on candidate trips for the new toll facilities, the travel time for toll paths in the Build network is compared to the toll path travel time in the No Build network. Trips that have a shorter toll path travel time in the Build network than the toll path travel time in the No Build network are defined as candidate trips for the new toll facilities. The trips from EJ zones are stratified as either candidate trips or non-candidate trips using the data from the two networks. Likewise, the trips produced by the Non-EJ zone are similarly stratified. Stated differently, the trips for a given trip purpose is segmented into four groups:

- Trips produced by EJ zones that are classified as "Candidate" trips;
- The remaining trips produced by EJ zones are classified as non-"Candidate" trips;
- Trips produced by non-EJ zones that are classified as "Candidate" trips;
- The remaining trips produced by non-EJ zones are classified as non-"Candidate" trips.

Using toll path travel times and free path travel times from the Build and the No Build networks, there are four travel times for each trip, (i.e. 1) Build network-toll path option, 2) Build network-free path option, 3) No Build network-toll path option, and 4) No Build network – free path option). By computing the average trip lengths for each of the options, the impacts of the two networks on the choice options can be quantified, compared, and analyzed.

Using this approach, the results allow the comparison of the toll and free path options for each network for each segmentation of trips. Clearly, the implementation of new toll facilities should be expected to benefit those who might choose to use a toll facility. Of perhaps more interest is determining if there are any expected overall disadvantages to those who might chose not to use a toll facility or that are not candidates for using one of the new toll facilities.

One of the interesting side benefits of the approach used is that it calls attention to the fact that there will be some potential travel time savings realized for trip makers who chose not to use a toll facility. These time savings would be expected to accrue from the reduced congestion on free facilities due to trips diverted to toll facilities.

The analyses are regional level analyses and focus on average regional results. Such analyses do not isolate any zone specific analyses or the impacts in the immediate proximity of the new proposed facilities. These impacts were addressed by the analyses performed for the individual facilities. Indeed, the purpose of these analyses are to determine if there are any cumulative regional impacts to the EJ populations represented by the zones designated as EJ zones.

A key focus of the analysis was to determine if the "free" path travel time under the Build scenario is significantly greater than the "free" path travel time under the No Build scenario for the EJ and Non-EJ zones. The analyses show the expected travel time benefits that may be realized by EJ and Non-EJ zone residents if they chose the pay options for their travel.

Trips were divided into Home-Based-Work trips (HBW) and Home-Based Non-Work trips (HBNW), and for both EJ zones and Non-EJ zones that can save highway travel time by using one of the new proposed toll facilities. For a given trip purpose, the forecasted person travel was divided into four (4) market segments for analysis:

Trips produced by a EJ zone that are candidates for using one of the proposed new toll facilities (i.e., that could save travel time by electing to use one of the proposed new tolled facilities for their scheduled travel).
Trips produced by a EJ zone that are not candidates for using one of the proposed new toll facilities (i.e., that could not save travel time by electing to use one of the proposed new tolled facilities for their scheduled travel).

Trips produced by a EJ zone that are candidates for using one of the proposed new toll facilities (i.e., that could save travel time by electing to use one of the proposed new tolled facilities for their scheduled travel). Trips produced by a Non-EJ zone that are not candidates for using one of the proposed new toll facilities (i.e., that could not save travel time by electing to use one of the proposed new tolled facilities for their scheduled travel).

As mentioned in the discussion of the approach, the objective of the EJ analysis is to quantify the impacts of the Build and the No Build options on the travel time of potential users. Examination of the results will show whether the introduction of the proposed new tolled facilities is expected to generally have a significant and/or disproportionate negative impact on the EJ population of the region.

Table 6-9 shows the number of year 2035 HBW person trips and the expected average trip length (ATL) for free and tolled path options under both the Build and No Build Scenarios. The travel times are based upon AM peak period congested travel times. EJ and non-EJ population trips are each segmented into two separate groups:

- Those trips that can save travel time by using a toll facility; these trips are essentially trips that are "candidate trips" for using a toll facility, and
- Those trips that cannot save travel time by using a toll road; these trips are essentially "non-candidate trips" for using a toll facility. Consequently for purposes of the analysis, only the free path is examined for these trips.

Table 6-9: 2035 Home Base Work Person Trips

			AM Peak Average Trip Length (ATL) in minutes for Free and Tolled Facilities under the Build and No Build Network Scenarios				Difference in AM Peak ATL in minutes	
			Build Network Scenario		Non-Build Network Scenario			
Zones	**2035 HBW Trip Scenarios**	**Number of 2035 HBW Person Trips**	**ATL Using Tolled Facility**	**ATL Using Free Facility**	**ATL Using Tolled Facility**	**ATL using Free Facility**	**Difference in ATL for the Tolled Facility (No Build – Build)**	**Difference in ATL for Free Facility (No Build – Build)**
EJ Zone	Trips that save 0+ minutes using a new tolled facility	1,124,064	34.72	42.88	36.30	43.70	1.58	0.82
	Trips that cannot save 0+ minutes using a new tolled facility	1,517,692	18.36	18.80	18.50	18.95	0.14	0.15
Non-EJ Zone	Trips that save 0+ minutes using a new tolled facility	1,571,960	44.57	54.84	49.18	56.96	4.61	2.12
	Trips that cannot save 0+ minutes using a new tolled facility	1,526,036	20.56	20.89	20.96	21.3	0.40	0.41

Source: H-GAC, Regional Cumulative and Indirect Effects of Toll Facilities, October 2013.

Both EJ and Non-EJ Zones Benefit from the Build Alternative:

From an EJ perspective, perhaps the most important observation in **Table 6-9** is that ATL for both toll path options and free paths are reduced under the Build Alternative for both EJ and Non-EJ zones. Therefore, the analyses did not find any significant and/or disproportionate adverse impacts on the ATL of the path options for the EJ zones; in fact, these results show that both EJ and Non-EJ zones realize an overall benefit from the proposed new toll facilities in the Build Alternative.

Table 6-10 shows the number of year 2035 HBNW person trips and their expected ATL for free and tolled path options under both the Build and No Build Alternatives. Since most of the HBNW trips do not occur during the peak traffic periods, the travel times based on the 24-hour speeds were used for these analyses. The 24-hour speeds are generally considered to represent typical off-peak speeds. Therefore, the 24-hour travel times are used by the H-GAC's HBNW mode choice model rather than the peak travel times. Again, the EJ and Non-EJ population trips are each segmented into two separate sub-groups:

- Those trips that can save any travel time by using a toll facility (i.e., essentially trips that are "candidate trips" for using a toll facility), and
- Those trips that cannot save any travel time by using a toll road. Most of these trips don't have a minimum time path that would use any toll facility. There are some trips in this group that do not have a toll path and hence are unable to be toll users. These trips are "non-candidate trips" for using a toll facility. Hence, for purposes of the EJ analyses, only the free path travel times will be examined for these trips.

Table 6-10: 2035 Home Based Non-Work Person Trips

			AM Peak Average Trip Length (ATL) in minutes for Free and Tolled Facilities under the Build and No Build Network Scenarios				Difference in AM Peak ATL in minutes	
			Build Network Scenario		Non-Build Network Scenario			
Zones	2035 HBW Trip Scenarios	Number of 2035 HBW Person Trips	ATL Using Tolled Facility	ATL Using Free Facility	ATL Using Tolled Facility	ATL using Free Facility	Difference in ATL for the Tolled Facility (No Build – Build)	Difference in ATL for Free Facility (No Build – Build)
EJ Zone	Trips that save 0+ minutes using a new tolled facility	1,134,814	25.65	30.07	27.27	31.08	1.62	1.01
	Trips that cannot save 0+ minutes using a new tolled facility	5,266,409	12.13	12.26	2.26	12.39	0.13	0.13
Non-EJ Zone	Trips that save 0+ minutes using a new tolled facility	1,313,864	28.92	34.22	34.13	37.32	5.21	3.10
	Trips that cannot save 0+ minutes using a new tolled facility	5,306,422	13.54	13.59	14.09	14.14	0.55	0.55

Source: H-GAC, Regional Cumulative and Indirect Effects of Toll Facilities, October 2013

Toll Path Option Benefit for the Build Alternative for Both EJ and Non-EJ Zones:

From an EJ perspective, perhaps the most important observation in **Table 6-10** is that ATL for both the toll path and free path options are reduced under the Build Alternative for both EJ and Non-EJ zones. Hence, the analyses did not find any significant and/or disproportionate negative impacts on the ATL of the path options for the EJ zones. Indeed, these results show that both EJ and Non-EJ zones realize an overall benefit from the proposed new toll facilities in the Build Alternative.

Latent demand is essentially unrealized demand of travel due to constraints of the roadway network that becomes realized when improvements to the network are made, and can show increases in traffic on capacity-enhanced networks. The travel demand model used in the analysis uses an equilibrium assignment that disperses any latent demand throughout the toll and non-toll network, thus reducing the overall congestion in the region. This is evident by observing the changes in VMT and vehicle hours traveled (VHT) in the Build scenario, which includes the regional tolled roadway network. As seen in **Table 6-11** below, the daily VMT decreases by approximately 1.5 million miles in the Build scenario versus No Build scenario. Furthermore, daily VHT decreases by nearly 5 percent for the region when the network is fully built out. This gives evidence that the 2035 roadway network with toll facilities would improve the overall system performance and provide travel time savings to both EJ and Non-EJ populations.

Table 6-11: Regional VMT and VHT

	Build	No Build
Daily VMT	252,578,686	254,031,712
Daily VHT	7,349,969	7,761,311
AM VMT	42,929,640	43,058,792

Source: H-GAC, Regional Cumulative and Indirect Effects of Toll Facilities, October 2013.

Overall Toll Network Findings

For HBW trips and HBNW trips, EJ population trips that are candidate toll users are benefited by the introduction of the new toll facilities in terms of both the toll and free path travel times. Equally important, EJ population trips that are not candidate toll users benefit by the introduction of the new toll facilities, as the free path travel time ATL is reduced between the No Build and Build scenarios. As such, EJ populations experience an overall benefit under the Build Alternative for their HBW and HBNW travel.

Although EJ zones spread throughout the region, they are generally clustered within Beltway 8 and are not in close proximity to the majority of future toll facilities as the Non-EJ zones are. Consequently, as the ATL

of the EJ zones are less than the ATL of Non-EJ zones, the EJ zones cannot derive as much travel time savings as the longer trips from Non-EJ zones. However, the analysis did not explicitly examine the impact on ATL. As seen in Appendix P, Page 28, Figure 6, the significant amount of future transit improvements are targeted at EJ zones; the ATLs for the populations within those zones would tend to improve due to increased access to improved transit facilities.

Although EJ populations would see an increase in spending for toll facilities, the entire region would also see an increase in spending and usage as the toll and managed lane system expands. Both EJ and Non-EJ populations would benefit greatly from future toll facilities. In fact, the 2035 RTP Update relies heavily on toll funding to finance a significant portion of future added capacity projects, both free and toll. Additionally, for both populations who choose to use non-toll options, the Build scenario for 2035 would provide a roadway network that would operate at better traffic conditions than the No Build scenario and would provide an increased benefit for those users over the No Build scenario.

An analysis was also conducted to determine the annual financial burden of utilizing the toll road system for HBW trips. The analysis assumed a 2035 toll rate per mile of 19.96 cents (current toll rate of 10 cents per mile with an annual escalation rate of 2.5 percent). In addition the analysis assumed that an average HBW trip length is 23.30 miles and the SOV user makes 250 round-trips per year using the toll facility. Under this scenario, the annual cost would be approximately $2,325 per year. However, the accrual cost should be substantially less since the likelihood of a trip using only tolled facilities is diminutive.

The 2013 HHS poverty guideline for a family of four is $23,550, of which approximately 10 percent would equate to the annual cost per year for utilizing the toll road system for HBW trips. According to the U.S. Census (2007-2011) the median household incomes within the Houston-Galveston region are as follows:

- Brazoria County-$67,018
- Chambers County-$72,850
- Fort Bend County-$82,571
- Galveston County-$59,645
- Harris County-$52,675
- Liberty County-$47,460
- Montgomery County-$66,657
- Waller County-$50,609

Based on the previous discussion and analysis, the Build scenario for the 2035 RTP Update would not cause cumulative disproportionately high and adverse effects on any EJ populations, as per EO 12898 regarding EJ.

The results of the analysis suggest that although most of the new toll facilities are not being implemented in EJ zones, EJ populations would enjoy benefits the of future toll facilities. It is important to note that future toll facilities are generally not being proposed in EJ zones because those zones are largely inside the urban core. The costs of ROW acquisitions, community disruption, etc. make those locations prohibitive. However, it is important to note that much of the proposed light rail and bus improvements in the region are being implemented in the EJ zones identified in the analysis, thereby improving mobility for those populations.

The analysis only sought to determine whether disproportionate benefits or disbenefits are accruing to the EJ and Non-EJ populations based upon travel time savings. In no way does the analysis replace the work required in the project development phase of a project per NEPA.

6.4.1 Conclusion: Cumulative Regional Effects of Tolled Facilities and Managed Lanes

The regional priced facility system would cause minor impacts to some resources discussed in the analysis. Regional mitigation for some of the resources is addressed by the H-GAC. As part of the Transportation Planning Process, H-GAC addresses issues related to air quality and EJ. The priced facility projects would be included in the STIP/TIP and MTP, and the STIP/TIP and MTP would need to be found to conform to the State Implementation Plan (SIP). Additionally, the transportation planning process would need to comply with the requirements of Title VI of the Civil Rights Act of 1964 and Executive Order 12898 on Environmental Justice. This assures that the STIP/TIP and the MTP are in compliance for air quality under the CAAA and for EJ under Title VI of the Civil Rights Act of 1964 and Executive Order 12898.

Although land use impacts cannot be mitigated at a regional level, they can be mitigated and/or controlled at the municipality level because these entities have direct control over land use. However, the MPO can aid in land use impact avoidance at the regional level by only funding transportation projects consistent with the regional vision and by working with municipalities to address regional infrastructure changes in their comprehensive plans. State and federal regulatory agencies that have direct jurisdiction over natural and cultural resources would be responsible for requiring avoidance, minimization, and mitigation from any

entity whose proposed project (transportation or other type) has a direct impact to any of these resources on their project.

6.5 Cumulative Impacts Analysis Summary

Table 6-12 summarizes the analysis and conclusions for each resource carried through the cumulative impacts analysis.

Table 6-12: Cumulative Impacts Analysis Resource Summary

Resource Category (Step 1)	Resource Study Area (Step 2)	Current Health/Historical Context of Resource (Step 3)	Direct Impacts (Step 4)	Indirect Impacts (Step 4)	Impacts from Other Past, Present, Foreseeable Projects (Step 5)	Potential Cumulative Impacts (Step 6)	Report Issues/Discuss Mitigation for Adverse Impacts (Steps 7 and 8)
Land Use	15-minute travel shed	Changing – Historically, a highly disturbed study area due to farming, timbering, petro-chemical industrial activities. The existing land use continues to change due to increasing development. Changing land use from undeveloped to developed could contribute to the decline in health of natural resources.	Conversion of 1,933 ac of undeveloped land to transportation land use (less than 0.3%) of total RSA). Development in the RSA would be consistent with all state and local government plans and policies.	Conversion of approximately 25,944 ac of undeveloped land to developed land (3% of RSA). Induced development in the study area would be consistent with all state and local government plans and policies.	Within the land use RSA, impacts from other past, present and foreseeable projects were gathered from the H-GAC's 2035 projections, the RTPs, the expert panel survey, and meetings with local planners and elected officials.	Existing and proposed land development and transportation improvements would result in conversion of 291,477 ac of undeveloped land to developed land. Based on this acreage calculation, it was determined that anticipated cumulative effects represents approximately 38% of the land use RSA.	The mitigation of the development of the area considered for this study would rest with the agencies which have the authority to implement such controls. Grand Parkway Segments H and I-1, as well as any other links in the transportation network, would complement the land use and transportation changes in the area, but it cannot be considered the sole reason for the changes to occur. Therefore, no mitigation is proposed.
Environmental Justice	H-GAC's MPO region, including Harris, Chambers, Fort Bend, Liberty, Brazoria, Galveston, Montgomery, and Waller counties	The EJ population of the MPO area is growing. The total environmental justice population percentage for the RSA is anticipated to increase between 2000 and 2035 based on the demographic trend observed between 2000 and 2010.	Although the Preferred Alternative would result in traffic noise impacts, no substantial direct socio-economic impacts would result from tolling Grand Parkway Segments H and I-1. No displacements are anticipated in census blocks with median household incomes below the HHS 2013 poverty guideline of $23,550. Tolling costs would be comparable to existing Harris, Montgomery, and Chambers County toll roads. The project impacts would not be isolated within a limited number of census tracts, but would be incurred by all users, including minority and low-income users of the Grand Parkway Segments H and I-1 facility. Although the impacts would not be substantial, it should be noted that low-income populations would be impacted by toll rates, toll collection, and other matters associated with user fees.	Induced land development could create additional job opportunities and increased access to job opportunities through enhanced transportation infrastructure. Indirect impacts pertaining to public facilities and services, traffic operations, and traffic noise would be experienced by the environmental justice population to the same extent and the same manner (whether positive or negative) as experienced by the non-environmental justice population.	Existing toll facilities that factor into the cumulative impacts of the proposed toll system include the Sam Houston Tollway, the Westpark Tollway, and the Hardy Toll Road. Linkage to these toll facilities would be available to users of Segments H and I-1 as well as the non-tolled alternatives associated with those existing toll facilities. Other reasonably foreseeable toll projects in the immediate area include the completion of Segments G and I-2 of the Grand Parkway.	The Grand Parkway, as an element of the system of toll roads now being developed for the H-GAC area, would contribute to a cumulative impact on low-income users of the system. Although it is likely that a user may routinely travel one or more elements of the toll system en-route to and from various destination points throughout the city, it is unlikely that the user would travel the entire length of those elements. Further, given the lay-out and orientation of the regional system, it is not likely that a driver would routinely travel the entire length of the entire Houston-area toll system during the course of normal activities.	The anticipated increase of tolled mainlanes in the regional transportation network is indicative of an emerging regional tolling network. It is reasonable to assume that there would be a cumulative impact on environmental justice populations upon build-out of the toll system; however, given the lay-out and orientation of the regional system, it is not anticipated that a driver would routinely travel the entire length of the entire system during the course of normal activities. The proposed tolling of Segments H and I-1 would not exclude any person on the grounds of race, color, or national origin from participation in the project, be denied the benefits of the project, or be subject to discrimination under the proposed project; therefore, according to Title VI of the Civil Rights Act of 1964 and EO 12898, mitigation associated with environmental justice is not currently proposed. Through the excess toll revenue generated from the proposed toll project could be programmed to benefit the regional community including environmental justice populations.
Air Resources	Air Quality	Houston-Galveston-Brazoria 8-hour nonattainment eight-county area, including Harris, Chambers, Fort Bend, Liberty, Brazoria, Galveston, Montgomery, and Waller counties	Air Quality: Poor, the Houston-Galveston-Brazoria region is classified as a marginal nonattainment area. Texas has made substantial progress over the past 15 years in addressing ozone in the MPO area. The 1-hour and 8-hour ozone concentrations have decreased over the 15 year period from 1991 to 2005. This trend is expected to continue despite a rapid growth in the area's economy and population. Controlling air toxic emissions became a national priority with the passage of the CAA Amendments of 1990, whereby Congress mandated that the EPA regulate 188 air toxics which include MSAT. Based on an FHWA analysis using EPA's MOVES2010b model, national trends indicate that even if vehicle-miles travelled (VMT) increases by 102 percent as assumed from 2010 to 2050, a combined reduction of 83 percent in the total annual emissions for the priority MSAT is projected for the same time period.	Direct impacts on air quality from the project are primarily those associated with the increased capacity, accessibility and the resulting projected increases in VMT. The Grand Parkway Segments H and I-1 are included in H-GAC's 2035 RTP Update and 2013-2016 TIP found to conform to the SIP by FHWA and FTA on January 25, 2011 and November 1, 2012, respectively.	Indirect impacts on air quality are primarily related to any expected development resulting from project's increased accessibility, or capacity to the area. Any increased emissions resulting from the potential development of the area must meet regulatory emissions limits established by the TCEQ and EPA, as well as obtain appropriate authorization from the TCEQ, and therefore are not expected to result in any degradation of air quality or MSAT levels.	Increase in urbanization would likely have a negative effect on air quality. This would be minimized by the enforcement activities by EPA and TCEQ to help ensure that growth and urbanization would not prevent attainment with the ozone standard or threaten the maintenance of the other air quality standards.	Increase in urbanization would likely have a negative effect on air quality. This would be minimized by the enforcement activities by EPA and TCEQ to help ensure that growth and urbanization would not prevent attainment with the ozone standard or threaten the maintenance of the other air quality standards.	The evaluation for direct, indirect, and cumulative impacts from the proposed toll project did not result in the identification of any negative impacts for which specific mitigation actions are necessary and required. Due to traffic redistribution, traffic congestion along the frontage roads and the local arterial network is anticipated to increase, causing a potential for localized degradation of air quality. In an effort to reduce congestion, TxDOT would continue to promote appropriate congestion reduction strategies through the H-GAC. Overall, current federal, state, and local regulatory controls as well as local plans and projects have had, and would continue to have a beneficial impact on overall regional air quality.

Table 6-12: Cumulative Impacts Analysis Resource Summary

Resource Category (Step 1)		Resource Study Area (Step 2)	Current Health/Historical Context of Resource (Step 3)	Direct Impacts (Step 4)	Indirect Impacts (Step 4)	Impacts from Other Past, Present, Foreseeable Projects (Step 5)	Potential Cumulative Impacts (Step 6)	Report Issues/Discuss Mitigation for Adverse Impacts (Steps 7 and 8)
			The Houston-Galveston-Brazoria Area is currently in attainment for CO.					
Water Resources	Water Quality	Six regional watersheds are found within the study area: Buffalo-San Jacinto, East Fork San Jacinto, Lower Trinity, North Galveston Bay, Spring, and West Fork San Jacinto watersheds	Declining – continued changes in land use due to development are expected to increase impervious surfaces and increase run-off.	Impervious surfaces may be directly increased by as much as approximately 419 ac with the construction of the Preferred Alternative. Direct project impacts to resources that would affect water quality include impacts to wetlands and riparian areas as well as direct crossings of water bodies. The Preferred Alternative would cross three ecologically substantial stream segments, including Caney Creek, East Fork San Jacinto River and Luce Bayou. Project construction would result in temporary increase in sedimentation and turbidity. Construction impacts would be minimized through the incorporation of appropriate BMPs for erosion control.	Approximately 25,944 ac of undeveloped land would be converted to residential and commercial use as a result of the Preferred Alternative. This induced development could result in adverse effects to water resources through degradation of surface water and groundwater. The Preferred Alternative would require groundwater pollution prevention measures to minimize potential impacts to up to seven well capture zones. Indirect impacts to groundwater wells and capture zones are anticipated to be minor in the context of regional development as a whole.	Regional land development projections from the Envision Houston report and the H-GAC for the area indicated approximately 22.2% of the water resources RSA is already developed or planned for development, resulting in an approximately 1,270,000 ac increase of impervious surfaces.	Increased construction would result in disturbance to ground cover, and sediment discharge resulting from the disturbance and increased impermeable area would be likely. Increases in runoff can cause erosion of surface waters. These activities are regulated and subject to stormwater management criteria designed to minimize these impacts. Stormwater runoff from the completed facility could also introduce pollutants into surface water, which could result in long-term adverse effects on surface water quality.	The cumulative impact of reasonably foreseeable future actions to water quality could be minimized by adherence to applicable USACE, USFWS, TCEQ, TPWD, and USCG regulations for projects subject to state and federal jurisdiction. The net effect of all development reasonably foreseeable within the RSA in the next 20 years may require a reassessment of CWA 401 goals and sedimentation and erosion guidelines. The proposed project would not contribute to substantial cumulative impacts to the area water quality due to the regulatory guidelines in place to protect this resource.
	Waters of the U.S.	Six regional watersheds are found within the study area: Buffalo-San Jacinto, East Fork San Jacinto, Lower Trinity, North Galveston Bay, Spring, and West Fork San Jacinto watersheds	Declining – continued changes in land use due to development are expected to convert more wetlands to non-wetlands. However, the USACE's "no net loss" policy has continued to keep the losses of jurisdictional wetlands at a stable number. According to the 2010 Texas 303(d) list, several listed segments are within the RSA. In the project RSA, development and urbanization has resulted in channelization, excavation, and filling of many of the area's natural streams and wetlands.	The Preferred Alternative would potentially impact approximately 327 ac of wetlands and 22.9 ac of Waters of the U.S.	The potential indirect impacts to Waters of the U.S. and wetlands due to induced development within the AOI is anticipated to be zero acreage of Waters of the U.S. and approximately 2,997 ac of wetlands.	Regional land development projections from the Envision Houston Report and the H-GAC for the area indicated approximately 22.2% of the water resources RSA is already developed or planned for development. Up to 114,000 ac of waters and waters may be cumulatively impacted.	There is a high likelihood that minor regulatory infractions would occur in the proposed development in the RSA, resulting in limited unpermitted and unmitigated impacts to waters of the U.S., including wetlands. It is impossible to predict how large impacts would be because of the federal "no net loss" policy and limits to development these constraints present, but development of land in the RSA may result in some loss of surface waters and wetlands, both permitted and unpermitted.	The cumulative impact of reasonably foreseeable future actions to Waters of the U.S., including wetlands, could be minimized by adherence to applicable USACE, USFWS, TPWD, and USCG regulations for projects subject to state and federal jurisdiction. The proposed project would not contribute to substantial cumulative impacts to the area Waters of the U.S., including wetlands, due to the regulatory framework that exists to protect this resource.

Source: Study Team, 2012

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CHAPTER 7
MITIGATION AND PERMITTING

7.1 INTRODUCTION

Practicable efforts have been made in the planning process to avoid adverse impacts to the human and natural environment. When impacts are unavoidable, steps would be taken to minimize impacts and mitigate for impacts, as required under National Environmental Policy Act (NEPA), Federal Highway Administration (FHWA), and Texas Department of Transportation (TxDOT) guidelines. According to the Council on Environmental Quality (CEQ) regulations (40 Code of Federal Regulations [CFR] 1508.20), mitigation efforts may be defined as:

- Avoiding an impact altogether;
- Minimizing the impact;
- Limiting the degree or magnitude of the action;
- Rectifying the impact;
- Repairing, rehabilitating, restoring the resource;
- Reducing or eliminating the impact over time;
- Preservation and maintenance activities;
- Compensating for the impact; and
- Replacing or providing substitutes to the impacted resource.

Every effort has been made in the selection of alternatives and the identification of the Preferred Alternative to avoid or minimize adverse effects. Where impacts to resources require coordination and permitting, required processes would be followed with the appropriate jurisdictional agency.

As discussed in **Chapters 3** and **4**, several resources either do not occur within the study area or adverse impacts to the resources would not occur as the result of the proposed project. In these cases, permitting or mitigation is not proposed for these resources. The following is a list of the resources that would not be adversely impacted based on information available at the time the document was prepared:

- Minority or low-income populations;
- Limited English Proficiency populations;
- Economics;
- Pedestrian and Bicycle Accommodations;
- Unique or Prime Farmlands;

- Noise;
- Navigable Waters of the U.S.;
- Wild and Scenic Rivers;
- Coastal Barriers;
- Coastal Zone Management;
- Essential Fish Habitat;
- Non-archeological historic resources; and
- Energy.

No permitting or mitigation for the above listed issues is proposed as a result of the proposed project.

7.1.1 Land Use

The proposed project is on new location and would convert developed and undeveloped, forested, and agricultural land to transportation use. The Preferred Alternative would have controlled access and no frontage roads, except where required along Farm-to-Market Road (FM) 1485. Grade separations would be provided for all major arterial roadways and railroad crossings. Final right-of-way (ROW) and access determinations would be evaluated during the design phase. No mitigation is proposed for changes in land use associated with the proposed project.

7.2 SOCIAL IMPACTS

7.2.1 Community Cohesion and Quality of Life

Efforts have been made in the planning stages to avoid or minimize adverse effects to sensitive resources, including farmlands, community cohesion, and quality of life standards. Grade separations would be incorporated into the design of the Preferred Alternative, allowing for adequate movement of school buses and emergency vehicles under the proposed facility. Where possible, the Preferred Alternative alignment would be placed along and close to existing property lines to minimize the splitting or fragmentation of farms and other properties. Bisection of farms would convert portions of existing farmland or prime farmland soils to transportation land use. Existing roads used for property access that may be split by the Preferred Alternative would be re-aligned in accordance with TxDOT policies to accommodate the property owner's access needs. Furthermore, public meetings have been held, and additional meetings will be held as required during the environmental process to discuss specific community and landowner concerns prior to construction of the Preferred Alternative.

7.2.2 Relocation

TxDOT offers relocation counseling and financial assistance to residents and business owners that are displaced by the acquisition of highway ROW in accordance with the Federal Uniform Relocation and Real Property Acquisition Policies Act of 1970. Once it has been determined that a structure must be acquired in order to construct the highway, the property owner and/or tenant is contacted by a relocation counselor who provides information on exactly what benefits for which the owner/tenant is eligible and who assists the owner/tenant in applying for those benefits. In general, the relocation counselor would provide listings of comparable housing, transportation to inspect the housing (especially for elderly and handicapped persons), and referrals to other agencies that provide assistance for relocated persons.

Properties presented as comparable must be of similar size in terms of number of rooms, living space, location, and square footage. The properties would be available for purchase and within the financial means of the relocatee. The replacement housing must meet all minimum standards established by FHWA and TxDOT (decent, safe, and sanitary) and conform to all local building codes.

In the case of the Segments H and I-1 study area, property values are rising rapidly. Newly constructed housing in the area is considerably more expensive than the assessed valuations of the older housing stock. Market values for older housing stock in the Houston Realtors Association Multiple Listings are also higher than the assessed valuations for these properties (HAR, 2012). Depending on the difference in prices of properties that are comparable in all other criteria, financial assistance in the form of a purchase supplement, rental assistance payments, or a mortgage down payment may be offered to the relocatee. In any case, a potentially displaced person would not be required to move until comparable replacement dwellings are presented.

In addition to residential relocation assistance, TxDOT also provides assistance to businesses, farms, and nonprofit organizations required to relocate. These benefits may be in the form of reimbursements for reasonable moving expenses and reestablishment expenses.

7.3 SOILS AND FARMLANDS

7.3.1 Soils

Potential impacts presented in **Chapter 4 (Environmental Consequences)** were calculated for the entire proposed ROW. The actual acreage of proposed impacts would be less since vegetation within the ROW

would remain in place to the extent feasible and practicable in order to minimize impacts to soils and reduce erosion. The use of silt fences and other erosion control measures during construction would prevent erosion of native soils and reduce the runoff of soil particles into area streams. Furthermore, implementing revegetation of native species along constructed corridors would help prevent future erosion after construction and thereby increase the success rate of any revegetation.

To the maximum extent possible and where required, material excavated from the road cuts would be used as fill material. If suitable soils are not found within the ROW, they would be obtained from other sites within a reasonable haul distance of the project. Detailed investigation of soils for construction would be conducted during the final design phase of development of the Preferred Alternative.

Soil erosion and sedimentation would be minimized by the use, where practicable and feasible, of a combination of any of the following generally recommended methods. Other best management practices (BMP) not specifically identified below may be appropriate to address unanticipated site conditions:

- Limit the surface area of unprotected soil exposed to erosion at any one time during construction activities. Stage clearing of vegetation as needed to keep pace with construction, rather than clearing far in advance.
- Upgrade unstable ground underlying the proposed action by means of various engineering activities: the addition of extra sub-base materials to buffer the paved roadway from effects of shrinking and swelling ground, lime-stabilization, and avoidance of cut or fill slopes greater than ten degrees. Where such slopes are unavoidable, other means of protection may be required such as geotechnical fabrics, reduction of top-slope loads, and/or shoring of the toe of the slopes.
- Revegetate disturbed areas as soon as possible using nature's seasonal cycles to an advantage.
- Use native plant species, particularly long-lived, rapid growing species requiring minimum maintenance. An excellent mixture consists of little bluestem (*Schizachyrium scoparium*), hairy grama (*Bouteloua hirsuta*), sideoats grama (*Bouteloua curtipendula*), and various annual wildflowers. Weedy species, such as King Ranch bluestem (*Bothriochloa ischaemum*), should not be used as they become invasive to natural areas outside of the ROW.
- Limit duration of exposure of soils to erosion to the shortest possible time.
- Stage mulching and seeding to closely follow the progression of construction operations, particularly on high cuts and fills.
- Protect native vegetative cover (where active construction is not required) from equipment traffic and personnel parking. Natural vegetative areas not destined for active construction should be clearly marked as equipment-free areas. All construction personnel should be clearly instructed in the identification and restricted use of equipment-free areas.

- Coordinate construction activities to provide the least interference with agricultural operations.
- Reduce the volume and velocity of construction runoff.
- Utilize temporary measures such as berms, dikes, dams, sediment basins, and slope drains to control surface drainage.
- Construct earth or brush berms along the top and/or bottom edges of embankments to intercept runoff during construction.
- Utilize temporary slope drains to carry runoff from cuts and embankments to the bottom of slopes.
- Complete permanent drains and slope protection at the earliest practical time.
- Stabilize permanent soil berms by placing rock rubble on the downslope side, further reducing loss of soil moisture.
- Mulch and/or chipped vegetation may be used to reduce soil erosion on slopes, newly constructed embankments, and revegetated areas.

Temporary and permanent erosion control measures would be coordinated to ensure the best possible control during the construction and post-construction period. Permanent erosion control features would be installed at the earliest practicable time.

7.3.2 Farmlands

The Preferred Alternative includes areas containing prime farmland soils. While these impacts (i.e., removal of topsoil, compaction, and removal of vegetation) do cause temporary or permanent loss to these resources, they are considered minor as rated and scored on the Natural Resources Conservation Service (NRCS) Form Conservation Planning Assistance (CPA)-106. Therefore, mitigation measures for permanent loss of farmlands are not required. Mitigation measures to be implemented during and after construction for temporary soils impacts, including erosion control measures, are considered prudent and positive in helping to restore a portion of these same resources. As noted in **Section 7.2.2 Relocation**, TxDOT also provides assistance to businesses and farms.

7.4 AIR QUALITY

The proposed project is located within Montgomery, Harris, Liberty, and Chambers counties, which are within the Houston area's financially constrained 2035 Regional Transportation Plan (RTP) Update and fiscal year 2013-2016 Transportation Improvement Program (TIP) adopted by the Houston-Galveston Area Council (H-GAC) on April 27, 2012 and found to conform to the Strategic Implementation Plan (SIP) by FHWA/Federal Transit Admiration (FTA).

The proposed Transportation Control Measures (TCM) in the vicinity of this project, included in H-GAC's 2035 RTP Update, that are anticipated to have an effect on the Level of Mobility (LOM) are listed in **Table 2-3**. The proposed project is not anticipated to have any long term impacts on air quality in the region. During the construction phase of the project, temporary impacts on air quality include additional dust generated from construction activities. Efforts would be made to mitigate for temporary air quality impacts during construction, including minimizing or eliminating unnecessary idling of construction vehicles and employing a combination of watering, chemical stabilization, and vehicle speed reduction techniques.

The contractor would be required to adhere strictly to dust control measures as outlined in the current TxDOT specifications, which would help minimize air quality impacts. Following the standard procedures, efficient dust control measures would be implemented in areas where fugitive dust control is a problem. Any debris material not disposed of in a landfill would be mulched. Open burning of waste such as vegetative material would not be allowed.

7.5 NOISE

The Preferred Alternative would result in traffic noise impacts to 38 residential structures and 1 commercial structure. The following noise abatement measures were analyzed: traffic management, alteration of horizontal and/or vertical alignments, acquisition of undeveloped property to act as a buffer zone, and construction of traffic noise barriers. However, none of the aforementioned noise abatement measures would be both feasible and reasonable; therefore, no abatement measures are proposed for the Preferred Alternative.

Noise levels during all phases of the project, such as site preparation and roadway construction, are essentially non-predictable. One reason is that heavy machinery, the major source of construction related noise, operates in unpredictable patterns. However, construction activities normally occur during the daylight hours when high noise levels are more tolerable. Receivers are not expected to be exposed to construction noise for extended periods. Therefore, any disruption of normal activities as a result of construction noise is not anticipated. Provisions would be incorporated in the construction plans and specifications that require the contractor to make reasonable efforts on noise abatement measures such as work hour adjustments and proper equipment maintenance.

7.6 WATER QUALITY

7.6.1 Surface Water Quality Mitigation

Long-term operation of the facility would likely produce changes in the quantity and quality of the runoff from the paved roadway. Grass swales have been shown to be an effective and low-maintenance mitigation measure to cleanse highway runoff. In combination with stormwater management ponds, the grass swales would collect and treat the runoff from the highway. Therefore, grass-lined swales and stormwater management ponds would be used to minimize the adverse effect of highway runoff to surface water quality.

Since project construction would impact greater than five acres (ac), a Notice of Intent (NOI) would be prepared and filed with the Texas Commission on Environmental Quality (TCEQ) and Environmental Protection Agency (EPA) per 40 CFR 122 prior to the issuance of a Texas Pollutant Discharge Elimination System (TPDES) construction stormwater discharge permit, as per Section 402 of the Clean Water Act (CWA). The TPDES permit requires completion of a Stormwater Pollution Prevention Plan (SWPPP) in order to avoid adverse impacts potentially resulting from construction stormwater runoff discharges. TxDOT has its own stormwater management guidelines and BMPs for construction activities that would be used in the development of the SWPPP. The project SWPPP would be prepared pursuant to the TxDOT manual, *Storm Water Management Guidelines for Construction Activities* (TxDOT, 2002). A SWPPP would be prepared prior to construction and followed throughout the construction phases to minimize the discharge of sediment laden stormwater to study area streams. The SWPPP may include, but is not limited to, the use of silt fences, inlet protection barriers, hay bales, and seeding or sodding. As part of the SWPPP, TxDOT staff or a designee would be required to inspect both stabilized and unstable areas of the construction site for evidence of, or the potential for, pollutants entering Waters of the United States (U.S.) via stormwater runoff through a drainage system. Summary reports of these inspections would be written and retained as part of the SWPPP. Once construction has been completed and the disturbed areas achieve 70 percent stabilizing vegetative cover, a Notice of Termination would be filed per permit requirements. No other point source discharges that may require additional authorizations under Section 402 of the CWA are anticipated at this time.

Mitigation for impacts listed previously would incorporate the following BMPs at appropriate stages during construction. To the extent feasible, temporary erosion control measures would be installed prior to ground disturbing activities and maintained regularly throughout the various phases of construction. The erosion

control plan would be phased to coincide with construction activities to ensure maximum protection throughout the construction process. At the completion of construction, the TxDOT specifications, *Seeding for Erosion Control*, would be followed to restore and reseed all disturbed areas. For erosion control, sod would be utilized and remain in place until the area has been stabilized. For sedimentation, a combination of silt fencing and hay bale dikes would be utilized and would remain in place until project completion. The existing ditches would be used for retention storage during construction. For post-construction BMPs, a combination of retention and vegetative filter strips would be utilized to control total suspended solids after construction. Vegetation within the existing ditches would be reestablished after construction and would act as vegetative filter strips. Other areas of ROW would be seeded with native species of grasses, shrubs, or trees as needed.

7.6.2 Groundwater Mitigation

Avoidance and minimization of impacts to the public and private water supply wells would be performed during the design phase of the project. Measures would include minor alignment shifts to minimize impacts to source water protection areas and/or avoid direct impacts to the public and private water supply wells. Any water supply wells affected by construction would be mitigated using measures such as providing a new well or connection to the public water system, if feasible. Wells taken out of service would be sealed in accordance with the specifications outlined by the Water Well Drillers Advisory Council (Texas Department of Licensing Regulation, 2007).

A stormwater management plan would be developed according to FHWA and TxDOT criteria to reduce the risk of contaminating local aquifers. Stormwater management basins would collect and control spills of hazardous materials, sediments, and others particulates found in highway runoff. The use of established BMPs would be employed to prevent highway stormwater runoff from entering the aquifer at wellheads.

An emergency spill control pollution prevention plan would be developed and coordinated with local officials prior to construction. Special stormwater management measures would be designed to isolate potentially hazardous spills, for treatment and removal, before entering groundwater. The BMPs listed in the previous section would be considered and incorporated into the plans during the preliminary and final design of the project.

7.7 WETLANDS AND VEGETATIVE COMMUNITIES

7.7.1 Waters of the U.S., Including Wetlands Permitting/Regulation

Implementation of the Preferred Alternative would require a Section 404 permit, Section 401 water quality certification, and an appropriate mitigation plan. The proposed project would also require a TPDES construction stormwater discharge permit, completion of a SWPPP, and a NOI. Impacts to jurisdictional Waters of the U.S., including wetlands, associated with construction of Segments H and I-1 are anticipated with the Preferred Alternative. Refer to **Chapter 4** for the discussion and locations of potential impacts to Waters of the U.S., including wetlands.

Currently, the United States Army Corps of Engineers (USACE) Galveston District provides jurisdictional determination guidance on whether an area is adjacent or isolated in the context of the USACE Regulatory Program. The USACE Galveston District interprets "isolated waters" to be any waterbody not located within the 100-year floodplain or otherwise connected to the surface tributary system, surface water connections, continuous wetland system, ditch, or water course that carries water from a waterbody to navigable waters, or waters that are part of a surface tributary system during normal expected flows. Based on this approach, the USACE Galveston District would make permit decisions on direct impacts to jurisdictional wetlands based on their Section 404 authority, the regulatory definitions of a wetland, with consideration given to indirect impacts, and to other natural resources.

A Section 404 permit application would be submitted to the USACE following the Final Environmental Impact Statement (FEIS) or the Record of Decision (ROD) for this project, during the design phase of the proposed project. The application and mitigation plan would take into account recommendations and suggestions made during the agency coordination meetings. Prior to issuance of the Section 404 permit, all practicable measures would be taken to avoid and minimize wetland and waterbody impacts as appropriate. Those impacts that cannot be avoided or further minimized would be appropriately mitigated per coordination with the USACE and other appropriate state and federal agencies and in accordance with the Section 404 permit requirements. Please refer to **Chapter 4, Waters of the U.S., Including Wetlands** for preliminary wetland mitigation recommendations.

Water quality certification from the TCEQ would also be necessary prior to construction. The USACE would initiate the Water Quality Certification through the permit process. However, TxDOT may negotiate directly with the TCEQ staff to address issues regarding Section 401 Water Quality Certification. A CWA

Section 404 permit that disturbs more than three acres of Waters of the U.S. is subject to individual review by the TCEQ as Tier II project impacts. Tier II projects affect more than three acres of Waters of the U.S. and/or 1,500 linear feet of stream. They include projects that would not qualify for a Tier I review or for which the applicant elects not to incorporate Tier I BMPs, including the applicant choosing to use alternative BMPs.

7.7.2 Navigable Waters of the U.S.

No navigable Waters of the U.S. occur within the Grand Parkway Segments H and I-1 study area. Therefore, neither a Section 9 permit from the United States Coast Guard (USCG) nor a Section 10 permit from the USACE would be required. The proposed project does not include a bridge in or over a navigable Water of the U.S.; therefore, the General Bridge Act and Section 9 of the Rivers and Harbors Act does not apply.

7.7.3 Waters of the U.S., Including Wetlands Mitigation

Every effort has been made to avoid and minimize Waters of the U.S. impacts to the extent practicable during the planning process. This effort would continue through the design phase of the proposed Grand Parkway Segments H and I-1. Avoidance measures would also likely include spanning major drainages along the selected Preferred Alternative.

Preliminary mitigation options include both on-site and off-site mitigation. On-site mitigation (i.e., immediately adjacent to the new highway) may include stabilization of disturbed stream banks, re-vegetation, and creation or enhancement of wetlands within the final Grand Parkway Segments H and I-1 ROW. Creation or enhancement of wetlands would primarily involve development of shallow forested wetlands similar in function and value to the forested wetlands impacted during roadway construction.

On-site mitigation for highway projects may not be considered adequate for replacement of all lost Waters of the U.S. functions and values. On-site mitigation would not be considered as the only source of Waters of the U.S. mitigation for impacts associated with this project. On-site mitigation may be considered as a supplement to additional off-site mitigation. Further coordination with United States Fish and Wildlife Service (USFWS), Texas Parks and Wildlife Department (TPWD), and the USACE may determine the likelihood of on-site mitigation as an option for this project.

Off-site mitigation for wetlands must be designed to reestablish, to the extent reasonable, similar wetland

functions, values, and types as the pre-existing site. Off-site mitigation would be conducted in the same geographic vicinity or in proximity, and most likely within the same watershed as the project, particularly for wetlands. Waters of the U.S. mitigation may include expanding existing wetlands, restoration with hydrophytic species, or regulating water levels in impoundments or streams.

Natural resource agencies (including TPWD, USFWS, USACE, EPA, and TCEQ) would be involved in decisions regarding the appropriate type of mitigation, mitigation ratios, and the location, size, and character of the mitigation. A compensatory mitigation plan would be submitted to the USACE as part of the Section 404 permit review process. The mitigation plan would include a discussion of the avoidance and minimization measures used in the routing and design of the roadway. In addition, the plan would include specifications for accomplishing the proposed compensatory mitigation measures. The approved mitigation plan would be a condition of the USACE Section 404 permit for the Grand Parkway Segments H and I-1 project. The approved mitigation plan would provide a detailed discussion of mitigation commitments, including those that must be implemented during construction.

A search for previously permitted potential mitigation sites was conducted in June and July 2007, at the USACE Galveston District Headquarters located in Galveston, Texas. This search was conducted to both identify any potential impacts to existing mitigation sites along the project corridor and to determine which, if any, mitigation sites may be appropriate for use with the proposed project. The search involved designating seven points along the Grand Parkway Segments H and I-1 study area. Once these points were designated and the Global Positioning System (GPS) coordinates were determined, the coordinates were entered into Terra Term USACE software, with a 5-mile radii search constraint. Terra Term compiled lists for each search that included any incident or permit that involved a documented USACE action within the radii. The combined area of these searches encompassed the entire Grand Parkway Segments H and I-1 study area.

During the file search for appropriate mitigation sites, the USACE actions found sites within the study area that were designated as: individual permits, nationwide permits, general permits, or investigations. The investigations were disregarded because no mitigation would have been associated with those actions. The remaining actions were researched in the file room located at the USACE Galveston District Headquarters. These files were either original hard copies or archived microfiche. In February 2013, the designated points along the Grand Parkway Segments H and I-1 study area were entered into the

Regulatory In-lieu Fee and Bank Information Tracking System (RIBITS) sponsored by the USACE, EPA, USFWS, and FHWA (USACE 2013). The RIBITS search results provide information on approved service areas with the USACE Galveston District. The February 2013 RIBITS results were used in conjunction with the 2007 file search conducted at the USACE Galveston District Headquarters.

The USACE file and RIBITS review determined that no mitigation sites are located along the Preferred Alternative alignment. The majority of mitigation that occurred in the study area was done with the following mitigation banks, which are all outside the proposed study area for the Preferred Alternative:

- Greens Bayou Wetland Mitigation Bank;
- Trinity River Habitat Fund;
- Blue Elbow Swamp Mitigation Bank;
- Daisetta Swamp Mitigation Site;
- Spellbottom Mitigation Site; and
- Gin City Mitigation Bank.

The USACE would make the final determination of mitigation required for the proposed project. In summary, several viable wetland mitigation alternatives would be investigated and evaluated in the mitigation plan. Of the mitigation banks found in the 2007 USACE file and 2013 RIBITS searches, only the Blue Elbow Swamp Mitigation Bank would be appropriate for the proposed project, due to ownership and previous credit commitment issues with the other banks. However, additional mitigation banks such as the Daisetta Swamp Mitigation Site and Spellbottom Mitigation Site may be considered for the proposed project (USACE 2013). In the event that an appropriate mitigation bank is not found, an in lieu fee or permittee-responsible mitigation may be considered by TxDOT and the USACE. The technical and regulatory merit of these mitigation recommendations would be evaluated and further discussed with resource agency staff and ultimately presented via the USACE's public notice process under Section 404 of the CWA.

As an example mitigation process, if mitigation were provided within the Blue Elbow Swamp Mitigation Bank, low quality wetlands are typically mitigated at a 3:1 ratio; moderate quality wetlands are typically mitigated at a 5:1 ratio; and high quality wetlands are typically mitigated at a 7:1 ratio. The Preferred Alternative 10R would potentially impact 217.28 ac of adjacent agricultural wetlands, 2.71 ac of adjacent non-forested wetlands, 2.52 ac of adjacent forested wetlands, and up to 22.9 ac of potential Waters of the U.S., not including wetlands. Segments H and I-1 of the Grand Parkway could have up to 222.51 ac of

wetland impacts that would require permitting and mitigation. Additionally, mitigation for stream impacts would be evaluated and provided separately from wetland mitifation and may not be available at all mitigation banks. If mitigation were provided through the Blue Elbow Swamp Mitigation Bank, mitigation for wetland impacts could range from 661.98 to 1,544.62 ac; however, this is a planning level estimate and final mitigation requirements would be determined through coordination with the USACE through the permitting process. TxDOT has begun discussions with the City of Houston Parks and Recreation Department regarding mitigation opportunities in and around the Lake Houston Wilderness Park. If applicable at the time of permitting, this is an off-site option TxDOT would pursue.

7.7.4 Habitat Mitigation - Regulatory

Mitigation includes measures which avoid, minimize, and/or compensate for unavoidable losses to resources that cannot be further minimized. The assessment of mitigation measures (avoidance, minimization, and compensation) is an integral part of the NEPA process. The preferred means of mitigation is avoidance, which is inherent in impact evaluation analysis and alternative development/assessment. For those adverse impacts that cannot be avoided, other mitigation efforts must be considered. These efforts include minimization of potentially adverse impacts and compensation for those remaining adverse impacts that cannot be further reduced.

Initial mitigation measures in the planning or alignment of highway projects minimize the probable occurrence of habitat (vegetation communities) and wetland impacts (both adjacent and isolated) through route location (avoidance) and construction practices. Activities to minimize the impacts to habitats from highway construction include: minimizing disturbance of vegetation within the construction areas wherever safety allows, decreasing the amount of fill placement, and implementation of BMPs, including an erosion and sedimentation control plan. Specific impact minimization to wetland areas may include: the roadway design (use of bridge crossings instead of filling embankment); the use of retention basins and revegetated swales to minimize runoff, sedimentation, turbidity, leaching of soil nutrients, and leaching of chemicals from petroleum products, pavement, and waste material; and maintaining flow patterns to ensure wetland hydrology in spite of roadway design requirements.

The fact that some degree of impact is often unavoidable, regardless of the care applied during the planning, design, and construction of a highway, requires a plan for compensatory mitigation to replace functions, values, and features or habitats that may be disturbed. On occasion, on-site restoration of

degraded wetland habitat or creation of wetland habitat within the highway ROW through creative use of detention basins, borrow pit areas, or drainage runoff channels may be appropriate. Where such measures may not effectively restore resource functions and values, off-site mitigation measures may be considered.

7.7.5 Habitat Mitigation – Non-Regulatory

Non-regulated, non-wetland resources (e.g., remnant prairie topography, riparian habitat, etc.) identified as environmentally sensitive, socially desirable, or ecologically valuable have been avoided to the extent practicable. In accordance with Provision (4)(A)(ii) of TxDOT's Memorandum of Understanding (MOU) with TPWD signed in 1998 and at the TxDOT district's discretion, habitats given consideration for non-regulatory mitigation during project planning include:

- Habitat for federal candidate species (impacted by the project) if mitigation would assist in the prevention of the listing of the species;
- Rare vegetation series (S1, S2, or S3 TPWD designations) that also locally provide habitat for a state-listed species;
- All vegetation communities listed as S1 or S2, regardless of whether or not the series in question provides habitat for a state-listed species;
- Bottomland hardwoods, native prairies, and riparian sites; and
- Any other habitat feature considered to be locally important that the TxDOT district chooses to consider.

In accordance with the Executive Memorandum of August 10, 1995, all agencies shall comply with NEPA as it relates to vegetation management and landscape practices for all federally-assisted projects. The Executive Memorandum directs that where cost-effective and to the extent practicable, agencies would 1) use regionally native plants for landscaping; 2) design, use, or promote construction practices that minimize adverse effects on the natural habitat; 3) seed to prevent pollution by, among other things, reducing fertilizer and pesticide use; 4) implement water-efficient and runoff reduction practices; and 5) create demonstration projects employing these practices. Landscaping included with this project would comply with the Executive Memorandum and the guidelines for environmentally and economically beneficial landscape practices. In accordance with Executive Order (EO) 13112 on Invasive Species and the Executive Memorandum on Beneficial Landscaping, landscaping would be limited to seeding and replanting the ROW with native species of plants where possible. A mix of native grasses and native forbs would be used to revegetate the ROW, as available.

Mitigation alternatives associated with on-site mitigation and off-site mitigation would continue to be investigated and evaluated by the Grand Parkway Association (GPA), TxDOT, TPWD, USFWS, and the USACE. Replacement of values for unregulated habitat (habitat not under USACE jurisdiction where compensation can be required) within transportation corridors and highway ROW may not always be practical, feasible, or safe. TxDOT and the GPA would continue to coordinate with the federal and state natural resource agencies and project stakeholders to develop a final compensatory mitigation plan that protects, enhances, and preserves the integrity of the natural environment.

7.8 WILDLIFE

Wildlife relocating from within the study area because of the loss of habitat would move into established territories of other wildlife that are theoretically maintaining population numbers at carrying capacity. The stressors and impacts to wildlife associated with the emigration of individuals from the project area would be greater during times of drought or when the carrying capacity of the population within the area is already exceeded. The increased stressors would lead to an increase in mortality and/or a decrease in recruitment due to the limited resources available within adjacent habitats. Depending on the longevity and fecundity of the species, the effects of the relocated wildlife would be temporary as the carrying capacity equilibrium is established. Initial mitigation measures in the planning process of the project minimized the probable occurrence of prime habitat (vegetation communities) and wetland impacts through careful consideration of the routes (avoidance). However, construction of the project would impact vegetative communities that provide wildlife habitats. It is anticipated that a non-wetland component would be included in the mitigation plan to compensate for impacts to non-regulated natural resources **(Section 7.7.5 Habitat Mitigation - Non-Regulatory)**.

Impacts to wildlife and habitat resources can be minimized through the use of a combination of any of the following generally recommended methods or other BMPs not specifically identified below, but that may be appropriate to address unanticipated site conditions:

- Minimize the crossing of flowing streams and utilize bridge spans to the greatest extent (as opposed to fill) to minimize impacts on riparian and aquatic communities.
- Have the ROW surveyed to identify significant wildlife areas, high quality vegetation, and sensitive features such as caves, springs, and colonial nesting areas.
- Particularly dangerous wildlife crossings (i.e., where culverts, bridge spans, etc., are not practicable) can be fenced to divert wildlife through wooded areas along the ROW to culverts or bridge spans where crossings can be more safely made.

- Limit the use of herbicides and other chemicals for ROW maintenance.
- In accordance with EO 13112 on Invasive Species and Executive Memorandum on Beneficial Landscaping, landscaping would be limited to seeding and or planting of the ROW with native species of grasses, shrubs, or trees. Soil disturbance would be minimized to ensure that invasive species would not establish in the ROW.
- Schedule mowing for ROW maintenance to facilitate the natural reseeding of indigenous spring and autumnal herbaceous communities.
- Thoroughly clear areas identified as harboring oak wilt infestation and properly dispose of all plant material. All working surfaces (blades, buckets, etc.) of equipment used in clearing and grading such areas should be cleaned with a strong bleach or chlorine (hypochlorite) solution prior to use in other areas.
- Minimize the use of construction haul work roads and minimize construction traffic impact areas. Work road areas would be restored following construction to as good as or better than conditions that existed prior to construction.
- Because of safety requirements, no trees can be left within 30 feet of the roadway without roadside protection. Trees outside this safety zone, which are not affected by construction, would be preserved.
- If nesting or wintering migratory bird species or rookeries are identified on or along the route, deferring especially loud or noisy activities in the adjacent areas until after the birds have left the area would reduce negative impacts to these species.

Coordination with the appropriate resource agency would ensue should wildlife and habitat or sensitive natural resource areas as per the TPWD MOU be encountered during construction.

7.8.1 Migratory Bird Treaty Act (MBTA)

The MBTA of 1918 states it is unlawful to kill, capture, collect, possess, buy, sell, trade, or transport any migratory bird, nest, or egg in part or in whole, without a federal permit issued in accordance with the Act's policies and regulations. A cursory nest survey would be conducted once right of entry is obtained by qualified personnel prior to construction. To avoid impacts to migratory birds, any active breeding areas found during the cursory survey would be avoided entirely during the breeding season of any migratory birds identified within the project area. In accordance with the MBTA, no vegetation would be removed containing nests, eggs, or young should clearing occur during the nesting and breeding season. If a nest, eggs, or young of a ground-dwelling bird is observed before or during construction, the participating agencies would be notified and the steps would be taken to avoid impacts to the bird and the nest. Every effort will be made to prevent migratory birds from nesting in the project area during the breeding season.

7.9 THREATENED AND ENDANGERED SPECIES

According to a check of the TPWD's "mimic" version of the Texas National Diversity Database (TxNDD) obtained February 2013, two state-listed threatened species, three state-listed species of concern, and two rare plant communities have been documented within a 1.5-mile radius of the study area. These include Rafinesque's big eared bat (*Corynorhinus rafinesquii*), bald eagle (*Haliaeetus leucocephalus*), Correll's false dragon-head (*Physostegia correllii*), threeflower broomweed (*Thurovia triflora*), Texas windmill-grass (*Chloris texensis*), loblolly pine-white oak-southern red oak series (*Pinus taeda-Quercus alba-Quercus falcata* series), and water oak-willow oak series (*Quercus nigra-Quercus phellos* series), as referenced in **Chapter 4 (Environmental Consequences)**. Potential habitat for the American peregrine falcon (*Falco peregrinus anatum*), arctic peregrine falcon (*Falco peregrinus tundrius*), Bachman's sparrow (*Aimophila aestivalis*), bald eagle, black rail (*Laterallus jamaicensis*), Henslow's sparrow (*Ammodramus henslowii*), red-cockaded woodpecker (*Picoides borealis*), snowy plover (*Charadrius alexandrinus*), Western snowy plover (*Charadrius alexandrinus nivosus*), swallow-tailed kite (*Elanoides forficatus*), white-faced ibis (*Plegadis chihi*), white-tailed hawk (*Buteo albicaudatus*), wood stork (*Mycteria americana*), American eel (*Anguilla rostrata*), creek chubsucker (*Erimyzon oblongus*), paddlefish (*Polydon spathula*), two mayfly species (*Tricorythodes curvatus* and *Plauditus gloveri*), gulf coast clubtail (*Gomphus modestus*), Texas emerald dragonfly (*Somatochloa margarita*), plains spotted skunk (*Spilogale putorius interrupta*), Rafinesque's big eared bat, Southeastern myotis bat (*Myotis austroriparius*), creeper squawfoot (*Strophitus undulate*s), fawnsfoot (*Truncilla donacformis*), little spectaclecase (*Villosa lienosa*), Louisiana pigtoe (*Pleurobema riddellii*), sandbank pocketbook (*Lampsilis satura*), Texas heelsplitter (*Potamilus amphichaenus*), Texas pigtoe (*Fusconaia askewi*), Wabash pigtoe (*Fusconaia flava*), alligator snapping turtle (*Macrochelys temminckii*), Louisiana pine snake (*Pituophis ruthveni*), Northern scarlet snake (*Cemophora coccinea copei*), smooth green snake (*Liochlorophis vernalis*), timber/canebrake rattlesnake (*Crotalus horridus*), coastal gay-feather (*Liatris bracteata*), Texas meadow-rue (*Thalictrum texanum*), Texas prairie dawn (*Hymenoxys texana*), Correll's false dragon-head, threeflower broomweed, and Texas windmill-grass may occur within the study area. Surveys for these species and their preferred habitat would be conducted for the Preferred Alternative prior to construction activities to ensure the proposed project would have no effect on the listed species.

There have been no other recorded sightings of any federal- or state-listed species within close proximity of the study area. At this time, no impacts to threatened or endangered species are anticipated. TPWD has

been involved in the planning process. TPWD would be coordinated with and species specific mitigation strategies would be developed to avoid, minimize, and/or compensate for any potential impact to a threatened or endangered species.

The February 2013 TxNDD documented two loblolly pine-white oak-southern red oak series within the study area. The rare water oak-willow oak series is known to occur within the Lake Houston Wilderness Park and surrounding areas. Compensation for bottomland hardwood forest impacts described in **Chapter 4 (Environmental Consequences)** would be considered and addressed in the compensatory mitigation plan. If required, such compensation may include a contribution to the acquisition of flood easements containing riparian forest remnants within Segments H and I-1 watersheds. No other rare vegetation series are known or expected to occur within the Segments H and I-1 project area (TPWD, 2013).

7.10 FLOODPLAINS

A location hydraulic study would be performed during the design phase of the project. The study would provide detailed hydraulic information necessary to determine the use of culverts or a bridge at each stream crossing. The structures would be designed according to FHWA and TxDOT standards. These studies would be reviewed by local, state, and federal regulatory agencies to confirm that adequate measures have been taken to ensure that floodplain encroachment does not increase the risk of flooding to adjacent property. Areas sensitive to local flooding would be identified during the final design phase of the project. If areas of severe flooding are identified, design criteria may be more restrictive than those specified by the particular county. The project would comply with the Montgomery, Harris, Chambers, and Liberty counties "floodplain program." Any proposed construction or development in a Special Flood Hazard Area would be coordinated with one or more of the county floodplain administrators to receive a development permit.

The Preferred Alternative was designed to avoid impacts to floodplains to the maximum extent feasible and practicable. All Build Alternatives were located to minimize encroachment on regulatory floodways and floodplains and maintain transverse encroachments to the extent possible. Each of the alternatives was shifted to avoid and minimize wetlands and longitudinal encroachments. All floodways would be bridged or culverted by the Preferred Alternative where possible. Further avoidance and minimization of floodplain encroachments would be considered during preliminary and final design of the Preferred Alternative.

Access points to the Grand Parkway Segments H and I-1 would be located outside of the floodplains to the greatest extent practicable to minimize the potential for future floodplain development.

Mitigation measures may include cross drainage structures or long bridge structures to allow sheet flow to be unchanged relative to existing conditions. Hydraulic structures would be designed pursuant to TxDOT and FHWA standards to accommodate periods of high flows without impacting downstream areas. Adverse impacts to the watershed are expected to be negligible. Mitigation of impacts would include BMPs during construction and detention facilities to offset increased flows.

The BMPs listed in **Chapter 4 (Environmental Consequences)** would be considered and incorporated into the plans during the preliminary and final design of the highway. Cross drainage and mitigation facilities associated with the proposed roadway and drainage improvements would be designed to handle a 100-year flood event. The hydraulic design practices on this proposed project would be in accordance with current TxDOT and FHWA design policies and standards. The proposed project would not increase the base flood elevation to a level that would violate applicable floodplain regulations or ordinances.

7.11 ARCHEOLOGICAL RESOURCES

No impacts to archeological resources are anticipated with the proposed project and no further archeological work is recommended. An MOU has been executed among FHWA, TxDOT, Texas Historic Commission (THC), and the Advisory Council on Historic Preservation (ACHP) to ensure that any archeological materials associated with the construction of this project would be properly evaluated, including any accidental discovery situations that arise. If archeological materials or human remains are identified within the ROW during construction, or a department-designated material source, all construction and related activities must cease. The discovery is to be reported to the TxDOT project inspector or the area engineer in accordance with TxDOT's Emergency Discovery Guidelines. If archeological materials or human remains are introduced into the ROW or easements in materials obtained from a material source under option to the contractor, all use of materials from this source must cease and the discovery reported to the TxDOT project inspector or the area engineer in accordance with TxDOT's Emergency Discovery Guidelines.

The archeological survey report was reviewed and coordinated with the State Historic Preservation Officer (SHPO) and the Texas Historical Commission (THC). The coordination was submitted on August 19, 2013 and THC concurred with the findings and recommendations as shown in **Appendix N**. TxDOT further

asked for THC's concurrence to allow the remainder of the survey to be deferred and to allow the NEPA process to continue and for property to be acquired. TxDOT will be obligated to complete the survey and coordinate the results with THC once the remainder of proposed ROW has been acquired

7.12 SECTION 4(f)

Construction of the Preferred Alternative would impact the Lake Houston Wilderness Park through the acquisition of 11 ac. The Section 4(f) mitigation would include improvements to the park entrance. Mitigation and commitments outlined in the *de minimis* Section 4(f) Evaluation for the park would be followed during the design phase of the project (**Appendix J**).

7.13 HAZARDOUS MATERIALS

Construction of the Preferred Alternative could have additional impacts on potential hazardous materials sites. However, risks can be minimized by conducting Phase I and II Environmental Site Assessments (ESA) according to American Society for Testing and Materials (ASTM) standards to identify, avoid, and mitigate hazardous materials sites. If hazardous materials are found during the construction phase, then TxDOT standard guidelines would be followed.

Asbestos and lead-based paint investigations for all structures impacted by the proposed project would be addressed during the ROW acquisition process prior to construction. If suspect material is encountered, a mitigation plan for the removal and disposal of materials containing hazardous materials would be developed according to federal, state, and local regulations. The project's plans, specifications, and estimates would disclose areas of asbestos and lead-based paint which would be disturbed. Special provisions would be developed for asbestos-related activities, notifications, required licenses, and monitoring.

Numerous documented federal- or state-regulated hazardous materials sites, as defined by the ASTM, were identified within the proposed ROW of the Preferred Alternative. The hazardous materials sources identified reflect the results of regulatory database queries provided by EDR (2012). The regulatory databases are maintained in electronic storage formats by federal and state agencies and contain geo-coded (geographic information system capable) information pertaining to a variety of hazardous materials releases or potential releases. The databases include EPA, TCEQ, and Railroad Commission of Texas listings of sites where hazardous materials are suspected to have been stored, used, and/or released to the

environment. The federal and state databases that were reviewed are described in **Chapter 3**. If an undocumented site is encountered during construction, a detailed evaluation would need to occur. Mitigation, if warranted, would depend on the type, size, and location of the encountered hazardous materials.

7.14 VISUAL AND AESTHETIC

It is likely that visual and aesthetic changes resulting from the Grand Parkway Segments H and I-1 would occur near intersections where access to the new roadway has been provided. These developments would likely include streetlights and/or security lighting that would be expected to result in incremental and localized increases in ambient light levels, glare, and nightglow. Where practicable, visual mitigation measures could include naturally vegetated medians, minimized ROW clearing, incorporation of design specifications to blend into the landscape, and promotion of roadside native wildflower planting programs. Native plants would be considered for roadside vegetation, where practicable, to improve the aesthetics and to control the introduction and growth of invasive species, landscape planting, and revegetation of natural areas impacted by construction. Wherever practicable, existing trees within the proposed ROW could be retained to block the view of the roadway from adjacent properties. As currently proposed, the roadway lighting system would be restricted to those areas where entrance/exit ramps and a mainlane toll facility or toll gantries are located and would consist of low impact, downward directional lightning.

The design of the facility would follow TxDOT's Green Ribbon Project (43 TAC 11). The Green Ribbon Project provides TxDOT with guidelines to integrate environmental and aesthetics issues with roadway functionality and is applicable to all TxDOT roadways within the Houston District. Five primary design principles guide the Green Ribbon Project enhancement concepts:

- Green First: When considering enhancements, planting would be Priority Number 1.
- Integration: Consider all improvements in context with each other. Solutions should emphasize the visual, as well as physical, integration of all components.
- Continuity: Improvements should create a continuous appearance.
- Freeways are Public Space: The freeway ROW belongs to the public and should provide a visually pleasing experience.
- Maintenance: All enhancements should consider ease of long-term maintenance.

In an effort to create regional identity and interest within the TxDOT Houston District, three regional zones are identified for structural elements, each receiving a specific design scheme. These schemes are:

vertical, horizontal, and wave. Each scheme establishes a design continuity and consistency of elements that share a common aesthetic characteristic reflecting the regional character of that corridor. These schemes provide guidelines and produce the preferred aesthetic form, function, and appearance of each new baseline highway element. While the different schemes each specifically reflect their corresponding regional corridor zone in their detailed appearance, all the schemes share a commonality in form and character to create a continuity and consistency on a distinct level. The Grand Parkway Segments H and I-1 would be located within the vertical scheme region. As the name implies, the vertical scheme, which is applied to the northern regional corridor zone, consists of predominantly vertical articulations and tree-like forms that reflect the character of the dominant pine forested landscape.

7.15 CONSTRUCTION IMPACTS

The contractor would be required to take every possible reasonable step and follow mitigation procedures in accordance with state and local governing regulations to avoid or minimize construction impacts **(Table 7-1).** During the construction phase, short-term effects related to noise and dust would be minimized. Traffic delays would be minimized through coordination between TxDOT, contractors, and affected neighborhoods or landowners (in the areas immediately adjacent to the proposed ROW), and by developing a construction schedule that would allow for a minimum delay for movement across the proposed ROW. Also, efforts would be made to provide appropriate construction detours, informative signage, and maintenance of access to residences, farms, businesses, and community facilities where practicable. Potential development associated with the construction of the Build Alternatives could have additional impacts on potential hazardous material sites. However, risks can be minimized by conducting Phase I ESAs according to ASTM standards to identify, avoid, and mitigate hazardous material sites. If hazardous materials are found in the construction phase, TxDOT standard guidelines would be followed.

Storage and use of hazardous materials would be necessary during the construction of the project. Temporary above ground storage tanks (AST) containing oil and diesel are typically used to provide fuels for the equipment and vehicles used in roadway construction. These ASTs would be regulated and would require control measures for spills and leaks. Potential impacts could occur from small spills and leaks from fueling and maintenance of equipment and vehicles. These impacts should be minimal and would not pose a substantial impact to the environment. Every effort would be taken to reduce these types of impacts during the construction activities. Activities dealing with the use and storage of hazardous materials during

roadway construction would be required to conform to TxDOT standards for spill containment and control strategies.

Table 7-1: Measures Required to Avoid or Minimize Construction Impacts

Construction Related Impact	Contractor Mitigation Measure(s)
Air quality	Implementing dust control measures such as the use of water sprinklers and prohibiting open burning except in accordance with applicable laws and regulations would minimize impacts to air quality.
Water quality	Preparation of Storm Water Pollution Prevention Plan (SWPPP) pursuant to TxDOT guidelines (TxDOT, 2000) including but not limited to berms, dikes, temporary seeding, sodding, sediment traps, geotextile fiber mats, silt fences, hay bales, slope drains, mulches, and crushed stone. An emergency spill control pollution prevention plan would be developed and coordinated with local officials prior to construction. Avoidance measures would include spanning major drainages along the Preferred Alternative. A Section 404 individual permit application would be submitted to the USACE following the FEIS or ROD for this project, during the design phase of the proposed project. A Section 401 Water Quality Certification would be coordinated with the TCEQ as a part of the USACE permit process. The Contractor would be required to follow the permit conditions.
Noise	Shifting construction timings to daylight hours or any other "noise tolerant" periods depending on the neighboring properties. Use of mufflers on construction equipment near residential areas.
Maintenance and control of traffic	Construction in a single geographic area would be limited to avoid inundating the adjacent communities with construction zones.
Health and safety	Contractor would comply with all federal, state, and local laws including Occupational Safety and Health Administration regulations governing safety, health and sanitation of construction personnel and general public.
Hazardous materials	If hazardous materials are discovered during the construction phase, TxDOT standard guidelines would be followed.
Pollution control on haul roads, borrow/material pits, waste material disposal areas	Contractor to exercise combination of erosion and pollution control measures listed under air and water quality control.

Source: Study Team, 2012

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CHAPTER 8
AGENCY AND PUBLIC COORDINATION

The Federal Highway Administration (FHWA), Texas Department of Transportation (TxDOT), and Grand Parkway Association (GPA) have engaged governmental agencies and the public in an extensive coordination effort to inform others of progress in the planning process and solicit input from them. The Grand Parkway Segments H and I-1 Project has been open to comments by any person and to all views on the scope of 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 will continue to consider all comments during the project development process into the future.

The study team documented the public coordination process in the public meeting summaries and public hearing summary and analysis reports for each of the two series of public scoping meetings and the public hearings. General summaries of the public scoping meetings held in February-March 2006 and May 2007 are contained in this chapter. The summary and analysis reports for the public hearings held in August 2011 and the summary and analysis for the Meeting with Affected Property Owners (MAPO) are included in **Appendix Q**.

8.1 NOTICE OF INTENT

TxDOT and FHWA filed a notice of intent (NOI) on February 17, 2006 to prepare and consider an Environmental Impact Statement (EIS) for Segments H and I-1 of the Grand Parkway. The NOI was published in the Federal Register on February 10, 2006 and in the Texas Register on February 3, 2006. Notification to the public was published in the *Houston Chronicle* on February 17, 2006. A copy of the NOI is included in **Appendix A**.

8.2 PROJECT COORDINATION PLAN

TxDOT and the GPA, in coordination with FHWA, the lead federal agency, prepared a Project Coordination Plan 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 Project Coordination 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 Project Coordination Plan was

prepared to meet the requirements of the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU), Title VI, Section 6002, and was formally approved by FHWA on April 13, 2007. Refer to **Appendix B** for a copy of the approved Project Coordination Plan for the Grand Parkway Segments H and I-1 Project.

The Project Coordination Plan identifies which participating/cooperating agencies were included for the proposed project and their respective roles and responsibilities. Participating/cooperating agencies consist of federal and state resource agencies and local agencies with jurisdiction by law, special expertise, or an interest in the proposed project. All federal, state, tribal, regional, and local government agencies that may have an interest in the project were invited to serve as participating agencies. Cooperating agencies are federal participating agencies that have been invited by the lead federal agency, FHWA, to serve as cooperating agencies in the process to assist in the preparation, coordination, and review of the EIS. The United States Army Corps of Engineers (USACE) is a cooperating agency for this project. A detailed list of the proposed project's participating and cooperating agencies is included in the Project Coordination Plan (**Appendix B**).

8.3 SCOPING AND STUDY AREA

Scoping involved an early and open process for determining the scope of issues to be addressed and for identifying the issues related to the Grand Parkway Segments H and I-1. A preliminary study area was identified through an interdisciplinary approach involving active agency participation and an outreach program. The scoping and outreach process included the involvement and participation of the public, local officials, resource agencies, and other interested parties. The following summarizes efforts for scoping and the corridor study phase of Segments H and I-1 of the Grand Parkway.

8.3.1 Public Involvement

8.3.1.1 February – March 2006 Public Scoping Meetings

The public was directly involved in the development of a study area for the Grand Parkway Segments H and I-1. Initial public scoping meetings were held at Wilson Junior High School in Dayton, Texas, on February 28, 2006, and at Barbers Hill High School in Mont Belvieu, Texas, on March 1, 2006.

Public meeting legal notices were printed in English in the *Houston Chronicle*, the *Conroe Courier*, the *Liberty Vindicator*, and the *Baytown Sun* approximately 30 and 10 days prior to the event. The legal notice

was also published in Spanish in the *Houston Chronicle's* Neighborhood News Zone 3. Public meeting announcements were also mailed to approximately 1,000 people two weeks prior to the meetings. The mailing list was comprised of property owners, individuals, businesses, and civic and neighborhood organizations within the preliminary study area, along with government officials, media, and other stakeholders. TxDOT mailed public meeting notices with informational packets to elected officials approximately 35 days prior to the public meetings. Press releases were sent to local news media approximately one week prior to the meetings.

A combined total of approximately 158 people attended the meetings, which were conducted in an open house format and consisted of various exhibits including maps of the preliminary study area, text informational boards, and large-scale aerial maps. TxDOT, GPA, and consultant team members were available to answer questions and discuss concerns. Attendees were provided a questionnaire/comment form and encouraged to complete and turn it in at the meeting or submit their comments to GPA by mail.

Comments provided and questionnaires completed at the public scoping meetings were used in combination with comments from local officials and resource agencies to develop the study area for Segments H and I-1 and to gather information on environmental constraints. Most respondents commented that there is "not an existing road that serves the same purpose," and the majority think the project would be "highly beneficial" to the area. During the meetings, the principal concerns identified for Segments H and I-1 were:

- Project would not begin soon enough to accommodate growth;
- Need for improved emergency evacuation route;
- Could positively impact the area with increased economic development;
- Accessibility and location of route; and
- Loss of personal property.

8.3.2 Local Elected Official Involvement

One-on-one meetings were held with local elected officials to discuss the proposed project's purpose and need, constraints in the study area, process, public involvement plan, and schedule. All of the elected officials that met with the study team were supportive of the proposed project and were pleased to see it moving forward. Specific issues from these meetings were used in combination with public and resource agency comments to develop reasonable alternatives for Grand Parkway Segments H and I-1. **Table 8-1**

provides meeting dates, a list of elected officials or agency attendees, their comments and concerns, and their affiliations.

Table 8-1: Local Elected Officials Involvement During Scoping and Corridor Study

Affiliation	Attendees	Comments/Concerns	Date
Chambers County Precinct 3	Commissioner Buddy Irby	Concerned about Cherry Point subdivision. Enterprise was going to build a brine well or storage well.	February 9, 2006
Liberty County Precinct 4 City of Dayton	Commissioner Norman Brown Mayor Steve Stevens	Salt Dome north of Dayton- companies looking to expand usage. County Road (CR) 615 at State Highway (SH) 321 - Enstore putting 70-80 acre storage facility. Mobile home community expanding Whitewing subdivision. Residential development west of FM 1413 between County line and FM 1413. Steamboat subdivision already subdivided.	February 9, 2006
City of Mont Belvieu	Mayor Nick Dixon; Bryan Easum, City Administrator; and Daniel Wouldiams, City Engineer	Concerned about Cherry Point subdivision. Would like an intersection at Langston, intersection every 0.5 mile. Development is occurring along FM 3360 and SH 565.	February 14, 2006
Montgomery County Precinct 4	Mark Bosma; Mike Beitler; and Mark Mooney, County Engineer	The Montgomery Independent School District has many parcels in the area.	February 16, 2006
Harris County Precinct 4	Commissioner Jerry Eversole; and staff Pamela Rocchi and Joanye Henderson	Interested in benefits to Harris County residents.	February 27, 2006
Chambers County Precinct 4	Commissioner Bill Wallace and Don Brandon, County Engineer	Proposed 50-acre cemetery south of Cherry Creek. New development planned along Cedar Bayou (20,000 acres). Union Pacific Rail Road (UPRR) putting another yard on FM 565. Dayton canal parallel to SH 146 is historic.	March 30, 2006
Harris County Precinct 2	Commissioner Sylvia Garcia; and staff Kim Harrison and Roel Garcia	Proposed soccer park at FM 1942 and North Main Banana Bend Beach Park need to add on constraint map, Cemetery at the Lynchburg Ferry area. New high school at North Main and Wallisville Road. Need to visit with Goose Creek, Channel View and Sheldon Independent School District (ISD) to avoid impacts to facilities.	April 3, 2006
City of Baytown	Gary Jackson, City Manager; Bob Leiper, Deputy City Manager; Bill Pederson, Director of Engineering; and Mike Prewitt, Assistant Director of Public Works	Need to get all planned development from Greg Stubbs (Planning Department).	April 18, 2006
City of Woodbranch	Mayor Sharon Frey; and Charlotte Smith	Federal Emergency Management Agency (FEMA) bringing housing to Patton Village for Katrina Evacuees. Large tract near Roman Forest being cleared for development.	April 27, 2006
City of Splendora	Mayor Wayne Careley	Super Wal-Mart planned on SH 242 west of United States Highway (US) 59 North (N), lots of development along SH 242. Patton Village. goes under water all the time.	May 17, 2006
City of Roman Forest	Mayor Floyd Jackson and Mary McFarland, Roman Forest Municipal Utility District (MUD); Billy Goss, New Caney MUD; and JD Marshall, Roman Forest Council Member	Kings Colony is starting to see sporadic development, it is platted. Property on the corner of Roman Forest and US 59 (N)/I-69 is for sale asking $35 million.	June 1, 2006

Source: Contract Meeting Report, Volume 1, 2006; and Administrative Record, Volume II., 2006

8.3.3 Participating Agency Involvement

Coordination with various participating agencies indicated that a number of issues needed to be addressed before a set of preliminary alternatives could be developed. These issues included timeline, traffic data, travel demand modeling, constraints mapping, and impact on environment. One-on-one meetings were held to brief agencies about the proposed project's purpose and need, constraints in the study area, process, public involvement plan, and schedule. **Table 8-2** provides meeting dates, locations, and attendees.

FHWA, TxDOT Houston and Beaumont Districts, TxDOT Environmental Affairs Division (ENV), GPA, and the consulting engineer team serve on a streamlining team known as the Fast-Track Advisory and Streamlining Team (FAST) to assist in streamlining and expediting project development. The FAST provided guidance throughout the National Environmental Policy Act (NEPA) process and assisted in the preparation and review of documentation. The FAST participated in periodic meetings to review decisions made, provide comments on materials, methodologies, and evaluation criteria. The team members that comprise the FAST are listed in the Project Coordination Plan (**Appendix B**).

Table 8-2: Participating Agency Involvement During Scoping and Corridor Study

Date	Location	Attendees
January 24, 2006	Houston-Galveston Area Council (H-GAC) Office	H-GAC and engineering consultant team
February 15, 2006	TxDOT Beaumont Office	TxDOT Beaumont and engineering consultant team
February 22, 2006	U.S. Army Corps of Engineers (USACE), Galveston	USACE, Environmental Protection Agency (EPA), U.S. Fish and Wildlife Service (USFWS), Texas Parks and Wildlife Department (TPWD), Texas Commission on Environmental Quality (TCEQ), TxDOT and engineering consultant team
March 2, 2006	Hermann Park Clubhouse	TPWD, City of Houston, and engineering consultant team
March 7, 2006	H-GAC Office	H-GAC, TxDOT ENV, FHWA, GPA, and engineering consultant team
March 16, 2006	Dayton High School Cafeteria	TCEQ, public, and engineering consultant team
May 2, 2006	TxDOT Houston District	TxDOT Houston, TxDOT Beaumont, TxDOT ENV, FHWA, GPA
May 3, 2006	USACE, Galveston	TxDOT Houston, TxDOT Beaumont, TPWD, TCEQ, USFWS, EPA, General Land Office (GLO), USACE, and engineering consultant team

Source: Contract Meeting Report, Volume 1, 2006; and Administrative Record, Volume II, 2006

8.3.3.1 January 2006

On January 24, 2006, a meeting took place with the Houston-Galveston Area Council (H-GAC) to discuss travel demand modeling support. Information obtained from the meeting indicated that H-GAC did not have the year 2030 model network, only year 2025, which cannot be modified as 2030 and would have to be linked up to the conformity network. However, 2030 demographics have been set.

Additional information indicated that the network can be modified if there are obvious errors and that Interstate 69 (I-69) is not in any of the H-GAC models.

8.3.3.2 February 2006

On February 15, 2006, a meeting took place in which the TxDOT Beaumont District expressed concern over coordinating Grand Parkway Segments H and I-1 with other projects in the area, including the proposed I-69 project.

On February 22, 2006, a joint evaluation meeting was held at the USACE, Galveston office. The agencies present were FHWA, TxDOT, GPA, the United States Fish and Wildlife Service (USFWS), Texas Parks and Wildlife (TPWD), Texas Commission on Environmental Quality (TCEQ), U.S. Environmental Protection Agency (EPA), and National Oceanic and Atmospheric Administration National Marine Fisheries Service (NOAA Fisheries). Principal issues of concern included the avoidance of impacts to previous mitigation sites; pristine waters; ecologically sensitive streams; and endangered species such as the bald eagle, osprey, red-cockaded woodpecker, and Texas prairie dawn.

8.3.3.3 March 2006

On March 2, 2006, a meeting was held to discuss the status of the Lake Houston Wilderness Park transfer from TPWD to the City of Houston. Representatives from the City of Houston Parks and Recreation Department and TPWD were present. To provide better access to the park, TPWD agreed to allowing the use of land in the northern portion of the park for an alignment that would follow on or near existing Farm-to-Market Road (FM) 1485. This action would require the preparation of a Section 4(f) statement, which is included in **Appendix J**.

On March 7, 2006, a meeting was held with the H-GAC to discuss traffic and air modeling issues in order to develop consistent horizon years for the preparation of the Draft Environmental Impact Statement (DEIS). The group jointly decided to use years 2019 and 2039 as the Estimated Time of Completion (ETC), and

ETC + 20 years, respectively, for the traffic, air, and noise modeling for the Grand Parkway Segments H and I-1. It was agreed that these would be the horizon years, based on 2025 demographics in the plan that was current at the time of the meeting and that these years had already been modeled and data was available under the current model.

On March 16, 2006, project team members attended a TCEQ public meeting to gather and document information regarding a potential State Superfund Site, the Cox Road Dump site, located 1 mile north of FM 1413 on the west side of County Road (CR) 491 (Cox Road), Dayton, Liberty County, Texas.

8.3.3.4 May 2006

A FAST meeting was held on May 2, 2006 at the TxDOT Houston District Office to gather input on the preliminary alternatives and the technical methodology for the alternatives analysis. Items discussed included the beginning and end points for the alternatives and constraints mapping. Input from FHWA during the meeting indicated the need to keep an alternative end point west of Mont Belvieu along I-10 (E).

On May 3, 2006, a joint evaluation meeting was held at the USACE, Galveston, to discuss the preliminary alternatives development process and technical methodology. Various resource agencies were present including EPA, TCEQ, USACE, USFWS, TPWD, and the General Land Office (GLO). The meeting focused on various environmental issues such as endangered species, floodplain crossings, and mitigation sites. All agencies present indicated that the alternatives development process was satisfactory.

8.4 ALIGNMENT STUDY

Alternative alignments were developed within the Grand Parkway Segments H and I-1 study area to meet the purpose and need of the project and minimize potential environmental impacts. The study area data, supplemented with field-collected data, was used as a guide to determine the alignments that provided the best opportunity to avoid and minimize adverse environmental effects. The following section summarizes outreach efforts conducted during the alignment study phase.

8.4.1 Public Involvement

8.4.1.1 May 2007 Public Scoping Meetings

The public was invited to participate in the alignment study through a second series of public scoping meetings held within the study area. The first of these public scoping meetings was held at New Caney

High School, in Porter, Texas, on May 8, 2007, and the second meeting was held at Eagle Pointe Recreation Complex in Mont Belvieu, Texas, on May 9, 2007.

Public meeting legal notices were printed in English in the *Houston Chronicle*, the *Conroe Courier*, the *Liberty Vindicator*, and the *Baytown Sun* approximately 30 and 10 days prior to the event. Additionally, display ads were placed in community newspapers, the *East Montgomery County Observer*, *Humble/Kingwood/Atascocita Observer*, and a Spanish ad was placed in the *Houston Chronicle's* Spanish-language publication *La Voz de Houston*. Public meeting announcements were also mailed to approximately 1,300 people two weeks prior to the meetings. The mailing list was comprised of property owners, individuals, businesses, attendees that signed in at the 2006 public scoping meetings, civic and neighborhood organizations within the study area, as well as government officials, media, and other stakeholders. TxDOT mailed public meeting notices with informational packets to elected officials approximately 35 days prior to the public meetings. Press releases were sent to local news media approximately three weeks prior to the meetings. The GPA and TxDOT websites were also updated with the meeting information.

A combined total of approximately 180 people attended the meetings, which were conducted in an open-house format and consisted of various exhibits including maps of the preliminary alternatives, text informational boards, and large-scale aerial maps. Public input was solicited to aid in the development of the project. Materials presented at the meetings included the following: Project Coordination Plan, schedule, alternatives development methodology, the universe of alternatives, preliminary alternatives, and reasonable alternatives.

The total number of preliminary alternatives shown included five alternatives in Section A, eight alternatives in Section B, and seven alternatives in Section C. A map of the study area and these alternatives accompanied the comment form given to attendees. In addition, the preliminary alternatives that were selected as recommended reasonable alternatives included three alternatives in Section A, five alternatives in Section B, and six alternatives in Section C (**Exhibit 2-4**). Project documents including the Project Coordination Plan, purpose and need, and the first series public scoping meeting records were available for review. TxDOT, GPA, and consultant team representatives were available to answer questions and discuss concerns. Attendees were encouraged to complete comment forms and submit them at the

meeting or to the GPA by mail. A total of 72 comments were received; 55 at the meetings and 17 via mail and e-mail.

Only two respondents commented on the No-Build Alternative, one citing a positive opinion toward the No-Build Alternative and the other expressing no opinion. In Section A, the majority of respondents indicated that these alternatives did not concern them or they had no opinion. Alternatives A-2, A-4, and A-5 received the most positive feedback. In Section B, Alternatives B-1, B-2, and B-3 received the most positive feedback. In Section C, Alternatives C-2, C-3, and C-6 received the most positive feedback.

8.4.1.2 August 2011 Public Hearings

Two similar public hearings on the Grand Parkway Segments H and I-1 DEIS were held on August 9 and 11, 2011, at Barbers Hill High School in Mont Belvieu and New Caney 6th Grade Campus in New Caney, respectively. The public hearings were conducted in two locations throughout the project area for the benefit of the local stakeholders and the public. The two hearings were conducted in the same manner and had the same information available for the public in an open-house format from 6 to 7 p.m. with a presentation starting at 7 p.m. The DEIS was posted online and was available for public review at seven locations at least 45 days prior to the public hearings. These locations included:

- Grand Parkway Association, 4544 Post Oak Place, Suite 222, Houston, TX, 77027;
- Texas Department of Transportation, 7600 Washington Avenue, Houston, TX, 77007;
- Houston Public Library (Texas Room) 500 McKinney, Houston, TX, 77002;
- Montgomery County Library, R.B. Tullis Branch, 21130 U.S. Hwy. 59 #K, New Caney, TX, 77357;
- Harris County Library, Kingwood Branch, 4102 Rustic Woods, Kingwood, TX, 77345;
- Jones Public Library, 307 West Houston Street, Dayton, TX, 77535; and
- West Chambers County Library, 10616 Eagle Drive, Mont Belvieu, TX, 77580.

The Notice of Availability of the DEIS for review and comment was published as follows:

- *Houston Chronicle* – June 24, 2011;
- Texas Register – June 24, 2011; and
- Federal Register – June 24, 2011.

Legal notices for the public hearings were published in English and in Spanish 30 and 10 days prior to the hearings, in newspapers having a general and local area circulation. The notices for the public hearings were published as follows:

- *Houston Chronicle* – June 24, July 10, and July 31, 2011
- *Baytown Sun* – July 13 and July 31, 2011
- *La Subasta* (Spanish) –
  - North Central – July 12, 2011
  - North East – July 14, 2011
  - August 2 and August 4, 2011
- Your Houston News –
  - Cluster 3 (*Kingwood Observer*, *Humble Observer*, *East Montgomery Observer*) – July 13, July 14, August 2, and August 4, 2011
  - Cluster 4 (*Atascosita Observer*, *Dayton News*, *Lake Houston Observer*) – July 13, July 14, August 2, and August 4, 2011
- *Liberty Vindicator* – July 14 and July 28, 2011

Public hearing notices were also mailed to the elected officials within the study area, adjacent property owners, and the mailing list of people who had registered to participate. Verbal comments were recorded at the public hearings and written comments were accepted at the hearings and via mail or e-mail until 10 business days following the hearings, up to and including the date of August 22, 2011. Comments received on the DEIS were considered in the selection of the preferred alternative.

Verbal comments were given to a court reporter in a private room by eight attendees at the two public hearings. The court reporter recorded 12 speakers (three public officials and nine members of the general public) on both nights. A total of 14 written comments were submitted during the public hearing sessions. Two written comments were mailed/e-mailed during the comment period for a total of 16 written comments that can be reviewed in **Appendix Q**.

8.4.1.3 May 16, 2013 Meeting with Affected Property Owners

The Meeting with Affected Property Owners (MAPO) was held to present a proposed minor design modification that is under consideration since TxDOT and FHWA issued the Draft Environmental Impact Statement dated March 2011, and to receive public comment. The MAPO primarily focused on the

proposed modification which occurs north and south of FM 1960; however, comments regarding any other features of proposed Grand Parkway, SH 99, were accepted.

The proposed minor design modification involves a slight shift in the Recommended Alignment beginning 2.15 miles north of FM 1960 and ending 1.41 miles south of FM 1960 for a total distance of 3.56 miles. This minor shift in alignment is in response to public comments and intended to reduce impacts in the proposed project area. The MAPO was held on Thursday, May 16, 2013 from 5:00 to 7:00 pm at the Dayton High School, 3200 N. Cleveland St. (Hwy 321), Dayton, Texas 77535.

Meeting notices were mailed to affected property owners and elected officials. An announcement of the meeting was also posted on the Grand Parkway Association website at www.grandpky.com.

Meeting attendees signed in at the registration table. A total of 16 individuals were in attendance, as well as, two elected officials. Copies of the attendance sign-in sheets are included in **Appendix O**.

The meeting was held as an open-house format between 5:00 pm and 7:00 pm. Representatives from TxDOT and the study team were available to discuss the project and answer questions. The open house was arranged with aerial exhibits and a welcome board. Copies of the exhibits are included in **Appendix O**.

Throughout the meeting, attendees had the chance to submit written comments. Comment tables were set up in the meeting area with comment drop boxes. Written comments could also be mailed or email by May 30, 2013. A total of 5 written comments were submitted within the comment period. Copies of the written comments and a comment response matrix are included in **Appendix O**.

The following is a tabulation of the written comments received as a result of the MAPO:

Issue (Number of comments concerning issue)

- Support of alignment shift (3);
- Oppose alignment shift (2); and
- Consider a route further to the east (2).

8.4.2 Local and Elected Officials Involvement

8.4.2.1 April 2007

Letters were sent to the elected officials listed in the Project Coordination Plan (**Appendix B**) inviting them to a coordination meeting held on April 26, 2007, at the GPA office. The local elected officials and their representatives were given an opportunity to review and provide input on the presentation materials prior to the second series of public scoping meetings for Segments H and I-1. Elected officials or their representatives that attended and their affiliations are listed in **Table 8-3**.

Table 8-3: April 26, 2007 Meeting Attendees

Affiliation	Attendees
Harris County Precinct 2	John Saavedra, staff member
Harris County Precinct 4	Pamela Rocchi, staff member
Liberty County	County Judge Phil Fitzgerald

Source: Elected Officials Sign-in Sheet, April 2007

8.4.2.2 May 2007

The City of Dayton held a city council meeting on May 21, 2007, in Dayton, Texas. The study team made a presentation to the mayor and the council members that included the information shown at the second series of public scoping meetings held on May 8-9, 2007. The information also included the project schedule, development process, constraints map, universe of alternatives, preliminary alternatives, and recommended reasonable alternatives. The preliminary alternatives were displayed on a large board and the preliminary alternatives were described. Comment forms were provided to each of the council members and the commenting process was explained, including the May 24, 2007 deadline for submitting comments to be included in the Official Public Meeting Summary Report. A resolution was adopted stating that the City of Dayton recommended Preliminary Alignment B-1 for the proposed Grand Parkway Segments H and I-1.

8.4.2.3 July 2007

Letters were sent to the elected officials listed in the Project Coordination Plan (**Appendix B**) inviting them to a coordination meeting held on July 18, 2007 at the GPA office. The local elected officials and representatives of local elected officials met with the project team to discuss input gathered from the May 8-9, 2007 public scoping meetings, draft reasonable alternatives, and alternative analysis methodology. Elected officials or their representatives that attended and their affiliation are listed in **Table 8-4**.

Table 8-4: July 18, 2007 Meeting Attendees

Affiliation	Attendees
City of Dayton	David Douglas, City Manager; Jenny Page, City Secretary; Felix Scappa, Councilman; Dave Draz
City of Mont Belvieu	Bryan Easum, City Administrator
City of Roman Forest	Mayor Floyd Jackson
Dayton Independent School District (ISD)	Greg Hayman
Harris County Judge's Office	Mark Annas
Liberty County	County Judge Phil Fitzgerald
Liberty County Precinct 4	Commissioner Norman Brown, Randy Bivins
Tarkington ISD	John Kirchner
Texas State Representative John Otto's Office	Terri Bivins
Dayton News	Mike George
Citizen	Ray Stuessen
Citizen	Kenneth Voytek

Source: Elected Officials Sign-in Sheets, July 2007

8.4.3 Participating Agency Involvement

During the preparation of the DEIS, meetings were held with participating agencies to address specific concerns and provide updates on the project development process. The participating agencies consisted of resource agencies and local agencies with a special interest in the proposed project (**Appendix R**). Summaries of the meetings are listed below.

8.4.3.1 April 2007

Letters were sent to the participating agencies listed in the Project Coordination Plan (**Appendix B**) inviting them to a coordination meeting held on April 18, 2007 at the GPA office. The participating agencies were given an opportunity to review and provide input on the presentation materials for the second series of public scoping meetings for Segments H and I-1. Agency meeting attendees and their affiliations are listed in **Table 8-5**.

Table 8-5: April 18, 2007 Meeting Attendees

Affiliation	Attendees
Chambers County	Don Brandon, County Engineer
Chambers-Liberty County Navigation District	Pudge Wouldcox
City of Houston Parks and Recreation	Rick Dewees, Joe Turner
Harris County Toll Road Authority	Shweta Arora, Page Rander
Houston Airport System	Carlos Ortiz
NOAA Fisheries	Rusty Swafford
TPWD	Amy Hanna
USACE	John Machol
U.S. EPA Region 6	Michael Jansky

Source: Agency Sign-in Sheets, April 2007

A meeting with the H-GAC and the study team was held on April 25, 2007 to discuss recent updates to the travel demand model and timing issues due to an updated schedule and to coordinate modeling support from the H-GAC.

8.4.3.2 May 2007

On May 21, 2007, the TCEQ Project Manager of the Cox Road Dump Site was contacted to discuss the potential impact of the Grand Parkway Segments H and I-1 preliminary alternatives. The TCEQ advised that a 0.5-mile avoidance buffer around the contaminated site would be a comfortable distance away from the site for the alternative alignments.

8.4.3.3 June 2007

The study team met with the H-GAC on June 7, 2007 to discuss coordination for the travel demand modeling of the reasonable alternatives.

8.4.3.4 July 2007

Letters were sent to the participating agencies listed in the Project Coordination Plan (**Appendix B**) inviting them to a coordination meeting held on July 16, 2007 at the GPA office. The participating agencies were given an opportunity to review and discuss the draft reasonable alternatives, alternative analysis technical methodology, and input gathered from the May 8-9, 2007 second series of public scoping meetings. Agency attendees and their affiliations are listed in **Table 8-6**.

Table 8-6: July 16, 2007 Meeting Attendees

Affiliation	Attendees
Chambers County	Don Brandon, County Engineer
City of Houston Parks and Recreation	Joe Turner
Harris County Toll Road Authority	John Tyler
Houston Airport System	Wouldiam Zrioka
Houston-Galveston Area Council	Roland Strobel
U.S. Fish and Wildlife Service	Edith Erfling

Source: Agency Sign-in, July 2007

8.4.3.5 August 2007

On August 3, 2007, coordination letters were sent to the participating agencies unable to attend the July 16, 2007 meeting, including the TPWD, USACE, and EPA to update them on the materials presented. The

coordination letters included the presentation materials and maps from the participating agency meeting and requested their input on the materials.

The project team historians met with TxDOT ENV on August 10, 2007 to discuss the findings of the preliminary historic resources survey. Items discussed included the historic resources identified within the study area and the approach and methodology of the survey. TxDOT ENV indicated that they would accept the agreed upon approach of conducting a preliminary survey for the reasonable alternatives and that a full reconnaissance survey would be performed for the preferred alternative, pending availability of access.

The project team met with H-GAC planning staff on August 11, 2007 to discuss development forecasts as a result of the Grand Parkway Segments H and I-1 for the indirect and cumulative impacts assessment. Maps of the indirect and cumulative impacts study areas along with existing and proposed development were discussed. The H-GAC provided information on the capabilities of their forecasting models but declined to provide quantitative input on areas of potential future development as an indirect result of the proposed project.

8.4.4 Indirect and Cumulative Impacts Expert Panel Survey

In late 2008 and early 2009, formal surveys were sent to the original stakeholders queried during 2007 and early 2008 and to additional planning experts identified in late 2008 and early 2009. The expert panel survey questionnaire was developed by the project team in conjunction with TxDOT, TxDOT ENV, and FHWA representatives. To determine the extent of potential induced development, regional and local land use planning authorities were contacted and asked to complete a questionnaire regarding the potential for the proposed project to induce development. The surveyed experts were also asked to give their opinions on the percentage of planned growth dependent on the Grand Parkway Segments H and I-1, and if possible, to provide information on the size and location of this growth. The study area for the indirect impacts questionnaire was the 15-minute travel shed. **Table 8-7** lists the expert panel that returned responses to the survey.

Table 8-7: Expert Panel Survey Participants

Name	Agency or Municipality Affiliation
Jeff Taebel	Director, Community and Environmental Planning; H-GAC
Bill Cobabe	City of Mont Belvieu, City Planner
David Draz	City of Dayton, Director of Planning
Don Brandon, P.E.	Chambers County, County Engineer
Harold Cheek	City of Baytown, City Planner

Source: Study Team, 2008

From the analysis of the expert panel survey results, it was determined that areas with the greatest potential for induced development are located at major intersections and adjacent to existing cities. The H-GAC also provided the *Envision Houston Region* report with the survey response.

8.5 ADDITIONAL COORDINATION

8.5.1 Community Groups

The GPA has coordinated extensively with community groups with an interest in the Grand Parkway project. The GPA accepted all invitations to speak to any group or organization concerning the Grand Parkway project. These community groups were provided a customized presentation that typically included the history of the Grand Parkway project, the general status of all segments of the Grand Parkway, and specific information about their particular area and interests. The presentations lasted approximately 10 to 20 minutes and were followed by a question-and-answer period. Handouts given to the participants included schedules, maps, and contact information. The level of detailed information provided was dependent on the stage of project development. The presentations were updated at the time of each request to reflect the most current information. The GPA and the study team have also been responsive in providing information for public media and community newsletters.

8.5.2 Regional Transportation Plan and Transportation Improvement Program

The 2035 Regional Transportation Plan (RTP) Update and the 2013-2016 Transportation Improvement Program (TIP), as amended, identify the addition of toll facilities, including Grand Parkway Segments H and I-1, as needed to address congestion and growth. The transportation needs identified during the development of the 2035 RTP Update and the 2013-2016 TIP, as amended, are consistent with those found by the Grand Parkway public outreach process. To define regional transportation needs, the H-GAC conducted an extensive public involvement program to gather input from citizens, neighborhood and

business groups, governmental bodies, and transportation agencies. The Grand Parkway Segments H and I-1 are included in the 2035 RTP Update and in the 2013-2016 TIP, as amended.

8.5.3 Website

The GPA maintains a website that can be accessed at www.grandpky.com for the proposed 180+mile circumferential highway. The website is updated routinely with current news items, segment status including Segments H and I-1, and project materials. The website also includes a place to register for the project mailing list and an opportunity for individuals to submit comments via e-mail.

The GPA maintains an open-office concept that allows any individual to telephone or drop by the office to request information on Segments H and I-1. Faxes and e-mails are also used to transmit information. The GPA routinely meets with anyone at his or her convenience at locations outside of the GPA office to answer questions, provide maps and detailed information, or to receive information. These contacts have included the general public, small groups or special interest organizations, agencies, and elected officials.

8.5.4 Section 4(f)/Chapter 26 Public Hearing on the Lake Houston Wilderness Park De Minimis Impact Determination

A public hearing will be held on December 18, 2013, to discuss the Lake Houston Wilderness Park De Minimis Section 4(f) determination per requirements of Chapter 26 of the Texas Parks and Wildlife Department Code. A public hearing summary is included in **Appendix J**.

CHAPTER 9
LIST OF PREPARERS

This document was prepared by FHWA, TxDOT, and GPA, with assistance from HNTB Corporation.

FEDERAL HIGHWAY ADMINISTRATION (FHWA)

Mr. Mike Leary, P.E. Director of Planning and Program Development	B.S. in Civil Engineering with 32 years of experience, including 7 years with TxDOT and 26 years with FHWA in design, construction, research, transportation planning, and environment.
Mr. Clarence Rumancik, P.E. Environmental/Transportation Planning Engineer	B.S. in Civil Engineering with 15 years of experience in transportation.

TEXAS DEPARTMENT OF TRANSPORTATION (TxDOT) – HOUSTON DISTRICT

Ms. Susan Theiss Environmental Supervisor	B.A. in Government with 22 years of NEPA experience.
Dr. Stanley W. Cooper Environmental Coordinator	B.S. and M.S. in Biology and a Ph.D. in Zoology, specializing in Animal Behavior and Ecology, with 16 years of experience in NEPA, wetland delineation, permitting, and noise analysis.
Mr. Pat Henry, P.E. Director of Project Development	Director of Project Development.
Mr. Brandon Hobbs Environmental Specialist	B.S. in Environmental Science, with 6 years of experience in NEPA studies, wetland delineation, permitting and mitigation, and public involvement.

TEXAS DEPARTMENT OF TRANSPORTATION (TxDOT) – BEAUMONT DISTRICT

Mr. Phillip Lujan, P.E. Director of Transportation Planning and Development	B.S. in Engineering with 27 years of experience in preliminary engineering, design, and construction.
Mr. Steven Stafford, P.E. Transportation Planning Engineer	B.S. in Civil Engineering with 28 years of experience in transportation design and planning.

TEXAS DEPARTMENT OF TRANSPORTATION (TxDOT) – ENVIRONMENTAL AFFAIRS DIVISION

Mr. Carlos Swonke Division Director	B.S. in Geology with 25 years of transportation and environmental experience in both the public and private sector.
Ms. Julia Ragsdale Project Manager	B.S. in Chemical Engineering with 8 years of managing the environmental coordination of transportation projects.

GRAND PARKWAY ASSOCIATION (GPA)

Mr. David W. Gornet, P.E. Executive Director	M.E. in Civil Engineering with 18 years of experience in route studies, traffic analysis, preliminary engineering, and NEPA coordination.

HNTB CORPORATION

Ms. Inas Aweidah P.E. Sr. Project Manager Engineering Task Manager	B.S. in Civil Engineering and M.B.A. with 21 years of experience in route studies, traffic analysis, preliminary engineering, schematic design, access management studies, public involvement, and NEPA coordination.
Ms. Deborah C. Taylor, CEP Environmental Task Manager	B.S. in Geology with 27 years of managing preparation and coordination of NEPA documents for transportation projects.
Mr. Martin Gonzalez IV, P.E. Sr. Project Engineer Project Manager	B.S. in Civil Engineering with 18 years of experience in transportation design and planning including route studies, feasibility studies, schematics, and several projects including concurrent NEPA documentation.
Mr. Tom Ellis, P.E. Sr. Engineer	B.S in Civil Engineering with over 29 years of experience in highway planning and design and management of schematic design and environmental assessment projects.
Ms. Jennifer Halstead Deputy Project Manager	B.S. in Geography and M.S. in Environmental Science with 17 years of experience and expertise with transportation-related NEPA document preparation and quality review, public involvement, and resource agency coordination.
Ms. Courtney H. Filer, AICP Sr. Environmental Planner	Masters in Regional and Community Planning (MRCP) with 7 years of planning experience including NEPA document preparation, community impact assessment, indirect and cumulative impacts assessment, and evaluation of socio-economic impacts related to tolling.
Ms. Julie Morse Environmental Planning Manager	B.S. in Biology and M.S. in Environmental Biology with 17 years of experience in transportation environmental planning, NEPA document preparation and review, quality assurance and control, and project management, plus experience providing environmental services for eight segments of the Grand Parkway project.
Ms. C. Lynn Smith Architectural Historian	Master of Architecture, Historic Preservation Certificate with 11 years of experience in Section 106 and NEPA coordination, preservation, architectural history, planning, and architecture.
Ms. Mandy Roper Environmental Planning Assistant	B.S. in Psychology with 6 years administrative experience and 2 years of experience preparing and coordinating NEPA documents.
Ms. Erin Culp Environmental Scientist I	B.S. in Environmental Science with a minor in Geology and her areas of concentration include Section 404 wetland delineation and permitting, and transportation and oil and gas-related NEPA document preparation.

Mr. John Williams Environmental Scientist	B.S. in Wildlife and Fisheries Science with 4 years of experience in NEPA document preparation, wetland delineation and permitting, threatened and endangered species surveys, and natural resource surveys.
Ms. Brittney Davis Environmental Planner	B.A. in Political Science and Master of Urban Planning with 4 years of experience in NEPA document preparation and public involvement on a wide range of projects including environmental impact statements, and traffic and corridor feasibility studies.
Mr. Sean Wray Sr. GIS Analyst	Ten years of experience in GIS, focused on environmental data collection, geodatabases, and cartography using ESRI ArcGIS.
Ms. Maria Pettit, P.E. Sr. Environmental Planner	B.S. and M.S. in Civil Engineering with 13 years of experience preparing NEPA documents, performing traffic noise assessments, and air quality analyses for transportation projects.
Mr. Scott Inglish Science Project Manager	B.S. in Range and Wildlife Habitat Management with 16 years of experience in NEPA studies, Section 404 permitting, natural resource surveys, threatened and endangered species surveys, hazardous materials assessments, GIS, and environmental compliance.
Ms. Beth Reed Architectural Historian	B.A. in History and M.S.A.S. in Architecture Historic Preservation with 10 years of experience in conducting cultural resource surveys and Section 106, Section 110, and NEPA document preparation and review.
Mr. Darren Dodson Sr. Environmental Planner	M.S. in Biology and B.S. in Geography with 15 years of experience in NEPA studies, threatened/endangered species, wetland delineation, permitting and mitigation, noise analysis, and public involvement.
Ms. Leah Oberlin Environmental Department Manager	B.S. in Marine Science and M.S. in Environmental Engineering and Geological Science with 13 years of experience and expertise with NEPA document preparation, permitting under the Clean Water Act and Rivers and Harbors Act, Endangered Species Act and other resource agency coordination, quality review, and public involvement.

THE LENTZ GROUP

Ms. Ruth Henshall Chief Operating Officer	Bachelor of Business Administration with 29 years of experience in communications associated with infrastructure projects, including 15 years specializing in public involvement.
Ms. Carmen Houston Public Involvement Project Manager	B.A. in Communication with 7 years of public involvement experience on a wide range of projects including environmental impact statements and assessments as well as traffic and corridor feasibility studies.

CDM SMITH ASSOCIATES

Mr. Butch Babineaux, P.E. Associate	B.S. in Civil Engineering with more than 25 years of experience in corridor feasibility studies, urban and regional transportation plans, environmental planning, comprehensive traffic engineering studies, and preliminary engineering.

Mr. Praveen Pasumarthy, PE, PTOE Transportation Engineer	M.S. in Civil Engineering with more than 9 years of experience in traffic operational analyses, transportation planning, corridor studies, crash analyses, traffic impact analyses, and traffic simulation modeling.
Mr. Ashish G. Loney, AICP Sr. Transportation Planner	M.S. in Transportation Planning with more than 12 years of experience in transportation planning studies, major corridor feasibility studies, travel demand forecasting, traffic signal timing optimization, traffic operations analyses, and traffic impact studies.
Mr. Madhu Narayanasamy, AICP Transportation Planner	M.S. in Urban Planning with 9 years of experience in preparing transportation plans, travel demand modeling, economic and financial analyses, and urban planning/design strategies.
Mr. Peter Ogonowski Sr. Economist	Masters in Economics with more than 13 years of industry experience including economic development/impacts, economic/financial feasibility, benefit-cost, and macroeconomic analyses of various infrastructure/transportation projects both nationally and internationally.
Mr. Evan Bigos Economist	B.A. in Economics with over 5 years of experience in economic impact and feasibility analyses of transportation projects.
Mr. Robert W. Ball, M.H.P., R.P.A. Cultural Resources Coordinator	Masters in Historic Preservation and Registered Professional Archeologist with 13 years of experience as an archeologist and architectural historian throughout Kentucky and in Tennessee, West Virginia, Michigan, Illinois, Mississippi and South Carolina documenting hundreds of structures and working on a full range of archeological sites.
Mr. Howard Beverly, R.P.A., GISP Sr. Historic Archeologist	M.A.A. in Applied Anthropology and M.A. in Anthropology with over 13 years of experience working as an archeologist in Kentucky, Tennessee, Indiana, West Virginia, Virginia, Pennsylvania, Michigan and Texas.
Mr. David McBride, R.P.A. Sr. Archeologist	M.A. in Anthropology with over 20 years of experience as a professional archeologist, with a wide range of experience in Kentucky and the eastern U.S. archeology having conducted investigations in Kentucky, Michigan, West Virginia, Tennessee, Virginia, Delaware, Louisiana, South Carolina, New Mexico, Alaska and Texas.
Mr. John R. Wisdom, GISP Sr. GIS Analyst	M.S. and B.A. in Geography with more than 20 years of experience in applying GIS to planning, environmental, and transportation projects, as well as experience in GIS application programming, including the development of the Corridor Analysis Tool (CAT).
Mr. Michael Belvin Sr. Environmental Planner	B.S. in Agriculture with 20 years of experience in transportation planning and project development, environmental documentation, and field investigation and analysis.

ATKINS

Ms. Heather Durden GEC Environmental Manager	M.S. in Environmental Science with over 13 years of NEPA and transportation planning experience on a wide range of transportation projects. Four years of experience as the GEC Environmental Manager for the Grand Parkway.
Mr. James R. Lowe Sr. Transportation Planner	B.S. in Environmental Science with 15 years experience conducting environmental studies including five years experience preparing NEPA documents for transportation related projects.

HOUSTON-GALVESTON AREA COUNCIL (H-GAC)

Mr. Chris van Slyke Program Manager Travel Forecasting/GIS	Over 17 years of experience in general transportation planning with a focus in travel demand modeling and graphic information systems.

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Mr. Dwayne Johnson Project Manager	Serves as a Project Manager with the USACE.

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CHAPTER 11
REFERENCES CITED

Advisory Council on Historic Preservation. 5 August 2004. 36 CFR 800: Protection of Historic Properties. http://www.achp.gov/progalt/.

Advisory Council on Historic Preservation. 2006. *National Historic Preservation Act of 1966, as amended in 2006*. http://www.achp.gov/nhpa.html.

American Association of State Highway and Transportation Officials. The Green Ribbon Project. http://environment.transportation.org/documents/stewardship/TX_Green_Ribbon_Project.htm.

American Association of State Highway and Transportation Officials. August 2007. Defining the Purpose and Need and Determining the Range of Alternatives for Transportation Projects. In *American Association of State Highway and Transportation Official's Practitioner's Handbook.*

American Planning Association, Texas Chapter. 2008. A Guide to Urban Planning in Texas Communities, 2008 ed.

Anders, R. B., McAdoo, G. D., & Alexander, W. H. 1968. *Groundwater Resources of Liberty County, Texas.* United States Geological Survey.

Ashley, P., & Robinson, J. 1997. Road Mortality of Amphibians, Reptiles, and Other Wildlife on the Long Point Causeway, Lake Erie, Ontario. *Canadian Field Naturalist 110*, 403-412.

Aten, L.E. 1983 *Indians of the Upper Texas Coast*. Academic Press, New York.

Banks Environmental Data. 2012. Environmental First Search Report TM, Banks Environment Data. Print.

CDM Smith. 2011. Crash Data Table.

CDM Smith. 2012. Level of Service Table.

Chambers County Appraisal District. 2007. http://chamberscad.org/.

City of Dayton. 2002. *Major Thoroughare Plan.* Dayton, Texas.

City of Houston. 24 April 2009. A Master Plan for Lake Houston Park. http://www.houstontx.gov/parks/pdfs/2009/LakeHoustonWildernessParkMasterPlan.pdf.

City of Houston. 2012. *Lake Houston Wilderness Park.* Houston Parks and Recreation Department: http://www.houstontx.gov/parks/ourparks/lakehoustonpark.html.

City of Houston. 2012. *Major Thoroughfare and Freeway Plan*. www.houstontx.gov. Accessed March 29, 2013.

City of Mont Belvieu. 2010. *Comprehensive Plan.* City of Mont Belvieu Community Development: http://www.montbelvieu.net/index.aspx?nid=225.

Clark, W., & Karr, J. 1979. Effects of Highways on Red-Winged Blackbird and Horned Lark Populations. *The Wilson Bulletin*.

Coastal Water Authority. 2012. Coastal Water Authority Website. http://www.coastalwaterauthority.org/Public/AboutUs.aspx.

Coastal Water Authority. 2012. Jerry Berry, Coastal Water Authority Employee. May 25, 2012 Telephone conversation with Sally Victor, HNTB Corporation, 2012.

Committee on Mitigating Wetland Losses, Board on Environmental Studies and Toxicology, Water Science and Technology Board, Division on Earth and Life Studies, National Research Council. 2001. *Compensating for wetland losses under the Clean Water Act.* http://www.nap.edu/catalog.php?record_id=10134.

Conover, M. 1997. Monetary and Intangible Valuation of Deer in the United States. *Wildlife Society Bulletin 25*, 298-305.

Conrey, R., & Mills, L. 2001. Do Highways Fragment Small Mammal Populations? *International Conference on Ecology and Transportation.*

Cook, K., & Dagget, P. 1995. *Highway Roadkill, Associated Issues of Safety, and Impacts on Highway Ecotones.* Washington, D.C.: Task Force on Natural Resources, Transportation Board, National Research Council.

Council on Environmental Quality. 1 January 1970. *National Environmental Policy Act.* http://ceq.hss.doe.gov/index.html.

Council on Environmental Quality. 28 November 1978. 40 CFR 1500-1508: CEQ Regulations for Implementing NEPA. http://www.gpo.gov/fdsys/granule/CFR-2011-title40-vol33/CFR-2011-title40-vol33-part-id1102/content-detail.html.

Council on Environmental Quality. 10 December 1997. *Environmental Justice: Guidance under the National Environmental Policy Act.* http://ceq.hss.doe.gov/nepa/regs/ej/justice.pdf.

Council on Environmental Quality. 2005. *Guidance on the Consideration of Past Actions in Cumulative Effects Analysis.* http://ceq.hss.doe.gov/nepa/ccenepa/ccenepa.htm.

Council on Environmental Quality. 2007. *Considering Cumulative Effects Under the National Environmental Policy Act.* http://ceq.hss.doe.gov/nepa/ccenepa/ccenepa.htm.

Cox Road Landfill Site. 2010. *Overall* Liberty County, Texas. http://www.coxroadlandfill.com/status.htm.

Davis, S.C. & Diegel, S.W. 2007. Transportation Energy Data Book: Edition 26. Prepared for the Office of Planning, Budget Formulation and Analysis, Energy Efficiency and Renewable Energy, and U.S. Department of Energy. http://stuff.mit.edu/afs/athena/dept/cron/project/urban_metabolism/TGOFF/readings%20and%20websites/Edition26_Full_Doc.pdf.

East River Baptist Church. 2011. East River Church Baptist Website. http://www.erbctexas.org/.

Environmental Data Resources, Inc. 2012. http://www.edrnet.com/.

Environmental Protection Agency. 40 CFR 122: *EPA Administered Permit Programs: The National Pollutant Discharge Elimination System.*

Environmental Protection Agency. 40 CFR 59: National Volatile Organic Compound Emission Standards for Consumer and Commercial Prodcuts. http://www.tceq.texas.gov/permitting/air/rules/federal/59/59hmpg.html.

Environmental Protection Agency. 40 CFR 80: Regulation of Fuels and Fuel Additives. http://www.law.cornell.edu/cfr/text/40/80.

Environmental Protection Agency. 40 CFR 85: Control of Air Pollution from Mobile Sources. http://www.law.cornell.edu/cfr/text/40/85.

Environmental Protection Agency. 40 CFR 86: Control of Emissions from New and In-Use Highway Vehicles and Engines. http://www.law.cornell.edu/cfr/text/40/86.

Environmental Protection Agency. CAL#QHC. NCHRP Study. http://www.epa.gov/ scram001/dispersion_alt.htm#hyroad.

Environmental Protection Agency. 1955. Air Pollution Control Act.

Environmental Protection Agency. 1970. 42 USC 85: *Clean Air Act.* http://www.gpo.gov/fdsys/pkg/USCODE-2008-title42/pdf/USCODE-2008-title42-chap85.pdf.

Environmental Protection Agency. 1972. 33 USC 1251: Federal Water Pollution Control Act (Cl*ean Water Act).* Law and Regulations: http://water.epa.gov/lawsregs/guidance/303.cfm.

Environmental Protection Agency. 1989. *Section 10 of the Rivers and Harbors Appropriation Act of 1899*. Water: Wetlands: http://water.epa.gov/lawsregs/guidance/wetlands/sect10.cfm.

Environmental Protection Agency. 1990. The Clean Air Act Amendments of 1990. http://www.epa.gov/air/caa/overview.txt.

Environmental Protection Agency. 10 August 1995. *Guidance for Presidential Memorandum on Environmentally and Economically Beneficial Landscape Practices on Federal Landscaped Grounds.* http://www.doi.gov/greening/buildings/upload/landscaping.pdf.

Environmental Protection Agency. 6 August 1996. The Safe Water Drinking Act Amendments of 1996. http://water.epa.gov/lawsregs/guidance/sdwa/theme.cfm.

Environmental Protection Agency. 1997. *23 USC 109(h) - Standards*. Environmental Review Toolkit: http://www.environment.fhwa.dot.gov/projdev/imp109_h.asp.

Environment Protection Agency. 1999. *Regulatory Impact Analysis Control of Air Pollution from New Motor Vehicles: Tier 2 Motor Vehicle Emissions Standards and Gasoline Sulfur Control Requirements.*

Engine Programs and Compliance Division, Office of Mobile Sources. Publication No. (EPA 420-R-99-24-023).

Environmental Protection Agency. 1999. *National Air Toxics Assessments.* http://www.epa.gov/ttn/atw/nata1999/.

Environmental Protection Agency. 29 March 2001. Final Rule for Controlling Emissions of Hazardous Air Pollutants from Mobile Sources (66 FR 17229).

Environmental Protection Agency. 2006. 40 CFR 122: *National Pollutant Discharge Elimination System.* from http://cfpub.epa.gov/npdes/.

Environmental Data Resources, Inc. 2006. http://www.edrnet.com/.

Environmental Protection Agency. 26 February 2007. *Control of Hazardous Air Pollutants from Mobile Sources; Final Rule.* Federal Register Vol. 72, No. 37: http://www.gpo.gov/fdsys/pkg/FR-2007-02-26/pdf/E7-2667.pdf.

Environmental Protection Agency. April 2010. *Inventory of US Greenhouse Gas Emissions and Sinks: 1990-2010*. Climate Change:

Environmental Protection Agency. 2012. *Clean Water Act, Section 402 - National Pollutant Discharge Elimination System.* Water: Wetlands: http://water.epa.gov/lawsregs/guidance/wetlands/section402.cfm.

Environmental Protection Agency. March 2012. *Clean Water Act, Section 404.* Water: Wetlands: http://water.epa.gov/lawsregs/guidance/wetlands/sec404.cfm.

Environmental Protection Agency. October 2012. *Integrated Risk Information System (IRIS)*. http://www.epa.gov/iris/.

Environmental Protection Agency. October 2012. *Water Quality and 401 Certification*. Water: Clean Water Act: http://water.epa.gov/lawsregs/guidance/cwa/waterquality_index.cfm.

Environmental Protection Agency. September 2012. *MOBILE6.2 Vehicle Emission Modeling Software*. Modeling and Inventories: http://www.epa.gov/oms/m6.htm.

Environmental Protection Agency. September 2012. *MOVES (Motor Vehicle Emission Simulator)*. Modeling and Inventories: http://www.epa.gov/otaq/models/moves/index.htm.

Environmental Protection Agnecy. March 2012. *Overview of EPA Authorities for Natural Resource Mangers Developing Aquatic Invasive Species Rapid Response and Management Plans: CWA Section 404 Permits to Discharge Dredged or Fill Material*. Retrieved from Water: Habitat Protection: http://water.epa.gov/type/oceb/habitat/cwa404.cfm.

Environmental Protection Agency. December 2012. *National Ambient Air Quality Standards*. Air and Radiation: http://www.epa.gov/air/criteria.html.

Environmental Systems Research Institute, Inc. & Geographic Data Technology, Inc. 2002. 1999 U.S. GDT Park Landmarks.

Executive Order 11988. 24 May 1977. *Floodplain Management.* Federal Register Vol. 42, 26951: http://www.archives.gov/federal-register/codification/executive-order/11988.html.

Executive Order 11990. 25 May 1977. *Protection of Wetlands.* Federal Register Vol. 42, 26961: http://water.epa.gov/lawsregs/guidance/wetlands/eo11990.cfm.

Executive Order 12898. 16 February 1994. *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations.* Federal Register Vol. 59, No. 32: http://www.archives.gov/federal-register/executive-orders/pdf/12898.pdf.

Executive Order 13112. 8 February 1999. *Invasive Species.* Federal Register Vol. 64, No. 25, 6183-6186: http://www.gpo.gov/fdsys/pkg/FR-1999-02-08/pdf/99-3184.pdf.

Executive Order 13166. 16 August 2000. *Improving Access to Services for Persons with Limited English Proficiency.* Federal Register Vol. 65, No. 159, 50121-50122: http://www.gpo.gov/fdsys/pkg/FR-2000-08-16/pdf/00-20938.pdf.

Executive Order 13423. 24 January 2007. *Strengthening Federal Environmental, Energy, and Transportation Management.* Federal Register Vol. 72, No. 17, 3919-3923: http://www.gpo.gov/fdsys/pkg/FR-2007-01-26/pdf/07-374.pdf.

Federal Emergency Management Agency. 26 October 1976. 44 CFR 60: Criteria for Land Management and Use. http://www.ecfr.gov/cgi-bin/text-idx?c=ecfr&rgn=div5&view=text&node=44:1.0.1.2.27&idno=44.

Federal Emergency Management Agency. August 2010. *Digital Q3 Data*. http://www.mmrs.fema.gov/hazard/map/q3.shtm.

Federal Highway Administration & Federal Transit Administration. 22 February 2005. *Joint Memorandum on Integration of Planning and NEPA Processes.* Environment and Planning Linkage Processes Legal Guidance: http://www.fhwa.dot.gov/hep/plannepalegal050222.htm.

Federal Highway Administration. Federal-Aid Highway Program Manual 6-7-3-2.

Federal Highway Administration. 1966. The Department of Transportation Act of 1966. http://www.environment.fhwa.dot.gov/4f/index.asp.

Federal Highway Administration. 1987. *The Uniform Relocation Assistance and Real Property Acquisiton Policies Act of 1970 as amended in 1987*. Realty: http://www.fhwa.dot.gov/realestate/ua/index.htm.

Federal Highway Administration. 30 October 1987. Technical Advisory T 6640.8A: *Guidance for Preparing and Processing Environmental and Section 4(f) Documents.* Environmental Review Toolkit: http://environment.fhwa.dot.gov/projdev/impTA6640.asp.

Federal Highway Administration. 18 September 1990. *The Importance of Purpose and Need in Environmental Documents*. Environmental Review Toolkit: http://www.environment.fhwa.dot.gov/projdev/tdmneed.asp.

Federal Highway Administration. 2 September 1992. *Notice: Impacts of the Civil Rights Restoration Act of 1987 on FHWA Programs: N 4720.6*. http://www.fhwa.dot.gov/legsregs/directives/notices/n4720-6.htm.

Federal Highway Administration. 7 December 1994. 23 CFR 650 Subpart A: *Location and Hydraulic Design of Encroachments on Floodplains http://www.fhwa.dot.gov/legsregs/directives/fapg/cfr0650a.htm.*

Federal Highway Administration. September 1996. *Community Impact Assessment - a Quick Reference for Transortation*. Community Impact Assessment: http://www.ciatrans.net/CIA_Quick_Reference/Purpose.html.

Federal Highway Administration. 15 April 1997. *US Department of Transportation Order5610.2 on Environmental Justice.* Federal Register Vol. 62, No. 72, 18377-18381: http://www.fhwa.dot.gov/environment/environmental_justice/facts/dot_ord.cfm.

Federal Highway Administration. 16 October 1997. 23 CFR 772: Procedure for Abatement of Highway Traffic Noise and Construction Noise. http://www.fhwa.dot.gov/legsregs/directives/fapg/cfr0772.htm.

Federal Highway Administration. 2 Deceber 1998. *FHWA Actions to Address Environmental Justice in Minority Populations and Low-Income Populations: 6640.23*. http://www.fhwa.dot.gov/legsregs/directives/orders/6640_23.htm.

Federal Highway Administration. 2001. 23 CFR 450: *Planning Assistance and Standards.* Legislation & Regulations: http://www.fhwa.dot.gov/hep/23cfr450.htm.

Federal Highway Administration. 2001. 23 CFR 771: *Environmental Impact and Related Procedures*. Legislation & Regulations: http://www.fhwa.dot.gov/hep/23cfr771.htm.

Federal Highway Administration. 2003. *Questions and Answers Regarding the Consideration of Indirect and Cumulative Impacts in the NEPA Process, Technical Advisory T 6640.8A.* Environmental Reivew Toolkit: http://www.environment.fhwa.dot.gov/guidebook/qaimpact.asp.

Federal Highway Administration. 2005. *First Amended Programmatic Agreement among the FHWA, Texas Department of Transportation, Texas State Historic Preservation Officer, Advisory Council on Historic Preservation Regarding the Implementation of Transportation Undertakings.*

Federal Highway Administration. 13 April 2007. *SAFETEA-LU: Safe Accountable Flexible Transportation Equity Act: A Legacy for Users*. http://www.fhwa.dot.gov/safetealu/.

Federal Highway Administration. 30 September 2009. *Interim Guidance Update on Mobile Source Air Toxic Analysis in NEPA.* Air Quality: Transportation & Toxic Air Pollutants: http://www.fhwa.dot.gov/environment/air_quality/air_toxics/policy_and_guidance/100109guidmem.cfm.

Federal Highway Administration. 7 July 2011. *A Methodology for Evaluating Mobile Source Air Toxic Emissions among Transportation Project Alternatives.* http://www.fhwa.dot.gov/environment/air_quality/air_toxics/research_and_analysis/mobile_source_air_toxics/msatemissions.pdf.

Fisher, W.L., et. al. 1972. Environmental Geologic Atlas of the Texas Coastal Zone: Galveston-Houston Area. Bureau of Economic Geology.

Forman, R., & Alexander, L. 1998. Roads and their Major Ecological Effects. *Annual Review of Ecology and Systematics 29*, 207-231.

Forman, R., Reineking, B., & Hersperger, A. 2002. Road Traffic and Nearby Grassland Bird Patterns in a Suburbanizing Landscape. In *Environmental Management* (pp. 782-800).

Gard, W. 2011. "Trinity River Navigation Projects", *Handbook of Texas Online.* http://www.tsha.utexas.edu/handbook/online/articles/TT/ett1.html.

Geib, H., Bushnell, T., & Bauer, A. 1928. *Soil Survey Map, Harris County, Texas.* U.S. Department of Agriculture: Bureau of Chemistry and Soils.

Gould, F.W., Hoffman, G.O., & Rechenthin, C.A. 1960. Vegetational areas of Texas in Texas Agricultural Experiment Station, Leaflet No. 492 (here modified by the Texas Parks and Wildlife Department). Texas A&M University, College Station, Texas.

Governor's Task Force on Evacuation, Transportation, and Logistics. 14 February 2006. *Final Report to the Governor.* http://www.txdps.state.tx.us/dem/documents/hurr/GovHurrTaskForceReport.pdf.

Grand Parkway Association. Grand Parkway Segments. Accessed in September of 2012. http://www.grandpky.com/segments/default.asp.

Grand Parkway Association. 2007. Typical Sections. http://www.grandpky.com/home/.

Grand Parkway Association. March 2011. Draft Environmental Impact Statement. SH 99: US 59 (N) to IH 10 (E): Montgomery, Harris, Liberty, and Chambers Counties, Texas. CSJs: 3510-07-003, 3510-08-001. 3510-09-001, 3510-09-002, 3510-10-001.

Grand Parkway Association. 2012. The Grand Parkway Association. www.grandpky.com.

Grand Parkway Association-GEC. 2012.

Grannis, W. 17, 18, and 22 May 2012. Email communication from W. Grannis, TxDOT ENV, to Sally Victor, HNTB Corporation.

H.R. 5518-102nd Congress: Department of Transportation and Related Agencies Appropriations Act, 1993. 1992. Library of Congress. http://thomas.loc.gov/cgi-bin/bdquery/z?d102:H.R.5518:.

Harris County Appraisal District. 2007. http://www.hcad.org/.

Harris County Flood Control District. 2010. *Tropical Storm Allison Recovery Project (TSARP).* http://www.hcfcd.org/tsarp.asp?flash=yes.

Harris County Office of Homeland Security and Emergency Management. 2006. Hurricane Evacuation Data. http://www.hcoem.org/.

Harris County Public Infrastructure Department: Architecture and Engineering Division. February 2007. *Harris County Parks.* Harris County GIS Map Library: http://www.eng.hctx.net/GIS/gis.htm#parks_shp.

Harris County Toll Road Authority. (n.d.). Harris County Toll Roads Non-Revenue Usage Policy. https://www.hctra.org/tollroads_rates. Accessed June 26, and https//www.hctra.org/about_forms/.

Harris-Galveston Subsidence District. 2009. http://www.hgsubsidence.org/.

Health Effects Institute. 2007. "Mobile-Source Air Toxics: A Critical Review of the Literature of Exposure and Health Effects." http://pubs.healtheffects.org/view.php?id=282.

Health Effects Institute. 2009. "Special Report 17." http://pubs.healtheffects.org/view.php?id=306

Henson, M.S. 2011. "Harris County, Texas." *Handbook of Texas Online.* http://www.tsha.utexas.edu/handbook/online/articles/HH/hch7.html.

Hoots, R. 2012. Pastor of East River Baptist Church, New Caney, Texas. Telephone Interview with Sally Victor, HNTB Corporation.

Hoover, J., Brittingham, M., & Goodrich, L. 1995. Effects of Patch Size on Nesting Success of Wood Thrushes. *Auk 112*, 146-155.

Houston Association of Realtors. 2012. Accessed on October 6, 2012. www.har.com.

Houston-Galveston Area Council. 1997. Operational Congestion Management System.

Houston-Galveston Area Council. 11 April 2007. *2035 Regional Bikeway Plan.* http://2035plan.org/docs/DraftRegionalBikewayPlan.pdf.

Houston-Galveston Area Council. October 2008. *GIS Data: High-Resolution Areial Photography.* Areial Imagery: http://www.h-gac.com/rds/gis_data/aerial/default.aspx.

Houston-Galveston Area Council. April 2009. *Regional Cumulative and Indirect Effect of Toll Facilities*

Houston-Galveston Area Council. October 2009. *GIS Data: High-Resolution Areial Photography.* Areial Imagery: http://www.h-gac.com/rds/gis_data/aerial/default.aspx.

Houston-Galveston Area Council. 2009. *Envision Houston Region.* http://2035plan.org/docs/final/Appendix%20A-Envision%20Houston%20Region%20Flyer.pdf.

Houston-Galveston Area Council. October 2010. *GIS Data: High-Resolution Areial Photography.* Areial Imagery: http://www.h-gac.com/rds/gis_data/aerial/default.aspx.

Houston-Galveston Area Council. 25 January 2011. *2035 Regional Transportation Plan Update.* http://www.h-gac.com/taq/plan/2035_rtp.aspx.

Houston-Galveston Area Council. 2012. *2035 Regional Growth Forecast.* http://www.h-gac.com/NR/rdonlyres/eb2rbxr4n4wn7xgjmqw5bsth5vkpwktq4gpy4grstbvb76oknvvbz2qkw2vrvrulk5qjbhw6j55zpqdb3ikyubdoacb/2035RGF.pdf.

Houston-Galveston Area Council. 2012. EMME/2 *Travel Demand Model.*

Houston-Galveston Area Council. 2012. *Hurricane Evacuation Routes Map.* Hurricane Evacuation Planning: http://www.h-gac.com/taq/hurricane/default.aspx.

Houston-Galveston Area Council. 27 April 2012. *2013-2016 Transportation Improvement Program.* Transportation Improvement Program: http://www.h-gac.com/taq/tip/docs/H-GAC_2013-2016%20TIP-As_Adopted-04-27-2012.pdf.

Houston-Galveston Area Council. 2013. EJ Toll Analysis Summary – SH 99 HI1. June 2013.

Houston-Galveston Area Evacuation and Response Task Force. 2006. *Recommendations Report.*

Hunt, P. 1996. Habitat Selection by American Redstarts along a Successional Gradient in Northern Hardwood Forests: Evaluation of Habitat Quality. *Auk 113*, 875-888.

Jackson, A. 2012. Member of East River Baptist Church, New Caney, Texas and relative of the Casey and Willaby families. Telephone Interview with Sally Victor, HNTB Corporation.

Keller, M., & Anderson, S. 1992. Avian Use of Habitat Configurations Created by Forest Cutting in Southeastern Wyoming. *Condor 94*, 55-65.

Kleiner, D.J. 2011. "Chambers County, Texas." *Handbook of Texas Online*. http://www.tsha.utexas.edu/handbook/online/articles/BB/hgb3.html.

Kleiner, D.J. 2011. "Lake Houston State Park", *Handbook of Texas Online*. http://www.tsha.utexas.edu/handbook/online/articles/LL/ro142.html.

Kleiner, D. J. 2011. "Liberty County, Texas", *Handbook of Texas Online*. http://www.tsha.utexas.edu/handbook/online/articles/LL/hcl8.html.

Kline, N., & Swan, D. 1998. *Quantifying Wildlife Road Mortality in Saguaro National Park.* International Conference on Wildlife Ecology and Transportation.

Kotliar, N., & Wiens, J. 1990. Multiple Scales of Patchiness and Patch Structure: a Hierarchical Framework for the Study of Heterogeneity. *Oikos 59*, 253-260.

Liberty County Appraisal District. 2007. http://clientdb.trueautomation.com/clientdb/main.asp?id=41.

Lindell, M., & Prater, C. 2008. *Behavioral Analysis: Texas Hurricane Evacuation Study.* College Station, Texas: Texas A&M University Hazard Reduction & Recovery Center.

Long, C. 2011. "Montgomery, County, Texas", *Handbook of Texas Online.* http://www.tshaonline.org/handbook/online/articles/hcm17.

LoopNet. 2012. *Commerical Real Estate Listings and Research*. http://www.loopnet.com.

Magnuson-Stevens Fishery Conservation and Management Act. PL 94-265, 1966. www.nmfs.noaa.gov/sfa/magact.

McMahan, C., Frye, R., & Brown, K. 1984. *The Vegetation Types of Texas Including Cropland.* Austin, Texas: Texas Parks and Wildlife Department.

Metropolitan Transit Authority of Harris County, Houston, Texas. June 2005. *METRO 2025 Solutions Transit Plan.*

Metropolitan Transit Authority of Harris County, Houston, Texas. September 2009. *METRO 2035 Long Range Plan.*

Montgomery County Appraisal District. 2007. http://www.mcad-tx.org.

Mumme, R., Schoech, S., Woolfenden, G., & Fitzpatrick, J. 2000. Life and Death in the Fast Lane: Demographic Consequences of Road Mortality in the Florida Scrub-Jay. *Conservation Biology 14*, 501-512.

National Oceanic and Atmospheric Administration. 1929. *National Geodetic Vertical Datum.*

National Oceanic and Atmospheric Administration. 27 October 1972. *16 USC 1451-1464 - Coastal Zone Management Act of 1972.* http://coastalmanagement.noaa.gov/czm/czm_act.html

National Oceanic and Atmospheric Administration. 1996. *Ocean and Coastal Management Program in Texas.* http://coastalmanagement.noaa.gov/mystate/tx.html.

National Oceanic and Atmospheric Administration. 2009. *Essential Fish Habitat Mapper.* http://www.habitat.noaa.gov/protection/efh/habitatmapper.html.

National Oceanic and Atmospheric Administration. *National Climate Data Center.* http://www.noaa.gov/climate.html.

National Park Service. 36 CFR 60: National Register of Historic Places. http://www.law.cornell.edu/cfr/text/36/60.

National Park Service. 36 CFR 61: Procedures for State, Tribal, and Local Government Historic Preservation Programs. http://www.law.cornell.edu/cfr/text/36/61.

National Park Service. 23 November 2004. *Nationwide Rivers Inventory, Texas Segments.* http://www.nps.gov/ncrc/programs/rtca/nri/states/tx.html.

National Wild and Scenic Rivers System. January 2007. *River Mileage Classifications for Components of the National Wild and Scenic Rivers System.* http://www.rivers.gov/publications/rivers-table.pdf.

Natural Resources Conservation Service. 1972. *Soil Survey of Montgomery County, Texas.*

Natural Resources Conservation Service. 1976. *Soil Survey of Chambers County, Texas.*

Natural Resources Conservation Service. 1976. *Soil Survey of Harris County, Texas.*

Natural Resources Conservation Service. 1981. *7 USC 23, Section 4201 - Farmland Protection Policy Act of 1981.* http://www.usda.gov/wps/portal/usda/usdahome.

Natural Resources Conservation Service. January 1991. *Farmland Conversion Impact Rating for Corridor Type Projects.* NRCS-CPA-106: http://www.tn.nrcs.usda.gov/technical/soils/CPA106.pdf.

Natural Resources Conservation Service. 1996. *Soil Survey of Liberty County, Texas.*

Natural Resources Conservation Service. 2001. *National Land Cover Data.* Land Cover Institute: http://www.mrlc.gov.

Natural Resources Conservation Service. 2005. *Prime Farmland Soils Data.* Natural Resources Conservation Service Soil Data Mart: http://soildatamart.nrcs.usda.gov/.

Natural Resources Conservation Service. 2012. *National Soil Survey Center.* http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/nssc.

Natural Resources Conservation Service. National Technical Committee for Hydric Soils (NTCHS). http://soils.usda.gov/use/hydric/ntchs/.

Natural Resources Defense Council v. EPA. 07-1053. U.S. Court of Appeals, D.C. Circuit. June 2008.

Pan Technica Corporation. 2006. *Barber Hill Cavern Stability Study, City of Mont Belvieu, Texas.* http://www.pantechnica.com/company/projects/barbers-hill.htm.

Patterson, L.W. 1979 *A Review of the Prehistory of the Upper Texas Coast*. Bulletin of the Texas Archeological Society 50:103–24.

Population and Survey Analysts. 2006. *Crosby Independent School District Demopraphic Update.*

Pressler, C., & Langermann, A. 1879. *Pocket map of the State of Texas.*

Railroad Commission of Texas. 2012. *Public GIS Map Viewer for Oil, Gas, and Pipeline Data.* http://www.rrc.state.tx.us/data/online/gis/index.php.

Roberts, C., & Norment, C. 1999. Effects of Plot Size and Habitat Charateristics on Breeding Success of Scarlet Tanagers. *Auk 116*, 73-82.

Romin, L., & Bissonette, J. 1996. Deer-Vehicle Collisions; Status of State Monitoring Activities and Mitigation Efforts. *Wildlife Society Bulletin 24*, 276-283.

Sanborn Fire Insurance Company. 1927. *Sanborn Fire Insurance Maps for Dayton, Texas 1927.*

Sanborn Fire Insurance Company. 1943. *Sanborn Fire Insurance Maps for Dayton, Texas 1943.*

Sarnoff, N. 10 August 2007. Investing with Patience: Former Houston Rocket Hakeen Olajuwon Buys Land along 1-10 East and Will Sell it to Developers...When the Time is Right. *Houston Chronicle*, p. D:1.

Schwabe, K., & Schuhmann, P. 2002. Deer-Vehicle Collion and Deer Value: an Analysis of Competing Literatures. *Wildlife Society Bulletin 30*, 609-615.

Secretary of the Interior. 29 September 1983. *Archeology and Historic Preservation: Standards and Guidelines.* http://www.nps.gov/history/local-law/arch_stnds_0.htm.

Solid Waste Agency of Northern Cook County vs. United States Army Corps of Engineers, et. al. Certiori to the US Seventh Circuit Court of Appeals, 99-1178 (Supreme Court of the United States January 9, 2001).

Spearing, D. 1991. *Roadside Geology of Texas.* Mountain P Company.

Statistical Policy Directive 14, issued by the Office of Management and Budget.

Stein, R., & et. al. 12 March 2009. *A Comparison of the Experiences of Harris County Residents during Hurricane Rita and Ike.* Rice University: http://www.media.rice.edu/images/media/0312_CCE_HurricaneIke_report.pdf.

Story, D.A. 1990 Cultural History of the Native Americans. In *The Archaeology and Bioarchaeology of the Gulf Coastal Plain*, vol. 1, by Story, D.A., J.A. Guy, B.A. Burnett, M.D. Freeman, J.C. Rose, D.G. Steele, B.W. Olive, and K.J. Reinhard, pp. 163–366. Research Series No. 38. Arkansas Archaeological Survey, Fayetteville, Arkansas.

Texas Administrative Code, Title 43, Part 1, Chapter 11, Subchapter D: Green Ribbon Projects. http://info.sos.state.tx.us/pls/pub/readtac$ext.ViewTAC?tac_view=5&ti=43&pt=1&ch=11&sch=D&rl=Y.

Texas Commission on Environmental Quality. 2006. *Houston-Galveston-Brazoria Air Monitor Summary.* http://www.tceq.state.tx.us/cgi-bin/compliance/monops/monitors.pl?12.

Texas Commission on Environmental Quality. 2007. Water Well Report Review. http://www.tceq.texas.gov/gis/waterwellview.html.

Texas Commission on Environmental Quality. 2010. 30 TAC *307: Texas Surface Water Quality Standards.* http://info.sos.state.tx.us/pls/pub/readtac$ext.ViewTAC?tac_view=4&ti=30&pt=1&ch=307&rl=Y.

Texas Commission on Environmental Quality. 2010. *Houston-Galveston-Brazoria 8-Hour Ozone Nonattainment Area.* http://www.tceq.state.tx.us/implementation/air/sip/hgb.html.

Texas Commission on Environmental Quality. 2010. *2010 Texas Water Quality Inventory and 303(d) List.*

Texas Commission on Environmental Quality. 2012. *Cox Road Dump Site.* Index of Superfund Sites in Texas: http://www.tceq.state.tx.us/remediation/superfund/state/coxroad.html.

Texas Commission on Environmental Quality. 2012. *TPDES Permit.* http://www.tceq.texas.gov/permitting/wastewater/pretreatment/nonapproved_programs_goals.html.

Texas Comptroller. 2010. *Texas Emissions Reduction Plan*. TCEQ. http://www.tceq.texas.gov/airquality/terp.

Texas Department of Agriculture. 2010. List of Family Land Heritage properties, 1974-2010. http://www.agr.state.tx.us/agr/program_render/0,1987,1848_5409_0_0,00.html?channelId=5409.

Texas Department of Licensing and Regulation. 2007. *Well Construction and Plugging Specifications.* http://www.license.state.tx.us/wwd/wwdspecs.htm.

Texas Department of Transportation. June 1993. Environmental Overview: Grand Parkway (SH 99): Third Outer Loop around the City of Houston: Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, and Montgomery Counties. http://www.grandpky.com/downloads/General/Grand%20Parkway%20SH%2099%20Env%20Overview.pdf.

Texas Department of Transportation. 2001. Transportation Planning Manual.

Texas Department of Transportation. July 2001. Memorandum on Purpose and Need Guidance.

Texas Department of Transportation. 2002. Storm Water Management Guidelines for Construction Activities. Revised July 2002. http://ftp.dot.state.tx.us/pub/txdot-info/library/pubs/bus/storm_water/1introtoc.pdf.

Texas Department of Transportation. 2004. Item 164: Seeding for Erosion Control. *Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges*, 103-115.

Texas Department of Transportation. 23 August 2004. Environmental Manual. Chapter 5, Section 2: State Historic Preservation Officer. "Historic Resources 50 Years of Age or Older Found within the Project Area." http://onlinemanuals.txdot.gov/txdotmanuals/env/state_historic_preservation_officer_thcshpo.htm#i1004471.

Texas Department of Transportation. 2006. *The Texas Historic Overlay*. Prepared for Texas Department of Transportation Environmental Affairs Division by PBS&J.

Texas Department of Transportation. 2006. *Guidance on Preparing Indirect and Cumulative Impact Analyses.*

Texas Department of Transportation. April 2006. Historic Resources Reconnaissance Survey SH 146: from US 90 in Dayton, Texas to the Chambers County Line, Liberty County, Texas. (TxDOT CSJ# 0389-01-036) Prepared by ECOMM.

Texas Department of Transportation. 3 April 2006. *Hazardous Materials in Project Development Guidance Document (TxDOT Draft 8/99).* http://www.dot.state.tx.us/env/hazmatprojguide.htm.

Texas Department of Transportation. September 2006. Intensive-Level Historic Resources Survey Report, Dayton Canal along SH 146 Liberty County, Texas. (WA No. 574 21 SH001), Prepared by Hardy Heck Moore.

Texas Department of Transportation. 8 September 2006. (2006f). Draft Historic Resources Section 106 Review and NEPA Guide.

Texas Department of Transportation. 11 July 2007. *MOA between Texas Department of Transportation & Texas Parks and Wildlife Department for Finalization of 1998 MOU Concerning Habitat Descriptions and Mitigation.* http://www.dot.state.tx.us/publications/environmental_affairs/habitat_desc_mitigation.pdf.

Texas Department of Transportation. 2008. Historic Resources Preliminary Survey of Grand Parkway Segments H and I-1, From US 59 to I-10E, Chambers, Harris, Liberty, and Montgomery Counties, Texas. Prepared by HNTB Corporation.

Texas Department of Transportation. September 2010. Revised *Guidance on Preparing Indirect and Cumulative Impact Analyses. ftp://ftp.dot.state.tx.us/pub/txdot-info/env/impact_analyses.pdf.*

Texas Department of Transportation. 2010. *Roadway Design Manaual, Revised May 2010.* http://onlinemanuals.txdot.gov/txdotmanuals/rdw/rdw.pdf.

Texas Department of Transportation. 2011. *Air Quality Guidelines Addenum.* https://ftp.dot.state.tx.us/pub/txdot-info/library/pubs/env/air/aq_guidelines_100311.pdf.

Texas Department of Transportation. 2011. Crash Records Information System. 2008-2010.

Texas Department of Transportation. 2011. *Guidelines for Analysis and Abatement of Roadway Traffic Noise.* http://ftp.dot.state.tx.us/pub/txdot-info/library/pubs/bus/env/traffic_noise.pdf.

Texas Department of Transportation. 2011. *Texas Motor Vehicle Crash Statistics - 2011.* http://www.txdot.gov/txdot_library/drivers_vehicles/publications/crash_statistics/default.htm.

Texas Department of Transportation. 26 October 2012 . Project Development Process Manual. Chapter 3 Section 3: Environmental Documentation. http://onlinemanuals.txdot.gov/txdotmanuals/pdp/environmental_documentation.htm.

Texas Department of Transportation. March 2013. Draft Non-Archeological Historic Age Resources Survey: Grand Parkway Segments H and I-1: SH 99: US 59 (N) to IH 10 (E). Prepared by HNTB Corporation.

Texas Economic Department and Tourism. 2009. *Overview of the Texas Economy.* Office of the Governor: http://www.governor.state.tx.us/divisions/ecodev/bidc/overview/index_html/view.

Texas Education Agency. 2012. *5 Years at a Glance Reports.* http://loving1.tea.state.tx.us/lonestar/selectdist.aspx?level=district.

Texas General Land Office. 2000. *Watersheds.* http://www.glo.state.tx.us/gisdata/gisdata.html.

Texas Historical Commission. 1 September 1997. *Antiquities Code of Texas as Amended.* http://www.thc.state.tx.us/rulesregs/RulesRegsPDF/AntiqCode.pdf.

Texas Historical Commission. 14 November 2006. Section 106 Determination of concurrence Correspondence. Adrienne Campbell, SHPO.

Texas Historical Commission. 2011. Historic Sites Atlas. http://www.atlas.thc.state.tx.us.

Texas Historical Commission. 2011. *Texas Archeological Sites Atlas.* http://www.atlas.thc.state.tx.us.

Texas Historical Commission. 2012. *Texas Archeological Research Laboratory.* http://www.utexas.edu/research/tarl/records/texsite.php.

Texas Parks and Wildlife Department. 1975. *Title 5 Chapter 68 - Endangered Species.* http://www.statutes.legis.state.tx.us/Docs/PW/htm/PW.68.htm.

Texas Parks and Wildlife Department. 1981. *Title 5 Chapter 88 - Endangered Plants.* http://www.statutes.legis.state.tx.us/Docs/PW/pdf/PW.88.pdf.

Texas Parks and Wildlife Department. 1984. *Vegetation Types of Texas.* http://www.tpwd.state.tx.us/publications/pwdpubs/pwd_bn_w7000_0120/.

Texas Parks and Wildlife. January 2004. *A List of the Rare Plants of Texas.* Wildlife Diversity Program: http://www.nature.org/wherewework/northamerica/states/texas/files/listofrareplants.pdf.

Texas Parks and Wildlife Department. July 2005. *East Texas Black Bear Conservation and Management Plan 2005-2015.* http://www.tpwd.state.tx.us/publications/pwdpubs/media/pwd_pl_w7000_1046.pdf.

Texas Parks and Wildlife Department. February 2013. *Bald Eagle (Haliaeetus leucocephalus).* http://www.tpwd.state.tx.us/huntwild/wild/species/baldeagle.

Texas Parks and Wildlife Department. February 2013. *The Texas Natural Diversity Database.* http://www.tpwd.state.tx.us/huntwild/wild/wildlife_diversity/txndd/.

Texas State Highway Department. 1882. *Chambers County, Texas General Highway Map.* http://www.tsl.state.ts.us.

Texas State Highway Department. 1939. *Harris County, Texas General Highway Map.* http://www.tsl.state.ts.us.

Texas State Highway Department. 1940. *Chambers County, Texas General Highway Map.* http://www.tsl.state.ts.us.

Texas State Highway Department. 1940. *Liberty County, Tezxas General Highway Map.* http://www.tsl.state.ts.us.

Texas State Highway Department. 1960. *Chambers County, Texas General Highway Map.* http://www.tsl.state.ts.us.

Texas State Highway Department. 1961. *Liberty County, Texas General Highway Map.* http://www.tsl.state.ts.us.

Texas State Historical Association. Handbook of Texas Online: http://www.tsha.utexas.edu/handbook/online.

Texas Transportation Code. Title 7. Subtitle C. Rules of the Road. Chapter 545: Operation and Movement of Vehicles. http://www.statutes.legis.state.tx.us/Docs/TN/htm/TN.545.htm

Texas Transportation Commission. April 2003. *Minute Order 109226.* Austin, Texas.

Texas Water Development Board. 2006. *TWDB Data.* http://www.twdb.state.tx.us/data/data.asp.

Texas Water Development Board. 2010. *Texas Natural Resources Information System (TNRIS)*. http://www.tnris.org/.

Texas Workforce Commission. 2012. SOCRATES. *County Narrative Report, Chambers, Harris, Liberty, and Montgomery Counties*. http://socrates.cdr.state.tx.us.

Thoms, R., & Gehle, R. 2000. *A Brief History of Salt Cavern Use.* College Station, Texas: AGM, Inc.

Transportation Research Board. 1999. National research on controlled-access facility crash rates. (Chapter 1 – 1.3.3).

Transportation Research Board. 2000. *Highway Capacity Manual.* Washington, D.C.

Transportation Research Board. 2002. *National Cooperative Highway Research Program Report 466: Desk Reference for Estimating the Indirect Effect of Proposed Transportation Projects.* Washington, D.C.

Transportation Research Board. December 2007. NCHRP *Report 25-25, Task 22*: *Forecasting Indirect Land Use Effects of Transportation Projects. http://onlinepubs.trb.org/onlinepubs/archive/NotesDocs/25-25(22)_FR.pdf*.

Transportation Research Board. 2012. *Glossary of Regional Transportation Systems Management and Operations Terms.* Transportation Research Circular Number E-C166. Accessed on February 22, 2013. http://onlinepubs.trb.org/onlinepubs/circulars/ec166.pdf.

U.S. Department of Transportation. 1979. *Floodplain Management and Protection, 5650.2.*

U.S. Fish and Wildlife Service. 2001. *Endangered Species List.* http://www.fws.gov/southwest/es/EndangeredSpecies/lists.

U.S. Fish and Wildlife Service. 2004. *National Wetlands Inventory (NWI).* http://wetlandsfws.er.usgs.gov/NWI/.

U.S. Army Corps of Engineers & Federal Emergency Mangement Agency. 2004. *Hurricane Evacuation Study: Galveston Region Transportation Analysis.* http://www.iwr.usace.army.mil/nhp/HESfacts.cfml?pgid=97.

U.S. Army Corps of Engineers. 1987. *Wetland Delineation Manual.* The Wetlands Regulation Center: http://www.wetlands.com/regs/tlpge02e.htm.

U.S. Army Corps of Engineers. 15 January 2002. Issuance of Nationwide Permits; Notice. Federal Register Vol. 67 No.10. http://www.gpo.gov/fdsys/pkg/FR-2002-01-15/pdf/FR-2002-01-15.pdf.

U.S. Army Corps of Engineers. 2006. *Section 404(b)(1) Guidelines for Specification of Disposal Sites for Dredged or Fill Material, 40 CFR 230.*

U.S. Army Corps of Engineers. 2010. *Galveston District*. http://www.swg.usace.army.mil/.

U.S. Army Corps of Engineers. 2013. Regulatory In-lieu Fee and Bank Information Tracking System. https://rsgisias.crrel.usace.army.mil/ribits/f?p=107:2:1979516728927772::NO:RP:P27_BUTTON_KEY:9.

U.S. Census Bureau. 2010. *2006-2010 American Community Survey, Tables B08301, B08303, B19013, B19001, B17001, and B16004.*

U.S. Census Bureau. 2010. *2010 Census, SF1 P1, P9, P12, P13, P17, P19, H1, H3, H4, H5: SF3 P6, P7, P41, P53, and P87.*

U.S. Census Bureau. 2012. *2007-2011 American Community Survey.* http://www.census.gov/acs/www/data_documentation/geography/.

U.S. Census Bureau. State and County Quickfacts: Chambers County Texas. http://quickfacts.census.gov/qfd/states/48/48071.html

U.S. Census Bureau. State and County Quickfacts: Harris County Texas. http://quickfacts.census.gov/qfd/states/48/48201.html

U.S. Census Bureau. State and County Quickfacts: Liberty County Texas. http://quickfacts.census.gov/qfd/states/48/48291.html

U.S. Census Bureau. State and County Quickfacts: Montgomery County Texas. http://quickfacts.census.gov/qfd/states/48/48339.html

U.S. Coast Guard. 2 August 1946. United States Code. Title 33. Sections 525. General Bridge Act. http://www.uscg.mil/hq/cg5/cg551/Regulation.asp.

U.S. Coast Guard. 20 June 2012. *Introduction to Coast Gaurd Bridge Permitting*. Office of Bridge Programs: Bridge Permit Application Process: http://www.uscg.mil/hq/cg5/cg551/INTRODUCTION%20TO%20COAST%20GUARD%20BRIDGE%20PERMITTING.pdf.

U.S. Department of Agriculture. 1922. Soil Map of Harris County, Texas.

U.S. Department of Heath and Human Services. 2013. *The 2013 HHS Poverty Guidelines.* Retrieved from http://aspe.hhs.gov/poverty/12poverty.shtml

U.S. Department of Labor. 1964. *Title VI, Civil Rights Act of 1964.* http://www.dol.gov/oasam/regs/statutes/titlevi.htm.

U.S. Fish and Wildlife Service Wetland Designation System.

U.S. Fish and Wildlife Service. 1918. *16 USC 590 - Migratory Bird Treaty Act of 1918.* http://www.fws.gov/laws/lawsdigest/migtrea.html.

U.S. Fish and Wildlife Service. 1940. *16 USC 668-668c - Bald and Golden Eagle Protection Act of 1940.* http://www.fws.gov/midwest/eagle/guidelines/bgepa.html.

U.S. Fish and Wildlife Service. 2 October 1968. *16 USC 1271-1287 - Wild and Scenic Rivers Act.* http://www.fws.gov/laws/lawsdigest/WILDRIV.HTML.

U.S. Fish and Wildlife Service. 1973. *Endangered Species Act of 1973.* http://www.nmfs.noaa.gov/pr/pdfs/laws/esa.pdf.

U.S. Fish and Wildlife. 18 October 1982. *16 USC 3501 st. Seq. - Coastal Barrier Resources Act.* http://www.fws.gov/laws/lawsdigest/COASBAR.HTML.

U.S. Fish and Wildlife Service. 2012. *Southwest Region 2.* http://www.fws.gov/southwest/.

U.S. Geological Survey. 1959. Montgomery County, Texas. TxDOT *Texas Historic Overlay*.

U.S. Geological Survey. 1969. Mont Belvieu, Texas. TxDOT *Texas Historic Overlay*.

U.S. Geological Survey. 1982. (1982a). 7.5 Minute Topographic Map, Crosby Quadrangle.

U.S. Geological Survey. 1982. (1982b). Topographic Map, Crosby Quadrangle.

U.S. Geological Survey. 1982. 7.5 Minute Topographic Map, Highlands Quadrangle.

U.S. Geological Survey. 1984 7.5 Minute Topographic Map, Liberty Quadrangle.

U.S. Geological Survey. 1993. Topographic Map, Cove Quadrangle.

U.S. Geological Survey. 1993. 7.5 Minute Topographic Map, Cove Quadrangle.

U.S. Geological Survey. 1993. 7.5 Minute Topographic Map, Dayton Quadrangle.

U.S. Geological Survey. 1993. 7.5 Minute Topographic Map, Sheeks Quadrangle.

U.S. Geological Survey. 1993. 7.5 Minute Topographic Map, Moss Bluff Quadrangle.

U.S. Geological Survey. 1994. 7.5 Minute Topographic Map, Mont Belvieu Quadrangle.

U.S. Geological Survey. 2002. http://www.usgs.gov.

U.S. National Archives and Records Administration. 1986. Code of Federal Regulations. Title 33. Chapter 328: *Navigation and Navigable Waters.* http://www.archives.gov/federal-register/cfr/subject-title-33.html.

U.S. National Archives and Records Administration. 2012. 49 CFR Transportation Subchapter B. Electronic Code of Federal Regulations: http://www.ecfr.gov/cgi-bin/text-idx?c=ecfr&tpl=/ecfrbrowse/Title49/49tab_02.tpl.

University of Texas Bureau of Economic Geology. 1992. *Geologic Atlas of Texas, Beaumont and Houston Sheets.*

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