Dallas to Houston High-Speed Rail

Draft Environmental Impact Statement

December 2017

Prepared by the Federal Railroad Administration

Federal Railroad Administration

Dallas to Houston High-Speed Rail

Draft Environmental Impact Statement

Prepared by:

USDOT Federal Railroad Administration
1200 New Jersey Avenue SE MS-20
Washington, DC 20590
Contact: Mr. Kevin Wright
202-493-0845

AECOM
1950 North Stemmons Freeway, Suite 6000
Dallas, TX 75207
Contact: Mr. Jerry Smiley, AICP
214-672-2842

Cooperating Agencies:

U.S. Army Corps of Engineers, Fort Worth District
819 Taylor Street, Room 3A47
Fort Worth, TX 76102
Contact: Mr. Darvin Messer
817-886-1744

U.S. Army Corps of Engineers, Galveston District
2000 Fort Point Road
Galveston, TX 77553-1229
Contact: Ms. Felicity Dodson
409-766-3105

Environmental Protection Agency, Region 6
1445 Ross Avenue
Dallas, TX 75202
Contact: Mr. Michael Jansky
214-665-7451

U.S. Fish and Wildlife Service
10711 Burnet Road, Suite 200
Austin, TX 78758
Contact: Mr. Adam Zerrenner
512-490-0057

Federal Highway Administration
300 East 8th Street, Room 826
Austin, Texas 78701
Contact: Ms. Barbara Maley
512-536-5900

Federal Transit Administration, Region 6
819 Taylor Street, Room 8A36
Fort Worth, TX 76102
Contact: Ms. Gail Lyssy, P.E.
817-978-0564

Surface Transportation Board
395 E Street SW
Washington, DC 20423
Contact: Ms. Victoria Rutson
202-245-0294

Dallas to Houston High-Speed Rail Draft Environmental Impact Statement
Washington, DC.

Dallas to Houston High-Speed Rail

Draft Environmental Impact Statement

Pursuant to:

National Environmental Policy Act (42 U.S.C. § 4332 et seq.), and implementing regulations (40 C.F.R. Parts 1500-1508), 64 FR 28545, 23 C.F.R. § 771, 49 U.S.C. § 303 (formerly Department of Transportation Act of 1966, Section 4(f); National Historic Preservation Act (16 U.S.C. § 470); Clean Air Act as amended (42 U.S.C. § 7401 et seq. and 40 C.F.R. Parts 51 and 93); the Endangered Species Act of 1973 (16 U.S.C. § 1531-1544); the Clean Water Act (33 U.S.C. § 1251-1387; and the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, as amended (42 U.S.C. § 3601).

The Federal Railroad Administration (FRA) will issue a single document that consists of the Final Environmental Impact Statement and Record of Decision pursuant to Pub. L. 112-141, 126 Stat. 405, Section 1319(b) unless FRA determines statutory criteria or practicability considerations preclude issuance of such a combined document.

Prepared by the:

U.S. Department of Transportation
Federal Railroad Administration

In Cooperation with:

U.S. Army Corps of Engineers, Fort Worth District
U.S. Army Corps of Engineers, Galveston District
Environmental Protection Agency, Region 6
Federal Highway Administration
Federal Transit Administration, Region 6
Surface Transportation Board
U.S. Fish and Wildlife Service

Paul Nissenbaum

Paul Nissenbaum, Associate Administrator
Office of Railroad Policy and Development
Federal Railroad Administration
U.S. Department of Transportation

Date: 12/15/17

The following individuals may be contacted for additional questions concerning this document:

Mr. Michael Johnson
Federal Railroad Administration
1200 New Jersey Avenue SE MS-20
Washington, DC 20590
202-493-1310

Mr. Kevin Wright
Federal Railroad Administration
1200 New Jersey Avenue SE MS-20
Washington, DC 20590
202-493-0845

Abstract: This document considers, describes and summarizes the environmental impacts of the Dallas to Houston High Speed Rail (HSR) Project proposed by Texas Central Railroad (TCRR). This 240-mile Project would implement a high-speed passenger rail system using the N700 Tokaido Shinkansen bullet train system to achieve an approximate 90-minute travel time between Dallas and Houston, with achievable speeds exceeding 200 miles per hour (mph) and in a fully sealed rail corridor.

FRA has jurisdiction over every area of railroad safety and is authorized to prescribe regulations and issue orders as necessary for railroad safety. Current FRA regulations do not comprehensively address safety requirements for train operations above 150 mph, such as the Project's proposed operations. Therefore, FRA may issue a Rule of Particular Applicability (regulations that apply to a specific railroad or a specific type of operation (RPA)), impose requirements or conditions by order(s) or waiver(s), or take other regulatory action(s) to ensure the Project is operated safely. This regulatory action(s) constitutes a federal action and triggers the environmental review under the National Environmental Policy Act (NEPA).

This document evaluates a No Build Alternative and six Build Alternatives. Potential environmental impacts of the Build Alternatives include displacement of commercial, residential and agricultural properties; community and neighborhood disruption; increase in noise; increase in traffic at each of the stations; impacts on historic and archaeological sites; impacts on park and recreational resources; visual impacts; impacts on sensitive biological resources and wetlands; and use of energy. Mitigation measures are proposed to address impacts identified in the Draft EIS. This Dallas to Houston HSR Project EIS is being made available to the public in accordance with NEPA. Visit the Federal Railroad Administration website (https://www.fra.dot.gov/Page/P0700), where you can:

- View and download the Draft EIS
- Provide comments on the Draft EIS
- Find information on dates and locations of Draft EIS public information hearings
- Locate a library near you to review a hard copy of the Draft EIS.

The comment period begins on Friday, December 22, 2017 and will close on Tuesday, February 20, 2018. Comments may be mailed to Kevin Wright at FRA or submitted through the FRA website.

Printed copies have been provided at a number of repositories throughout the Project area, including at main libraries in the following cities and communities:

Dallas County
J. Erik Jonsson Central Library: 1515 Young Street, Dallas, Texas 75201
(214) 670-1400

Martin Luther King Branch Library: 2922 Martin Luther King Jr. Boulevard, Dallas, Texas 75215
(214) 670-0344

Paul Laurence Dunbar Lancaster-Kiest Branch Library: 2008 E Kiest Boulevard, Dallas, Texas 75216
(214) 670-1952

Pleasant Grove Branch Library: 7310 Lake June Road, Dallas, Texas 75217
(214) 670-0965

Ellis County
Ennis Public Library Central Library: 501 W Ennis Avenue, Ennis, Texas 75119
(972) 875-5360

Navarro County
Corsicana Library: 100 N 12th Street, Corsicana, Texas 75110
(903) 645-4810

Freestone County
Teague Public Library Central Library: 400 Main Street, Teague, Texas 75860
(254) 739-3311

Limestone County
Gibbs Memorial Library Central Library: 305 E Rusk Street, Mexia, Texas 76667
(254) 562-3231

Leon County
Buffalo Public Library: 1005 Hill Street, Buffalo, Texas 75831
(903) 322-4146

Madison County
Madison County Library: 605 S May Street, Madisonville, Texas 77864
(936) 348-6118

Grimes County
Navasota Public Library Central Library: 1411 E Washington Avenue, Navasota, Texas 77868
(936) 825-6744

Waller County
Waller County Library Central Library: 2331 11th Street, Hempstead, Texas 77445
(979) 826-7658

Harris County
Fairbanks Library: 7122 Gessner Road, Houston, Texas 77040
(713) 466-4438

Houston Public Library: 500 McKinney Street, Houston, Texas 77002
(832) 393-1313

Northwest Branch Library: 11355 Regency Green Drive, Cypress, Texas 77429
(281) 890-2665

Spring Branch Memorial Library: 930 Corbindale Road, Houston, Texas 77024
(713) 464-1633

This page intentionally left blank.

ES.0 EXECUTIVE SUMMARY

ES.1 Introduction

The United States Department of Transportation's (DOT) Federal Railroad Administration (FRA) is preparing this Environmental Impact Statement (EIS) in compliance with the National Environmental Policy Act (NEPA) (42 U.S.C. § 4231 et seq) to assess the potential beneficial and detrimental effects of implementing the proposed Dallas to Houston High-Speed Rail Project (Project). This EIS documents FRA's evaluation of Texas Central High-Speed Railway's, LLC (TCR) and its affiliates' proposal to construct and operate a 240-mile, for-profit, high-speed passenger rail (HSR) system connecting Dallas and Houston using the Japanese N700 Tokaido Shinkansen technology.

FRA initiated this EIS to evaluate and document the possible environmental impacts of the Project as required by NEPA, Council on Environmental Quality (CEQ) NEPA regulations (40 Code of Federal Regulations (C.F.R.) Parts 1500-1508), and the FRA's *Procedures for Considering Environmental Impacts* (64 Fed. Reg. 28545 (1999)). FRA is the lead agency for the preparation of this EIS, in cooperation with Environmental Protection Agency (EPA), Federal Highway Administration (FHWA), United States Army Corps of Engineers (USACE), Federal Transit Administration (FTA), the Surface Transportation Board (STB) and United States Fish and Wildlife Service (USFWS). The Texas Department of Transportation (TxDOT) provided technical assistance to FRA in the preparation of the EIS. Other federal, state and local agency stakeholders directly involved in implementation of the Project include a wide range of entities that FRA identified and coordinated with during the NEPA process.

FRA has jurisdiction over every area of railroad safety and is authorized to prescribe regulations and issue orders as necessary for railroad safety (49 U.S.C. § 20101 et seq.; 49 C.F.R. § 1.89, Parts 200-299). Current FRA regulations do not comprehensively address safety requirements for train operations above 150 miles per hour (mph), such as the Project's proposed operations. Therefore, FRA may issue a Rule of Particular Applicability (regulations that apply to a specific railroad or a specific type of operation (RPA)), impose requirements or conditions by order(s) or waiver(s), or take other regulatory action(s) to ensure the Project is operated safely. This regulatory action(s) constitutes a major federal action and triggers the environmental review under NEPA. Additionally, one or more companies affiliated with TCR may apply to DOT for credit assistance through the Railroad Rehabilitation and Improvement Financing (RRIF) (45 U.S.C. § 821 et seq.) or Transportation Infrastructure Finance and Improvement Act (TIFIA) (23 U.S.C. Parts 601-609) programs to finance a portion of the Project. Should DOT provide credit or other financial assistance, this activity would also constitute a major federal action.

TCR, Texas Central Railroad (TCRR) and Texas Central Partners (Texas Central or TCP) are affiliated companies involved in the development of the Project. TCR is responsible for planning and coordinating with FRA for the NEPA regulatory approvals for the Project, which would include a Record of Decision for the EIS and related permits. TCRR submitted a petition for a Rule of Particular Applicability to FRA. Texas Central is the parent company of TCRR, and other corporate entities that are responsible for Project development and implementation (i.e., design, construction, financing, and operation). As the entity responsible for the petition for a Rule of Particular Applicability, TCRR is used as the Project Proponent throughout this EIS.

ES.2 Description of the Project

The Project includes the deployment of an electric-powered HSR passenger rail system based on Central Japan Railway Company's N700 Tokaido Shinkansen. In coordination with the FRA Office of Railroad Safety, the train technology would be adapted to meet the regulatory requirements and environmental conditions between Dallas and Houston, as established by an FRA Rule of Particular Applicability or other regulatory action(s) to ensure the Project is operated safely. To minimize risk and enhance passenger safety, the Project is proposed to be operated in a fully sealed corridor. The lack of crossings and other non-HSR traffic would enable trains to safely achieve speeds exceeding 200 mph and attain an approximate 90-minute travel time between Dallas and Houston. The design of the system includes a double-track with dedicated northbound and southbound operations. Minimum ROW would be 100 feet and would include the track, overhead catenary system (catenary), access road and security fencing. Based on existing infrastructure (e.g. roadways, well pads, transmission lines, etc.) and changes in topography, combined with the need to minimize vertical changes along the HSR line, the double-track system would be constructed using a combination of at-grade, retained fill/embankment and bridge-like structure, called viaduct. Approximately 60 percent of the HSR line would be constructed on viaduct.

TCRR is proposing three stations as part of the Project: two terminal stations (Dallas and Houston) and one intermediate Brazos Valley Station in Grimes County. In addition to the stations, the system would require additional facilities to support its operation. These facilities include Trainset Maintenance Facilities (TMF), Maintenance-of-Way (MOW) facilities and Traction Power Substations and other supporting power infrastructure.

ES.3 Overview of Study Area

With proposed terminal stations options in Dallas and Houston, the Study Area encompasses the counties of Dallas, Ellis, Navarro, Freestone, Limestone, Leon, Madison, Grimes, Waller and Harris. A proposed intermediate station, Brazos Valley Station, would be located in Grimes County. The Study Area is primarily rural in nature, and includes portions of all ten of these counties. Resource specific study areas are identified in the applicable sections of the EIS.

ES.4 Purpose of and Need for the Project

The purpose of the privately proposed Project is to provide the public with reliable and safe high speed passenger rail transportation between Dallas and Houston.

TCRR identified the Dallas to Houston corridor as an ideal location and distance to implement high-speed intercity passenger rail that is financially sustainable, constructible and connects two of the largest urban centers in the country.

To achieve TCRR's financial and ridership objectives, TCRR has identified the following functional criteria for the Project:

- Technological: bullet train vehicle and operating procedures based on the N-700I Tokaido Shinkansen system
- Operational: approximate 90-minute travel time between Dallas and Houston, with achievable speeds exceeding 200 mph in a fully sealed corridor
- Environmental: minimal impacts to the natural and built environments by maximizing adjacency to existing infrastructure right-of-way (ROW)

FRA's mission, "to enable the safe, reliable, and efficient movement of people and goods for a strong America, now and in the future," supports the development of safe and reliable intercity passenger rail. FRA's objectives are to:

- Ensure that the system operates safely in accordance with federal requirements
- Provide safe connectivity to existing transportation modes (i.e., heavy rail, light rail and bus) present throughout the Dallas-Fort Worth (DFW) Metroplex and the greater Houston area
- Ensure the Project does not preclude future rail expansion opportunities on adjacent corridors
- Avoid, minimize and mitigate impacts to the human and natural environment

The need for HSR as an alternative transportation mode is supported by several factors including population growth, congestion of the state transportation system and safety. Travel demand is increasing and the existing transportation infrastructure is not able to accommodate this growing demand between Dallas and Houston. Current transportation options between Dallas and Houston are limited to vehicular and air travel. Due to increasing congestion on IH-45, automobile travel times between the two regions are projected to increase as travel speeds decrease. Flight time between the two regions is relatively short; however, the overall trip duration when considering pre-arrival time, more than doubles. Additionally, flights are sensitive to inclement weather and other delay-causing events from inside and outside of Texas.

In order to meet the needs of growing travel demand spurred by population growth and a decrease in the level of service of existing transportation systems, both cities are addressing much needed infrastructure improvements. Intercity and intracity transportation infrastructure will require significant expansion and maintenance in the future; a reliable multimodal option to alleviate the strain on this existing infrastructure is needed to accommodate growing demand.

Previous passenger rail studies completed by FRA and TxDOT support the need for reliable multimodal transportation alternatives to promote congestion relief strategies. One of these strategies identified in the State Rail Plan included the potential implementation of HSR within the Dallas to Houston corridor. A reliable transportation alternative would also need to operate safely. The HSR system would not include grade crossings, which would remove any interactions between passenger vehicles and the HSR system. This separation would add more stringent security measures compared to traditional freight rail. After completing its own analysis, TCRR identified an opportunity to develop a profitable, privately financed and operated HSR system for this corridor. The Project would transport thousands of passengers every day and provide an alternative transportation mode for travelers between the two cities, consistent with previous plans and studies.

ES.5 Issues Raised During Scoping

FRA issued a Notice of Intent to prepare an EIS and opened the public scoping period on June 25, 2014. FRA held 12 scoping meetings in late 2014, and the scoping period closed on January 9, 2015. During this 6 month scoping period, more than 1,900 people, including elected officials, attended the public scoping meetings held in Dallas, Waxahachie, Corsicana, Teague, Jewett, Madisonville, Bryan, Huntsville, Navasota, Tomball, Waller and Houston. The majority of the public comments centered on the following items:

- Corridor alternatives for HSR service presented at the scoping meetings, primarily the Burlington Northern Santa Fe (BNSF) rail line and Utility Corridor

- Impacts to property value and the overall economic impact of the Project
- Impacts to communities and land use
- Impacts due to HSR noise and vibration
- Landowner rights related to eminent domain and acquisitions and displacements
- Public involvement process
- Safety and security of the HSR system and the areas surrounding the system

ES.6 Alternatives Analysis

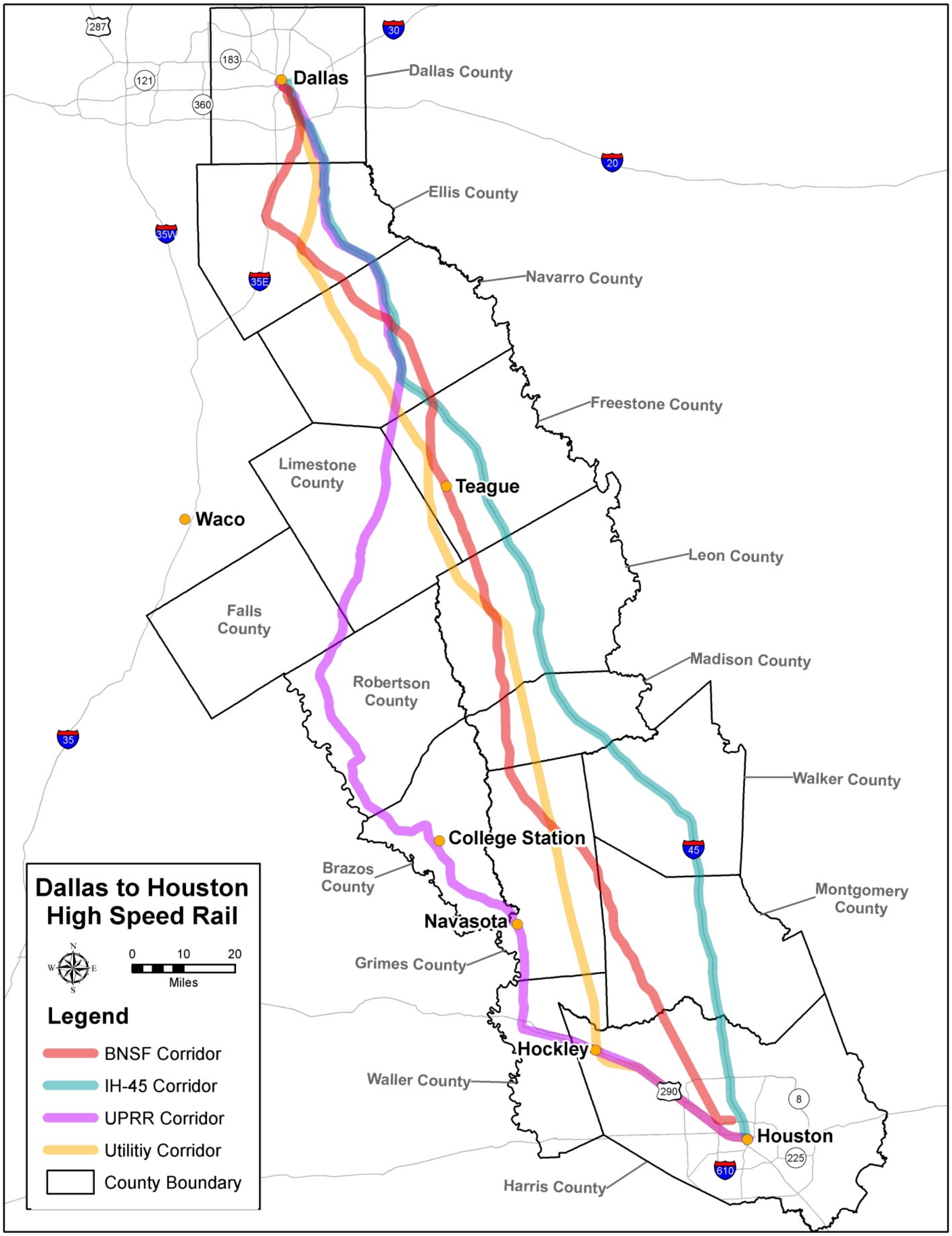
As part of its initial planning effort, TCRR identified and evaluated four HSR corridor alternatives (**Figure 1**). These early planning efforts resulted in TCRR recommending two corridor alternatives that primarily followed the BNSF rail line and existing high-voltage transmission line easements (i.e., Utility Corridor). TCRR proposed two terminal stations: one in Dallas and one in Houston. TCRR also considered a third, intermediate stop in the vicinity of Bryan/College Station. FRA presented these two corridor alternatives and general station locations to agencies and the public for input during the NEPA scoping process.

Subsequent to scoping, FRA completed a corridor analysis. FRA evaluated all four of the original HSR corridors. Additionally, FRA reviewed alternative transportation modes to high-speed rail service that included higher-speed and conventional speed rail services, direct bus service and expansion of IH-45 and determined that these modes would not meet the purpose and need of the Project. FRA determined that the Utility Corridor would be retained as the preferred corridor. FRA also determined that portions of the other three corridors would be retained for further investigation in the event that constraints were identified along the Utility Corridor that warranted potential route alternatives. The selection of the Utility Corridor as the preferred corridor also narrowed the TCRR proposed station locations to the downtown Dallas/IH-30 area, Grimes County (near Roan's Prairie) and the US 290/IH-610/IH-10 area of northwest Houston.

With a preferred corridor selected, TCRR developed 21 potential alignment alternatives within geographic groups that could be tied together to create end-to-end alternatives. These alignment alternatives were primarily located within the Utility Corridor; however, in response to public scoping comments, TCRR also proposed alignment alternatives that used a portion of the IH-45 corridor. TCRR developed the potential alignment alternatives to avoid known environmental and engineering constraints and were based on conceptual engineering completed as of June 25, 2015. FRA evaluated the alignment alternatives presented by TCRR using publicly available desktop data.

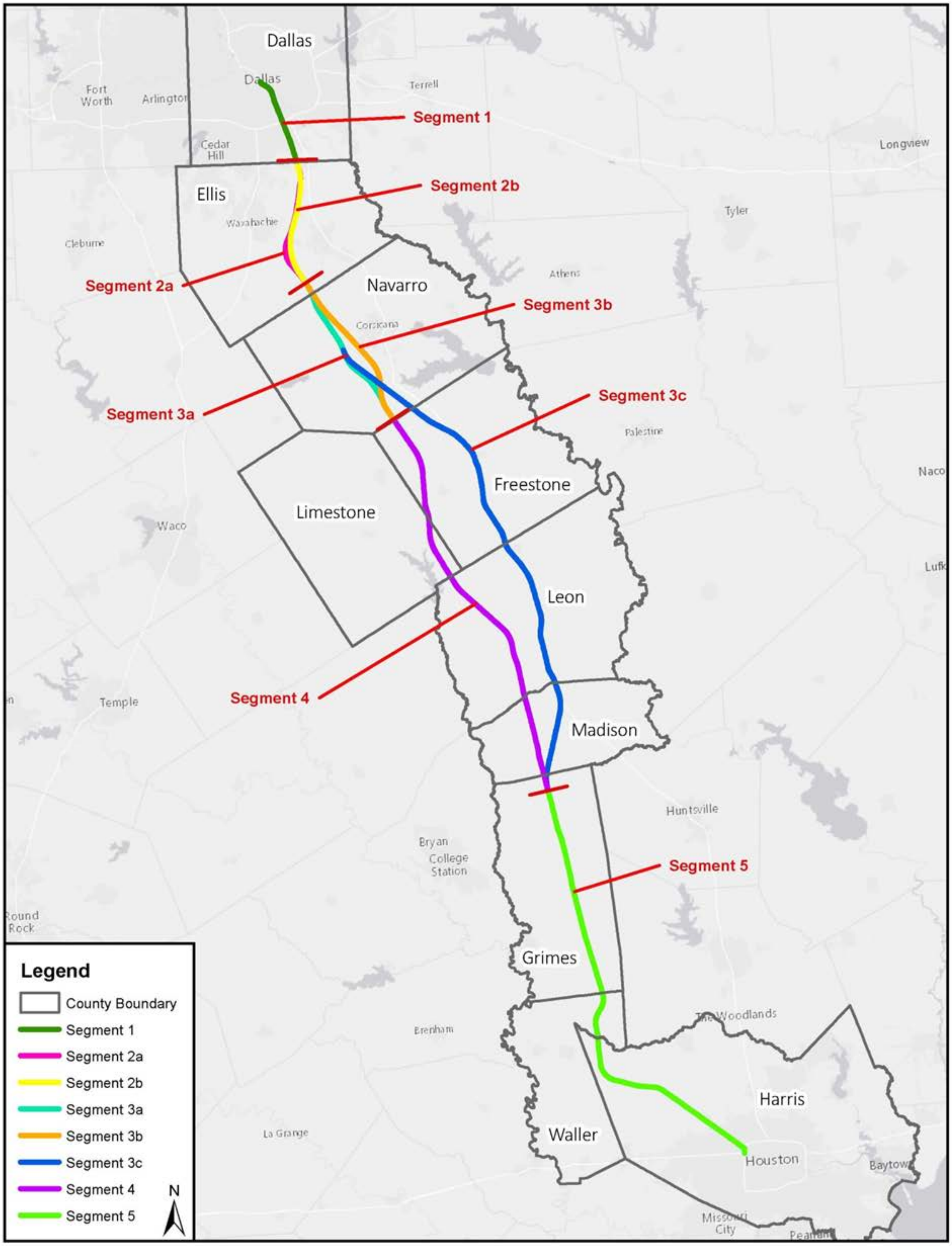
FRA completed an independent, multi-level screening analysis to evaluate TCRR's alignment alternatives. Level I considered the purpose and need of the Project, TCRR's alignment objectives and design guidelines. Level II assessed the remaining alignment alternatives within specific geographic groups and used a desktop level evaluation of environmental criteria and other factors to further refine the number of alternative alignments. The resulting analysis identified eight segments that create the six end-to-end Build Alternatives (A through F) for evaluation in this EIS (**Figure 2**). Given the length of the Project (approximately 240 miles) and to better illustrate the potential impacts to local communities, the evaluation of the Build Alternatives includes analysis at the county and segment level. Impacts are then summarized by Build Alternative.

Figure 1: Four HSR Corridor Alternatives



Source: AECOM, 2016

Figure 2: Alignment Alternatives that Create Build Alternatives



Source: AECOM, 2015

With the Build Alternatives identified, TCRR identified one Dallas Terminal Station option near IH-30 just south of downtown Dallas, one Brazos Valley Station location near SH 30 and three Terminal Station options in Houston – Houston Industrial Site (south of Hempstead Road), Houston Northwest Mall Site (north of Hempstead Road) and Houston Transit Center Site (west of IH-610).

The Japanese N700 Tokaido Shinkansen HSR technology is supported by a system of maintenance and operational facilities – TMF, MOW facilities, Traction Power Substations, sectioning posts, sub-sectioning posts, etc. – that work within a pre-determined sequence to monitor and power the system. As part of the alternatives analysis, FRA identified potential locations for these facilities to avoid or minimize impacts to highly vegetated and other sensitive areas.

TCRR proposed two TMF locations in Dallas County and two locations in Harris County. Two of the sites (one in each county) would also require an additional MOW facility to support the operation of the HSR system. FRA completed an independent review of the four sites using a desktop evaluation of publicly available resources similar to the assessment of the alignment alternatives. FRA determined that the Dallas South TMF site and its accompanying MOW site and the Houston North TMF site and its accompanying MOW site would be carried forward and are included in the evaluation of the Build Alternatives in this EIS.

ES.7 Design Considerations to Avoid and Minimize Impacts

As part of the design process, TCRR refined the design of the Build Alternatives to reduce the Project footprint and avoid or minimize impacts to the socioeconomic, natural, cultural and physical environment. Based on input received by TCRR through their stakeholder engagement efforts, these refinements resulted in the use of viaduct on approximately 60 percent of the Build Alternatives, which allows for greater movement around and under the HSR system. Additionally, TCRR designed 52 percent of the Build Alternatives adjacent to existing infrastructure, which typically includes areas that have previously been disturbed by development. This design approach minimized impacts to more environmentally sensitive areas and potentially reduces the fragmentation of existing habitat. TCRR refined the footprint of the Build Alternatives evaluated in this EIS by 16 percent to minimize potential impacts.

TCRR also engaged in early coordination with federal agency stakeholders such as the USACE and other stakeholders, such as utility providers and the public, to collect feedback and coordinate on other planned projects. TCRR's coordination efforts with USACE focused on fee lands, streams, wetlands and flood plains. Through coordination with utility infrastructure owners TCRR identified expected approaches to maintenance and protection of utilities along the Build Alternatives. Through coordination with electrical supply and transmission providers, such as Oncor and CenterPoint, TCRR developed proposed modifications to electrical transmission infrastructure along the Build Alternatives and proposed connections with the existing power grid to serve the traction power demand of the Project. The utility providers will need to confirm and evaluate these proposed locations through an independent environmental evaluation process at a later date. Early coordination with TxDOT and other agencies, utility suppliers, community groups, and private property owners allowed TCRR to design the Build Alternatives in coordination with other planned projects. Coordination with other municipalities, businesses and community groups along the Build Alternatives allowed TCRR to consider and coordinate the design with future corridor development plans.

ES.8 No Build Alternative

The No Build Alternative is included in this analysis as the baseline for comparison with Build Alternatives A through F. This is also known as the alternative of no action as required by NEPA. Under the No Build Alternative, FRA would not issue a Rule of Particular Applicability for the implementation of this technology within the U.S.; therefore, TCRR would not be able to operate the HSR system and associated facilities. Travel between Dallas and Houston would continue via existing highway (IH-45) and airport infrastructure.

The No Build Alternative would not meet the specified Purpose and Need for this Project, but is retained in the EIS as a basis for comparison. The No Build Alternative would not provide congestion relief, improve safety on IH-45, meet current and future transportation needs between Dallas and Houston and would not offer an alternative transportation mode that would connect to existing modes.

ES.9 Evaluation of the Build Alternatives

ES.9.1 Methodology

FRA independently evaluated the six Build Alternatives using data from readily available state and federal databases, fieldwork, modeling and detailed technical analyses. The six Build Alternatives are compared to the No Build Alternative. The methodology for each resource area is identified in the applicable section of the EIS.

FRA's evaluation of the potential impacts of the Build Alternatives is based on the Limits of Disturbance (LOD). The LOD of the Build Alternatives contains the permanent construction and operation footprint and includes the rail infrastructure, access roads, drainage swales and ancillary facilities (e.g., stations, TMF and MOW facilities, TPSSs, maintenance roads and signal houses). For this evaluation, FRA evaluated the maximum size of the proposed footprints for all stations, maintenance and ancillary facilities to ensure the system would not be capacity constrained under the ultimate buildout of the system. The LOD also includes other Project-specific locations that would be temporary or short-term in use and only required during the construction.

ES.9.2 Comparison of the Build Alternatives Physical Attributes

Table 1 summarizes and compares the physical attributes of the Build Alternatives. The length of the Build Alternatives would range from 233 to 239 miles. Additionally, the track configuration or type – at-grade, on embankment or on viaduct/structure would be comparable across all six Build Alternatives.

Table 1: Physical Attributes of the Build Alternatives

Attribute	ALT A	ALT B	ALT C	ALT D	ALT E	ALT F
Total Length (miles)	234.37	234.68	239.00	233.68	233.99	238.31
At-grade (miles)	21.04	21.42	20.45	21.91	22.29	21.32
Embankment (miles)	77.42	79.46	73.16	75.75	77.79	71.49
Viaduct (miles)	135.91	133.8	145.39	136.02	133.91	145.5

Source: AECOM, 2017

The following sections summarize the potential benefits or adverse impacts to the existing social, natural, physical and cultural environment analyzed for the No Build and Build Alternatives.

ES.9.3 Air Quality

FRA assessed air quality impacts through an analysis of emissions that would occur during construction and operation of the Build Alternatives. FRA made quantitative emissions estimates from construction and operational sources using standard modeling platforms, emissions data and spreadsheet calculations.

Construction emissions generated by on- and off-road construction equipment, on-road material hauling vehicles and freight rail material hauling vehicles would result in an increase of total Nitrous Oxide (NO_x) and volatile organic compounds (VOC) emissions in DFW and Houston-Galveston-Brazoria (HGB) nonattainment areas. FRA quantified construction-related sulfur dioxide (SO_2) emissions for the small section of the Project that would be located within the SO_2 nonattainment area surrounding the Big Brown power plant located on Fairfield Lake in Freestone County. Short-term (48 months) air quality emissions due to construction would occur; however these would not exceed general conformity *de minimis* thresholds.

During operation of the Build Alternatives, not all emission production would occur in non-attainment areas. Power generated for the HSR system and station areas would be generated at distant power plants operating away from the Build Alternatives; therefore, emissions produced due to the consumption of electricity for operation would be indirect. Additionally, any number of regional power plants connected to the Electric Reliability Council of Texas (ERCOT) grid can satisfy operational demand for the HSR system and station areas.

FRA used the 2024 and 2040 train operation emissions and vehicle emissions reduction for each nonattainment area to calculate the net operational emissions within each nonattainment area. Net reductions are shown for all pollutants except SO_2. The increase in SO_2 would be comparatively negligible and well below the current moderate nonattainment threshold of 100 tons per year. For operational emissions, 40 C.F.R. 93.153(d)(1), states that the portion of an action that includes major or minor new or modified stationary sources that require a permit under the new source review program or the prevention of significant deterioration program of the Clean Air Act, is exempt from the general conformity rules. Power plants are permitted as stationary sources under these programs and emissions from them would therefore be exempt. As such, the remaining operational emissions would consist of vehicle emissions reductions, and could therefore not exceed *de minimis* thresholds. However, operational analysis included the power plant emissions for demonstration, even though they do not technically apply to determining general conformity applicability.

For NO_x, VOC and carbon monoxide (CO), the net reductions in 2024 are greater than in 2040, despite ridership and vehicle miles traveled (VMT) reduction being greater in 2040. This is because the vehicle emissions of cars are expected to improve drastically by 2040 compared to 2024, making the potential emissions that would be reduced by taking cars off the road, smaller. For example, the NO_x emission factor drops by an order of magnitude from 2024 to 2040, countering the effects of greater ridership. By contrast, the train NO_x emissions factor only drops by roughly half. For the other pollutants, the relative drop in emissions rates from 2024 to 2040 would be smaller, and the increase in ridership helps make emissions smaller or have greater net reduction. Most criteria pollutant emissions would be reduced over the long-term under the Build Alternatives – a net benefit.

The Build Alternatives would provide another option for intercity travel between Dallas and Houston that would emit air pollutants, including Mobile Source Air Toxics (MSATs), into the atmosphere.

However, the Build Alternatives would decrease overall VMT from passenger vehicles compared to the No Build Alternative, thereby decreasing regional MSAT emissions generated by passenger vehicles, and consequently would have a beneficial impact on regional MSAT emissions.

ES.9.4 Water Quality

Water in the water quality Study Area generally drains to the southeast towards the Gulf of Mexico and the Build Alternatives intersect nine watersheds. The Build Alternatives would be designed to maintain existing drainage patterns and minimize potential contamination impacts to surface water quality, groundwater quality and water supplies.

Construction of the Build Alternatives would involve ground disturbances, such as excavation and grading, which are anticipated to contribute to short-term impacts from erosion and sedimentation; therefore, increasing the volume of sediment in stormwater. Sedimentation and stormwater runoff from construction may also contain bacteria, nutrients, particles and other constituents attached to sediment or carried separately by stormwater which contribute to pollutant loading. Increased pollutant loading in runoff may impact surface water and groundwater quality. While this could impact all water bodies, threatened or impaired water bodies and reservoirs or other public water supplies would be more sensitive to construction stormwater runoff. Additionally, permanent physical impacts would occur to groundwater wells during construction, including public water system wells, where the HSR would cross the location of the wells. Where possible, the location of wells would be considered and avoided during final design. When impacted and to avoid sediments and contamination from reaching wells and the groundwater supply, TCRR shall plug and abandon and/or relocate the wells. Prior to the start of construction, wells would be plugged, abandoned or relocated according to Texas Commission on Environmental Quality (TCEQ) regulations. Surface water impacts during construction of the Build Alternatives would be temporary and could consist of altering the concentration of one or more pollutants in water bodies and increasing erosion and sedimentation due to excavation and grading. Erosion and sedimentation best management practices (BMPs), storm water pollution prevention plan controls and other requirements would be implemented to avoid and minimize impacts caused by soil erosion and sedimentation during construction.

Operational impacts would result from stormwater runoff and operation activities, such as maintenance of culverts or bridges, fueling and train maintenance activities and obtaining water supplies for the operational facilities and trains. Operation of the Build Alternatives would have permanent impacts on surface water quality including impaired stream segments. Impacts to water quality would be minimized through the use of soil erosion preventative measures, efforts to keep runoff rates similar to existing conditions, such as retention basins, and measures to prevent collected sediment and contamination from entering water in all watersheds.

Table 2: Water Quality Impacts by Build Alternative									
Resource	**Build Alternatives**						**Houston Terminal Station Options**		
	ALT A	**ALT B**	**ALT C**	**ALT D**	**ALT E**	**ALT F**	**Northwest Transit Center Terminal**	**Northwest Mall Terminal**	**Industrial Site Terminal**
Impaired Waterbodies – 303(d) List (Feet)	913.8	913.8	913.8	913.8	913.8	913.8	0	0	0
Impaired Waterbodies with TMDLs (Feet)	1,044.2	1,044.2	1,044.2	1,044.2	1,044.2	1,044.2	0	0	0
Impaired Waterbodies Total (Feet)	1,044.2	1,044.2	1,044.2	1,044.2	1,044.2	1,044.2	0	0	0
Active Public Water System Wells	2	2	3	2	2	3	0	0	0
Groundwater Wells	9	11	7	8	10	6	0	1	1
Reservoir/Dam Crossings	0	0	0	0	0	0	0	0	0

Source: AECOM, 2017

ES.9.5 Noise and Vibration

FRA identified noise-sensitive and vibration-sensitive land uses in the Study Area based on GIS data, aerial photography, drawings, plans and a field survey. Calculation of noise impacts began with capturing baseline ambient noise measurements at key locations near sensitive receptors along the Build Alternatives. FRA compared these baseline noise measurements against modeled noise levels for both construction and operation of the HSR system.

High noise producing construction activities, including pile driving or use of other large machinery, would be relegated to daytime hours only. However, it is unlikely that these activities would occur close enough to sensitive structures to have significant effects. There could be some potential for vibration annoyance or interference with the use of sensitive equipment, but impacts would be temporary.

Operational noise impacts would primarily be caused by trains passing sensitive receivers close to the Build Alternative tracks within areas of low existing ambient noise levels. The Build Alternatives would severely impact 15 (Build Alternatives C and F) to 19 (Build Alternatives B and E) residential sensitive receivers. Across all Build Alternatives, zero institutional receivers would be severely impacted by operational noise. During final design, TCRR shall conduct additional noise and vibration assessments of the sensitive receivers on the preferred alternative. This evaluation shall determine if potential mitigation measures, such as sound barriers or building sound insulation, would be feasible and minimize noise impacts to a level that would not be severe.

The station locations include one terminal station option in Dallas County, one in Grimes County and three terminal station options in Harris County. Sources of potential operational noise impacts in the vicinity of stations include auto and bus traffic on access roads and parking facilities within a range of

100 to 225 feet from the source of the noise. Additionally, there are two proposed TMF and seven MOW facilities to support the operation of the system. Noise from these facilities is evaluated outwards of 1,000 feet from the center of the facility. There are no noise-sensitive land uses within these distances. Thus, noise impacts would not occur due to station or facility activities.

FRA did not identify any sensitive receivers across all Build Alternatives that would be impacted by construction or operational vibration impacts.

Table 3: Noise and Vibration Impacts by Build Alternative

Type of Impact		ALT A	ALT B	ALT C	ALT D	ALT E	ALT F
Severe Noise Impact	Residential	17	19	15	17	19	15
	Institutional	0	0	0	0	0	0
Moderate Noise Impact	Residential	247	261	242	236	250	231
	Institutional	1	1	1	1	1	1
Vibration Impact	Residential	0	0	0	0	0	0
	Institutional	0	0	0	0	0	0

Source: Cross Spectrum Acoustics, 2017

ES.9.6 Hazardous Materials and Solid Waste

Hazardous materials refer to a broad category of hazardous waste, hazardous substances and toxic chemicals that can negatively impact human health or the environment if released.

Impacts as a result of the construction of the Build Alternatives would occur due to the displacement of industrial or commercial facilities and equipment, or site excavation. Sites that pose the greatest concern are those with potential soil or groundwater contamination in, or adjacent to the Limits of Disturbance (LOD). Therefore, hazardous materials concerns are carefully considered throughout the planning and development process in order to address these concerns as early as possible, as well as to ensure compliance with federal, state and local environmental health and safety regulations.

Five to 6 (Build Alternatives D, E, F and A, B, C, respectively) high-risk hazardous materials sites would be located within or adjacent to the LOD and would be impacted. These sites are determined to be high risk due to ongoing remediation/monitoring activities and/or visible soil staining observed during field reconnaissance. Of the 3 terminal station options in Harris County, the Industrial Site Terminal Station option would have 2 high-risk designated sites.

Hazardous materials used during operation of the HSR system would primarily be generated at TMF and MOW facilities. These materials could include lubricants, hydraulic fluids and cleaning products. BMPs would be followed in accordance with federal, state and local requirements. Solid waste generated from the Build Alternatives would primarily be composed of typical municipal solid waste and food waste. Quantities of solid waste generated from station areas and operation of the train would not be expected to exceed capacity of existing landfills.

ES.9.7 Natural Ecological Systems and Protected Species

Natural ecological systems include plant and animal species, frequently referred to as natural resources, and the habitats where they occur. All Build Alternatives would result in temporary and permanent impacts to vegetation, direct loss of wildlife habitat, increases in habitat fragmentation and impediments to the movement of wildlife across the landscape. However, TCRR designed the Build Alternatives to avoid and minimize habitat fragmentation and loss by locating HSR infrastructure adjacent to existing transportation infrastructure, utility corridors and other development to the greatest extent practicable.

The Build Alternatives would temporarily impact between 337 to 341 acres of protected species habitat, and between 1,334 and 1,669 acres of protected species habitat would be permanently impacted. Construction would be completed in coordination with USFWS requirements or restrictions, and under the consultation of onsite qualified biologists, and would minimize impacts to protected species habitats. The terminal station options in Dallas and Harris counties would not impact protected species habitat due to their developed urban environments. The Brazos Valley Station would impact 4.9 acres of Navasota ladies'-tresses protected species habitat but, to date, no protected species have been identified in the area.

Table 4: Protected Species Impacts by Build Alternative

	ALT A		ALT B		ALT C		ALT D		ALT E		ALT F	
	Temp	Perm	Temp	Perm	Temp	Perm	Temp	Perm	Temp	Perm	Temp	Perm
Houston toad/ *Bufo houstonensis*	31	499	31	499	37	511	31	499	31	499	37	511
Large-fruited sand verbena/ *Abronia macrocarpa*	56	99	56	99	9	149	56	99	56	99	9	149
Navasota ladies'-tresses/ *Spiranthes parksii*	254	736	254	736	291	1009	254	736	254	736	291	1009
Protected Species Habitat	341	1,334	341	1,334	337	1,669	341	1,334	341	1,334	337	1,669

Source: AECOM, 2017

FRA will complete three years of presence/absence surveys for the three federally listed species – Houston toad, Large-fruited sand verbena and Navasota ladies' tresses. FRA completed the first year of surveys (October 2016 to June 2017) and did not identify the presence of any of the three species. As of October 2017, FRA initiated their second year of surveys. If FRA identifies protected species during their second or third year of surveys, formal coordination with USFWS, including the development of a Biological Assessment (BA) by FRA, would occur. The BA would summarize FRA's survey methodology, survey findings and identify potential mitigation measures. USFWS would respond to the BA with their Biological Opinion (BO). If FRA does not identify the presence of protected species over the three-year survey period, formal coordination and the development of a BA would not be required. FRA would continue to informally coordinate with USFWS on appropriate mitigation measures to avoid or minimize impacts to protected species habitat.

ES.9.8 Waters of the U.S.

The Build Alternatives would impact wetlands and waters of the U.S. including, intrastate rivers, streams, wetlands and waterbodies. Impacts would occur within waters of the U.S. during the construction and operation of the Build Alternatives. Short-term impacts would include grading and temporary fill from construction access, staging and laydown areas. Permanent impacts would occur for the placement of culverts and viaduct support structures that would allow the Build Alternatives to cross over water features. Additionally, the permanent footprint and construction of access roads, stations, facilities, and where the Build Alternatives would be constructed on embankment or fill would prohibit the flow of water and result in a permanent impact. Operational impacts to waters of the U.S. would be limited to the maintenance of culverts or bridges, and ongoing vegetation maintenance within the permanent HSR ROW.

Crossings of wetlands and waters of the U.S. would include 757 to 846 (Build Alternatives C and E) potential stream crossings that would permanently impact between 46,109.6 and 52,377.2 linear feet (Build Alternatives C and E). The Build Alternatives would necessitate 360 to 549 (Build Alternatives F and A) potential wetland crossings that would permanently impact 100.9 to 106.2 acres (Build Alternatives D and C, respectively). The Build Alternatives would necessitate 271 to 433 (Build Alternatives F and A) potential open water crossings that would permanently impact 25.4 to 38.0 acres (Build Alternatives F and A). Impacts from the construction of the Northwest Transit Center Terminal Station option would be limited to less than 0.01 acres of wetlands and 0.04 acres of open water at the site. No other wetlands or waters of the U.S. impacts would be anticipated at the terminal station options in Harris County.

TCRR designed the Build Alternatives to avoid and minimize impacts to waters of the U.S., to the greatest extent practicable; however, impacts would be unavoidable due to the linear nature of the Project, curvature restrictions associated with the operation of the HSR system and the number of features crossed. Permanent impacts would occur for the placement of culverts, viaduct support structures and within the permanent footprint of access roads, stations, MOWs, TMFs and where any of the Build Alternatives would be on embankment. Short-term impacts would include grading and temporary fill from construction access, staging and laydown areas. Operational impacts to waters of the U.S. would be limited to maintenance of culverts or bridges, and ongoing vegetation maintenance within the permanent HSR ROW. Impacts to wetlands and waters of the U.S. would require permits and permissions from the USACE that would include permit provisions to avoid, minimize and mitigate impacts.

Table 5: Impacts to Streams by Build Alternative

	ALT A	ALT B	ALT C	ALT D	ALT E	ALT F
# of Crossings	830	838	757	829	846	765
Temporary (linear feet)	14,719.0	15,375.3	15,841.6	14,709.4	12,365.7	15,831.1
Permanent (linear feet)	48,709.9	51,909.1	46,109.6	49,173.7	52,377.2	46,879.7

Source: USGS, 2016; FNI 2017

Table 6: Impacts to Wetlands by Build Alternative						
	ALT A	**ALT B**	**ALT C**	**ALT D**	**ALT E**	**ALT F**
# of Crossings	549	482	378	531	464	360
Temporary (acres)	19.3	10.8	13.2	19.3	10.8	13.2
Permanent (acres)	101.9	103.9	106.2	100.9	102.9	105.2

Source: USFWS, 2016; FNI, 2017

Table 7: Impacts to Waterbodies by Build Alternative						
	ALT A	**ALT B**	**ALT C**	**ALT D**	**ALT E**	**ALT F**
# of Crossings	433	414	285	419	400	271
Temporary (acres)	7.4	7.3	6.7	7.4	7.3	6.7
Permanent (acres)	38.0	34.3	26.6	36.7	33.0	25.4

Source: USGS, 2016; USFWS, 2016; FNI, 2017

ES.9.9 Floodplain Hazards and Floodplain Management

The Build Alternatives would temporarily impact regulatory floodplains due to the footprint of the LOD workspace areas, laydown yards and construction workspace. Construction activities would temporarily impact 60 to 83 acres (Build Alternatives C and F and Build Alternatives A and D, respectively) of 100-year and 500-year floodplains.

HSR track and supporting facilities (e.g., permanent roads, parking areas, access/maintenance areas, terminals and non-vegetated embankments) would result in permanent impacts to floodplains. Build Alternatives B and F, respectively would permanently impact 531 to 593 acres of 100-year and 500-year floodplains.

Final design of the Build Alternatives would minimize potential increases to the floodplain elevations by retaining existing water surface elevations where feasible to avoid impacting the available flood storage and minimizing fill in sensitive areas. Many regulatory floodplains and unregulated stream segments would be fully spanned and potential impacts avoided. Compliance and mitigation measures, including temporary detention, would be used to offset effects on floodplains from piers and construction within the floodplains.

Table 8: Impacts to Floodplains by Build Alternative						
	ALT A	**ALT B**	**ALT C**	**ALT D**	**ALT E**	**ALT F**
	Size of Floodplain (acre)					
Impacts to 100-Year Floodplain	606	565	601	611	570	606
Impacts to 500-Year Floodplain	46	46	47	46.5	46.5	47.5
Total Acres of Intersected Floodplain	**653**	**611**	**648**	**658**	**617**	**653**
Permanent Impacts to 100-Year and 500-Year Floodplains	570	531	588	575	536	593
Temporary Impacts to 100-Year and 500-Year Floodplains	83	81	60	83	81	60
Total Acres of Impacted Floodplain	**653**	**612**	**648**	**658**	**617**	**653**
	Length of Streams with Highly Erodible Soils (feet)					
Impacts to Streams	33,668	35,221	34,069	33,668	35,221	34,069
	Number of Crossings					
Bridge/Viaduct Crossings at FEMA Zone AE Crossings	33	33	36	32	32	35
Bridge/Viaduct Crossings at FEMA Zone A Crossings	66	64	50	69	67	53
Bridge/Viaduct Crossings at Non-FEMA Stream Crossings	207	205	197	206	204	196
Total Number of Bridge/Viaduct Crossings	**306**	**302**	**283**	**307**	**303**	**284**
Culverts or BCC Cross-Drainage Locations	109	100	95	111	102	97
Stream Crossings Having Highly Erodible Soils	90	90	81	90	90	81

Source: AECOM, 2017

ES.9.10 Utilities and Energy

The Build Alternatives would impact utility and energy infrastructure throughout the Study Area. The Build Alternatives would intersect water and sewer utility lines, as well as energy lines used for electricity, crude oil and natural gas. All crossings would be subject to case-by-case mitigation measures that could involve relocation, re-routing, vertical adjustments, modification, or removal of the impacted resource. Close coordination with utility providers and federal, state and local regulations would be necessary for appropriate actions to be taken for each crossing occurrence.

Build Alternatives C and F would require 10 new electrical connections required at the TPSSs, and Build Alternatives B and E would require the least amount of new connections, with 8 each. Pole adjustments, or raising the transmission line, could be required under all Build Alternative to accommodate vertical clearances for the HSR ROW. Estimates of pole adjustments range from 75 under Build Alternative C to 95 under Build Alternative E. Additionally, between 24 and 34 (Build Alternatives C and F and Build Alternatives A and D, respectively) oil and gas wells would require abandonment and mitigation.

Table 9: Comparison of Utility Impacts by Build Alternative						
	ALT A	**ALT B**	**ALT C**	**ALT D**	**ALT E**	**ALT F**
New Electric TPSS Connections	9	8	10	9	8	10
Electric Utility Pole Adjustments	88	90	75	93	95	80
Total Electric Connections	109	108	88	114	113	94
Abandoned Oil and Gas Wells	34	31	24	34	31	24

Source: AECOM, 2017

In addition to the utilities discussed above, TCRR identified three types of electrical utility modifications that would be required, including realignments, new connections to power the HSR system and vertical adjustments to existing pole lines. Modifications to these lines would be managed by the utility provider(s) and evaluated through a separate environmental process. The utility provider(s) would have ultimate decision-making authority over the size and location of the improvement; therefore, FRA did not evaluate impacts associated with the overhead utility lines at the project-level, but did include them in the indirect and cumulative impacts analysis.

Electricity demand during construction of the Build Alternatives would be limited to power requirements (primarily lighting and power tools) at laydown areas and facilities construction sites. Construction power usage would not require significant additional capacity, or result in a significant peak electric demand or base-period electric demand.

Operational energy consumption would include the electricity needed to power the HSR trains, stations, TMFs and MOW facilities. The Build Alternatives would obtain electricity from the major electrical service providers in the Study Area. Due to the size and expected electrical demand of the Build Alternatives, it is likely that statewide electricity reserves and electrical transmission capacity would be affected. As Texas grows, so does its demand for energy (electricity). The electrical load in the state is projected by ERCOT to increase between years 2015 and 2020. To accommodate the future electricity demand, ERCOT is expecting additions to the system to be developed through the year 2029. The net added capacity would provide an additional 489,840 MWh of daily generation. The daily HSR power consumption of 1,279.80 million watts consumed in one hour (MWh) would represent 0.26 percent of this net added capacity. Even if it were not accounted for in planned or forecasted demand, the daily demand of the Build Alternatives would represent significantly less than the reserve margin (13.75 percent more MWhs) considering its percentage of the planned added capacity. As part of the pre-construction design, planning and permitting process, TCRR would coordinate with and plan the HSR demand with power service providers, and this demand would have to be known and planned for within ERCOT.

ES.9.11 Aesthetics and Scenic Resources

Scenic resources can include a viewer's perception of an area, cultural landscapes and cultural or natural viewsheds. The assessment identified potential locations where the HSR system could constitute a significant aesthetic or scenic impact. FRA identified 13 landscape units, a defined boundary within the Project's area of visual effect, along the Study Area, as well as key viewpoints (KVPs), or a location that represents the view of the landscape unit. FRA completed renderings to simulate the change within each KVP and assist with assessing the impact. Mitigation measures including vegetation management, lighting, and use of screens would be used to minimize the visual impact of the elevated train (on viaduct) at grade embankment or at key station areas.

FRA assessed impacts on levels of viewer sensitivity, visual quality, and the compatibility of potential impacts to blend with their surrounding visual and aesthetic environments. Viewer sensitivity was graded from low to high and then combined with compatibility to find a degree of impact. Compatibility assessed the overall setting – does existing infrastructure, like roadways, freight or utility lines populate the landscape unit or is it relatively open and uninterrupted – to determine if the implementation of the Project would create an impact. The Build Alternatives would create two beneficial and one adverse visual impact. Beneficial impacts would be anticipated at terminal station areas where new development would replace older commercial and industrial or vacant areas in Dallas and Harris counties, which would improve the aesthetics and visual landscape. An adverse impact would be anticipated in Grimes County in relation to the Brazos Valley Station, which would be surrounded by a rural landscape with little other infrastructure. The Brazos Valley Station would be out of scale and not compatible with its surrounding landscape. The remaining ten landscape units would result in neutral impacts, meaning either the implementation of the Build Alternatives would not enhance or degrade the overall existing visual quality, or the change would occur within an environment where viewer sensitivities (the degree to which someone would be exposed to the change) would be low.

Table 10: Visual Impacts by Build Alternative

Landscape Unit	ALT A	ALT B	ALT C	ALT D	ALT E	ALT F
Landscape Unit 1	Beneficial	Beneficial	Beneficial	Beneficial	Beneficial	Beneficial
Landscape Unit 2	Neutral	Neutral	Neutral	Neutral	Neutral	Neutral
Landscape Unit 3	Neutral	Neutral	Neutral	Neutral	Neutral	Neutral
Landscape Unit 4	Neutral	Neutral	Neutral	Neutral	Neutral	Neutral
Landscape Unit 5	-	Neutral	Neutral	Neutral	Neutral	Neutral
Landscape Unit 6	-	-	Neutral	-	-	Neutral
Landscape Unit 7	Neutral	Neutral	-	Neutral	-	-
Landscape Unit 8	Adverse	Adverse	Adverse	Adverse	Adverse	Adverse
Landscape Unit 9	Neutral	Neutral	Neutral	Neutral	Neutral	Neutral
Landscape Unit 10	Neutral	Neutral	Neutral	Neutral	Neutral	Neutral
Landscape Unit 11	Neutral	Neutral	Neutral	Neutral	Neutral	Neutral
Landscape Unit 12	Neutral	Neutral	Neutral	Neutral	Neutral	Neutral
Landscape Unit 13	Beneficial	Beneficial	Beneficial	Beneficial	Beneficial	Beneficial
Total Number of Beneficial	2	2	2	2	2	2
Total Number of Neutral	8	9	9	9	8	9
Total Number of Adverse	1	1	1	1	1	1

Source: AECOM, 2017

ES.9.12 Transportation

All Build Alternatives would interact with existing transportation networks by necessitating roadway reconfigurations, freight rail crossings, aviation infrastructure mitigation, and bicycle/pedestrian improvements. The HSR is a closed system; all modes of existing transportation infrastructure crossed would be separated from the trainset including the 34 freight rail line crossings crossed by all of the Build Alternatives. There would be no permanent or long-term operational impacts associated with any of rail crossings as all Build Alternatives would be fully grade separated.

Roadways would be the primary transportation network impacted by the Build Alternatives. Each major road was inventoried for daily traffic volumes, existing travel patterns and geometric conditions. For each crossing, surrounding development and transportation plans, environmental and engineering constraints and the availability of alternative routing was consulted to propose revised configurations of the existing infrastructure relative to the Build Alternatives. The proposed configurations include:

- road under railway (the road would be reconfigured or depressed to allow the HSR track to go over the road)
- road over railway (road would be reconfigured and/or regraded to allow the rail to cross under the road)
- relocation or reroute (moving the road so that it no longer interacts with the rail)
- closure and acquisition (private roads only)

Build Alternative F would have the fewest permanent impacts to roadways at 147, and Build Alternative B would have the most at 246. All roadways impacted would be reconfigured according to TxDOT and local regulations. The Build Alternatives would require intersection improvements at all three of the Houston Terminal Station options. The Northwest Transit Center Terminal Station option would have the fewest (22) number of intersections operating at level of service (LOS) E or F, and the Industrial Site Terminal Station option would have the most (25). A traffic control plan would be developed and implemented to minimize interruptions and provide safe operations during construction of the Build Alternatives.

Transit services in Dallas and Harris counties, operated by DART and METRO respectively, could see increased ridership due to the Build Alternatives. Ridership increases would be a beneficial impact.

An Aviation facility on common segment in Harris County, Weiser Air Park, would be permanently impacted by the Build Alternatives. Elevation of the Build Alternatives above US 290 would affect clearance zones for aviation activities in the air park. Additional coordination would be required with the FAA to confirm impacts to the Air Park due to approach and departure impedance to the runway protection zone. Mitigation would involve coordination with Weiser Air Park owners, FAA and TCRR to find a solution that could include compensation, relocation or reconfiguration.

Table 11: Summary of Transportation Impacts by Build Alternative

	ALT A	ALT B	ALT C	ALT D	ALT E	ALT F
Freight Rail Crossings	34	34	34	34	34	34
Rail Facilities and Operations	There would be no permanent or long-term operational impacts associated with any of rail crossings as the Build Alternative would be fully grade separated.					
Roads Permanently Impacted	240	246	148	239	245	147
Length added to Public Roads (miles)	18.0	20.0	47.9	19.0	21.4	49.3
Length removed from Public Roads (miles)	11.0	11.1	26.9	9.7	11.1	25.9
Transit Services	All alternatives would have the same impacts on transit services. All alternatives could increase ridership on local transit systems, particularly in Dallas or where local rail connections would be most accessible from the station.					
On-Road Pedestrian & Bicycle Facilities	None of the segments would permanently impact on-road pedestrian or bicycle facilities.					
Impacts to airports	1	2	1	1	2	1

Source: AECOM, 2017

ES.9.13 Elderly and Handicapped

The Build Alternatives and station areas would be constructed in accordance with Americans with Disabilities Act (ADA) safety, accessibility, and reliability standards for disabled individuals. Additionally, all parking locations would adhere to minimum requirements for ADA accessible parking spaces. There would be no adverse or disproportionate impacts to elderly or handicapped individuals caused by the Build Alternatives.

ES.9.14 Land Use

FRA evaluated and assessed existing land uses to determine land use conversion, structure displacement and land acquisition for the Build Alternatives. Impacts to agricultural, pastoral, special status farmland

and agricultural conservation easements would constitute the largest categories for the conversion of existing land use; between 3,145 and 4,394 acres (Build Alternatives E and D, respectively) of special-status farmland would be permanently converted to transportation use. However, given the quantities of special-status farmland within the 10 counties (2.3 million acres), the Project would require 0.2 percent for the construction of the Build Alternatives, this would not result in a significant impact or loss to crop yields, livestock numbers or the state agricultural economy. Overall, between 7,957 and 8,218 acres (Build Alternatives A and D and Build Alternative F, respectively) of existing land would be converted.

FRA conducted quantitative analysis of anticipated acquisitions and displaced structures for comparative purposes only. Primary displacements include structures located directly within the proposed LOD or within 50 feet of the LOD. Build Alternative C would displace the least amount of residences with a total of 272, while Build Alternative E would displace the most residences with 298. Commercial displacements range from 49 with Build Alternatives A, B, D, and E to 68 with Build Alternatives C and F.

It is anticipated that total permanent parcel acquisition would range from 1,967 parcels under Build Alternative F to 2,025 parcels under Build Alternative B, while the temporary use of parcels would range from 154 parcels under Build Alternative F to 200 parcels under Build Alternative B. Depending on the Build Alternative, the estimated total structure acquisition (primary and secondary) would range from approximately 191 structures under Build Alternative C to 225 structures under Build Alternative E. Depending on the Build Alternative, the estimated total structure acquisition of businesses would range from 8 businesses under Build Alternatives A,B,D and E to 12 businesses under Build Alternatives C and F. Depending on the Build Alternative, the estimated total structure acquisition of residences would range from 56 residences under Build Alternative C to 72 residences under Build Alternative E.

Table 12: Summary of Land Use Impacts per Build Alternative							
Characteristic		**Area of Potential Impacts**					
		ALT A	**ALT B**	**ALT C**	**ALT D**	**ALT E**	**ALT F**
Regional and Local Land Use Plans		No conflict	No conflict	No conflict	No conflict	No conflict	No conflict
Existing Land Use Conversion (acres)	Temp	2,176.6	2,185.6	2,035.6	2,159.1	2,168.1	2,018.1
	Perm	7,957.4	8,042.1	8,217.3	7,957.7	8,042.4	8,217.8
Special-Status Farmland Conversion (acres)	Temp	1,563.8	1,561.6	1,546.1	1,544.8	1,542.6	1,285.5
	Perm	4,268.2	4,380.4	4,003.9	4,394.6	3,145	3.991.8
	25-foot Setback	896.5	924.9	825.8	886.2	914.7	815.6
Structure Displacements (within LOD)	Commercial	49	49	68	49	49	68
	Residence	283	293	272	288	298	277
	Community Facilities	1	1	1	1	1	1
Estimated Permanent Parcel Acquisitions		1,970	2,025	1,982	1,955	2,010	1,967
Estimated Temporary Parcel Acquisitions		191	200	169	176	185	154
Estimated Total Structure Acquisitions*	Agriculture	133	139	117	134	140	118
	Commercial	8	8	12	8	8	12
	Community Facilities	2	2	2	2	2	2
	Cultural/Civic Resources	1	1	0	1	1	0
	Oil and Gas	0	0	4	1	1	5
	Residence	65	69	56	68	72	59
	Transportation and Utilities	1	1	0	1	1	0

Source: AECOM, 2017

Table 13: Summary of Land Use Impacts for Houston Terminal Station Options				
Characteristic		**Area of Potential Impacts**		
		Industrial Site	**Northwest Mall**	**Northwest Transit Center**
Land Use Regional and Local Land Use Plans		No conflict	No conflict	No conflict
Existing Land Use Conversion (acres)	Temp	-	-	6.0
	Perm	101.2	91.5	79.6
Structure Displacements (Business)		9	9	16
Estimated Permanent Acquisitions		14	10	30
Estimated Temporary Acquisitions		0	0	0
Estimated Total Structure Acquisitions (Business)		1	2	2

Source: AECOM, 2017

ES.9.15 Socioeconomics and Community Facilities

FRA assessed impacts of the Build Alternatives on community character and cohesion, population and employment, the agricultural economy, children's health and safety and community facilities.

Community characteristics would be altered in five communities within the Study Area – downtown Dallas, the LeMay and Le Forge neighborhood in Dallas County, the Saddle Creek Forest development in Grimes County, the Plantation Drive neighborhood in Waller County and the White Oak Falls neighborhood in Harris County. Of these five, the most severe impacts would be anticipated in the LeMay and LeForge neighborhood. Impacts would be unavoidable as the displacements would occur on a common segment of the Build Alternatives. FRA completed an assessment of comparable available properties and found suitable relocations could be accommodated in the Cedar Crest Community should homeowners choose to relocate to nearby areas. Mitigation would include compensation and/or relocation.

Impacts to population and employment as a result of the Build Alternatives would result in a net increase in jobs. New jobs would be generated from the operation and maintenance of the HSR system. Most of these jobs would be located at TMF and station areas. The anticipated growth in each county would represent a fractional increase in the employment base, less than half a percentage point, everywhere except Grimes County. The percentage point would likely be smaller in the future as the employment base would be anticipated to grow. In Grimes County, the net new 124 full-time positions at the Brazos Valley Station would represent just over 2 percent of the existing job base. The 124 net new HSR jobs would be equivalent to about 37 percent of the county's unemployment base. These jobs would primarily be in service and support industries that could be filled from within the county. This would represent a significant increase for the county's employment rate and an expansion of economic opportunity.

TCRR estimates (see **Appendix F, TCRR Conceptual Engineering Design Report**) capital costs for the HSR system between $15 billion and $18 billion ($2017). This estimate includes construction labor, materials, indirect costs, and approximately $2.5 billion for systems and rolling stock. Of these costs, only direct construction costs and professional services (such as engineering and environmental review, and administration) would generate induced spending within the local economy. Additionally, TCRR estimates that the HSR system would generate between $11 and $12 billion of investment in the construction and professional services sector. The injection of capital into the construction and professional industries would lead to direct, indirect and induced employment earnings of up to $8.3 billion in the State of Texas. FRA completed an independent evaluation of the economic impact of the Project confirming a net positive tax impact, estimated to generate between $6.5 billion to $7.0 billion by 2040.

Additional sales tax revenue would result from the sale of tickets for travel on the new HSR system on an annual basis while it is in operation. HSR ticket sales could generate between $15 and $39 billion in sales tax for the state in addition to $5 billion to $12 billion in local tax revenue for Dallas and Harris counties.

The impacts to children's health and safety would occur at five schools adjacent to construction laydown areas contained within the LOD of the Build Alternatives. Four of the schools (Wilmer-Hutchins High School, the AIA Lancaster Elementary School, Cypress Falls High School, and Awty International School) would be located on common segments in Dallas and Harris counties. The Leon ISD Campus would be located along Segment 4 and would not be impacted under Build Alternatives C and F. The development and implementation of a Construction Management Plan would minimize impacts to adjacent community facilities by maintaining access, containing debris from construction areas and limiting daytime construction noise. One school, The Connection School of Houston, would be directly impacted by a common segment of the Build Alternatives and would result in acquisition.

Three community facilities would be located on common segment in Dallas and Harris counties and be impacted by the Build Alternatives: Smith Family Cemetery, Honey Springs Cemetery and The Science of Soul Study Center. Mount Zion Missionary Baptist Church and Hopewell Church would only be impacted by Build Alternatives C and F. Build Alternatives A, B, D and E would directly displace one additional facility, Union Church. These facilities would be subject to mitigation through compensation and relocation determined through one-on-one negotiations with TCRR.

Table 14: Summary of Socioeconomic Impacts by Build Alternative

Resource Area	ALT A	ALT B	ALT C	ALT D	ALT E	ALT F
Community Character and Cohesion	5	5	5	5	5	5
Economic Impacts*	Positive	Positive	Positive	Positive	Positive	Positive
Employment (job years)	241,513	241,513	256,400	241,513	241,513	256,400
Earnings (2016 billions)	$10.2	$10.2	$10.9	$10.2	$10.2	$10.9
Tax Revenue	Positive	Positive	Positive	Positive	Positive	Positive
Children's Health and Safety***	6	6	5	6	6	5
Community Facilities	4	4	5	4	4	5

Source: AECOM, 2017

ES.9.16 Electromagnetic Fields

All sources of electricity produce both electric and magnetic fields. Electric fields result from the strength of the electric charge, and magnetic fields are produced from the motion of the charge. Together, the combination of electric and magnetic fields is referred to as "electromagnetic fields" (EMFs). Standard equipment used during construction of the HSR is regulated by the Federal Communications Commission (FCC) and associated EMFs would be within the FCC regulatory limits. Typical construction equipment would not interfere with the operation of other nearby electric and electronic equipment.

During operation, EMF exposure levels within and outside the Shinkansen trainsets would be below International Commission on Non-Ionizing Radiation Protection Guidelines; therefore, passengers on the train, waiting at the platform or beyond the external security fencing of the HSR ROW would not be exposed to EMF levels above the International Commission on Non-Ionizing Radiation Protection guidelines.

ES.9.17 Public Safety and Security

FRA assessed safety and security issues that could result from natural disasters or criminal acts that would have the potential to affect the HSR system and the ability for emergency services to respond. Additionally, details on safety issues for construction and operation of the Build Alternatives are discussed.

FRA assessed potential impacts to safety and security by degrees of probable frequency and severity ranging from low to high. Potential events that could impact the safe operation of the HSR system include extreme weather or natural disaster, criminal or terroristic acts and impedance of emergency services.

The Build Alternatives would require construction of roadways that provide access across emergency response and fire protection jurisdictions. Road closures, detours and localized automobile congestion caused by construction could increase the response time for law enforcement, fire and emergency services personnel and school buses. However, closures and reroutes would be closely coordinated with local jurisdictions and both a construction transportation and traffic control plan would mitigate impacts.

No operational impacts would occur to the HSR System as a result of extreme weather or seismic events. The probability of an event severe enough to cause a significant operational impact occurring in the Study Area is low. Additionally, the HSR system has embedded safety detection systems throughout the rail corridor that can detect debris, flooding, seismic activity and other hazards that could threaten the operation of the system.

Potential passenger safety impacts would relate to emergency services access to the HSR ROW, criminal activity and terroristic activity. Design features in the HSR system would provide “safe harbors” that a train could quickly arrive at to allow emergency response teams to access the HSR ROW and train. The Build Alternatives have been designed to deter and provide early detection of criminal or terrorist activity with perimeter fencing, closed circuit television, security lighting and private security teams at station areas and on HSR trains. The HSR system’s design features work to minimize potential operational safety impacts.

ES.9.18 Recreational Facilities

Recreational facilities are defined as public parklands, off-street trails and other recreational facilities that may serve a public use. Of the 36 recreational facilities identified within the Study Area, 2 would be directly impacted by the Build Alternatives: Honey Springs Cemetery and Lake Bardwell. Impacts to Honey Springs Cemetery would be the same for all Build Alternatives. The cemetery includes a memorial wall that the City of Dallas designates as a special-use park. The Build Alternatives would span a portion of the eastern side of this facility via viaduct. During construction, the resource would be subject to short-term noise impacts. The use of and access to the memorial wall would be maintained during construction. Due to the location of this facility, surrounded by industrial land use and adjacent to IH-45, the recreational use of this City of Dallas special-use park would not be impacted by the Build Alternatives.

Lake Bardwell is a USACE-owned and operated lake and recreational facility. Build Alternatives D, E and F would impact Lake Bardwell property through the clearing of trees and brush to create a ROW for the Project. Construction and operation would result in permanent impacts in areas commonly used as multi-use trails and hunting grounds. Mitigation would be closely coordinated with the USACE to adjust bridge piers to avoid existing trails and minimize the number of piers used through USACE property. These construction activities could serve as a deterrent to wildlife, reducing availability during the hunting season (September 1 – March 31) of small game and feral hogs in the area. Construction could temporarily impact the multi-use trails located within the Lake Bardwell area (temporary access reroute or closure); however, no trails would be permanently impacted.

Build Alternatives C and F would impact a third recreational facility and 4(f) resource, Fort Boggy State Park. Build Alternatives C and F would be on park lands adjacent to the west side of IH-45 ROW (between the highway and frontage road) and reconstruction of the frontage road and construction of the Build Alternatives would directly impact Fort Boggy State Park property, this portion of the park is undeveloped and not accessible to park users. Roughly 88 percent of the HSR track would be on viaduct over park property. The Fort Boggy State Park recreational areas are located on the east side of IH-45 and outside of the Study Area, more than a quarter-mile from Build Alternatives C and F.

The Houston Terminal Station options would not impact any recreational facilities.

Table 15: Summary of Impacts to Recreational Facilities by Build Alternative

Resource Area	ALT A	ALT B	ALT C	ALT D	ALT E	ALT F
Parks	0	0	0	1	1	1
Trails	0	0	0	0	0	0
Total	0	0	0	1	1	1

Source: AECOM, 2016

ES.9.19 Environmental Justice

All Build Alternatives would cross communities defined as minority or low-income populations per U.S. Census Bureau (USCB) data. Pursuant to federal policy, agencies are required to identify and address minority and low-income populations that are affected by disproportionately high and adverse impacts due to a federal action and to provide opportunities for meaningful participation through project development.

A Study Area defined by a half-mile buffer around the LOD was used to identify block groups intersected by the Build Alternatives. Data from the American Community Survey 2014 5-year estimates was used to identify block groups that meet requirements for environmental justice (EJ) designation. FRA then developed a multi-step outreach plan to connect with EJ communities in Dallas, Ellis, Freestone, Leon, Grimes and Harris Counties. FRA scheduled and hosted listening sessions, when possible, in coordination with pre-existing community meetings to better engage the appropriate individuals potentially impacted by the Build Alternatives.

Overall 132 total block groups intersect the Study Area. Of these block groups, 68 have been identified as EJ block groups, representing 52 percent of total block groups. EJ block groups are primarily located in Dallas and Harris counties with fewer being located in Ellis, Freestone, Leon and Grimes counties.

Construction impacts would affect all populations and communities; however, only 29 percent of temporary construction zones would be located in EJ communities. This represents 24 percent of the total temporary construction zones by acres. Temporary construction laydown areas would not be disproportionately located in EJ communities.

The operational analysis considered permanent impacts to air quality, water quality, noise and vibration, hazardous materials, aesthetics and visual, transportation, land use, socioeconomic, safety and security, and recreation facility. Overall, construction and operation impacts would not affect EJ communities in a disproportionately high and adverse manner.

ES.9.20 Cultural Resources

Cultural resources is an inclusive term that consists of the subset of historic and archeological resources, both of which provide the physical evidence of past human activity and include any prehistoric or historic structure, building, object, archeological site, district (a collection of related structures, buildings, objects and/or archeological sites), landscapes, natural features, traditional cultural properties and cemeteries that may have historical, architectural, engineering, archeological or cultural significance.

Not all cultural resources are considered significant under applicable cultural resources laws. A historic or archeological resource must be significant and possess characteristics that qualify the resource as a historic property, as defined by the National Historic Preservation Act (NHPA). Section 106 of the NHPA, *Protection of Historic Properties* (36 C.F.R. § 800), requires that prior to issuing federal funding, partial funding, permitting, licensing, approval or taking other action, federal agencies consult to take into account the effects of their undertakings on historic properties and provide the Advisory Council of Historic Preservation (ACHP) an opportunity to comment on the undertaking (54 U.S.C. 306108).

Certain types of resources are not usually considered for listing in the National Register of Historic Places (NRHP), including religious properties, birthplaces and graves, cemeteries, reconstructed properties, commemorative properties, and resources achieving significance within the past 50 years. However, a resource that falls within one of those categories can be eligible for listing in the NRHP if it meets one of the following Criteria Considerations in conjunction with one or more of the four standard NRHP criteria listed above.

a. a religious property that derives its primary significance from its distinctive art or architecture, or is historically important;
b. a moved property that is primarily significant for architectural value or it is the only extant property associated with an important historic person or event;
c. a birthplace or grave site of a historical figure if the person is of transcendent importance, and if it is the only extant property directly associated with the person’s significance;
d. a cemetery that is primarily significant because it contains graves of transcendent importance, from its age, its design, or association with historic events;
e. a reconstructed property that is in a suitable environment and presented in a proper physical context and with a suitable interpretation in a master plan, and when it is the only surviving example of a property with the same associations;
f. a commemorative property that has in itself gained significance in design, age, symbolic value, or tradition; and
g. a property less than 50 years of age that is of exceptional importance.

In the State of Texas, archeological resources may also qualify for designation as a State Antiquities Landmark (SAL).

In addition to historic properties considered under Section 106, the Build Alternatives have the potential to affect cemeteries. Cemeteries, which are not usually considered for listing in the NRHP, are protected under provisions of the Texas Health and Safety Code in Chapters 711-715; (Title 13, § 2, Chapter 22 of the TAC;), and in Section 28.03(f) of the Penal Code. Each resource must be evaluated to ascertain classification criteria.

Potential impacts to cultural resources include multiple Study Areas and would be coordinated with the Texas Historical Commission, the preservation agency for the State of Texas, and FRA. The Study Area, or Area of Potential Effect (APE), for historic resources evaluated through this Project varies from 350 feet beyond the LOD or Project footprint of the Build Alternatives within an urban setting, to 700 feet beyond the LOD of the Build Alternatives in a suburban setting and 1,300 feet beyond the LOD of the Build Alternatives in a rural setting. For this project and this resource, Dallas and Harris counties include urban, suburban and rural APEs. FRA evaluated the remaining eight counties under the rural setting APE. Archeological resources would be evaluated based on an APE that includes the LOD and focuses on potential ground-disturbing activities associated with the construction of the Project.

The evaluation of cultural resources for the Build Alternatives included a phased approach of literature review (previously recorded and/or designated historic and archeological resources within the respective APEs), background research (review of historic and modern aerial photographs and topographic maps) and field survey; all of which informs the reporting, evaluation and assessment of impacts.

The literature review, background research and fieldwork conducted for the historic resources investigation found a total of 858 sites (containing 1,334 resources) located within the historic resources APE. FRA documented 407 sites (containing 628 resources) of the total historic resources within the APE during fieldwork. Not all of the historic resources identified through the literature review and background research could be documented in the field due to the lack of visibility from the public ROW and changes to the Build Alternatives that caused additional historic resources to be identified within the APE post-fieldwork. FRA did not evaluate resources not documented during fieldwork for NRHP eligibility at this time. Field documentation and NRHP evaluation of the undocumented resources will be completed during a subsequent phase of fieldwork and prior to construction.

As part of the background research of the Build Alternatives, FRA identified a total of 20 previously recorded archeological resources within the archeological APE. During the survey, FRA documented three previously unrecorded archeological sites along with four historic isolated archeological resources. To date, the archeological resources survey has covered 2,289.88 acres in the counties of Ellis, Navarro, Freestone and Leon. Approximately 88 percent of the archeological APE remains unsurveyed for archeological materials. Additional archeological resources survey and NRHP eligibility evaluation will be conducted during a subsequent phase of fieldwork and prior to construction.

Of all of the sites identified and reviewed, the cultural resources evaluation resulted in an impact assessment of 30 potential NRHP-eligible historic properties, including both historic and archeological resources. The potential impacts to these resources was distinguished as either direct or indirect, based on the location of the resource being within or outside of the Build Alternatives LOD. The distinction is that construction and operation of the Build Alternatives could have a direct adverse impact on resources within the LOD and an indirect adverse impact on resources outside of the LOD, but within the historic resources APE. Build Alternatives A and B have the potential to adversely impact 11 resources, Build Alternatives C, D and E have the potential to adversely impact 10 resources, and Build Alternative F has the potential to adversely impact 9 resources. Impacts associated with the Houston Industrial Site Terminal Station option are included in these findings. To date, no archeological sites within the Build Alternatives LOD have been listed or eligible for listing in the NRHP.

Design refinements by TCRR have considered cultural resources and resulted in avoiding or minimizing impacts to several known cemeteries. Where refinements would not avoid impacts, mitigation measures would be completed through the Programmatic Agreement that will be developed in consultation with the Texas Historical Commission (THC) and other consulting parties. Coordination of the survey results with the THC is also ongoing as part of this phased approach. The Programmatic Agreement, a legally binding document between FRA, THC, TCRR and other entities will establish the process that FRA will manage to continue the evaluation of cultural resources post-Record of Decision and prior to construction.

Table 16: Historic Properties Impacts by Build Alternative

	ALT A	ALT B	ALT C	ALT D	ALT E	ALT F
Adverse Impacts	10	10	9	9	9	8

Source: AECOM, 2017

ES.9.21 Soils and Geology

FRA evaluated the existing soil and geological conditions along the Build Alternatives to determine if the necessary soil and geological setting to plan safe and cost-effective construction practices, as well as structurally sound facilities, would be present.

Permanent changes to the landscape would be necessary for operation of the HSR system. These changes would include structure types such as HSR bridges, roadway bridges, crash walls, retaining walls, noise walls, fences and utilities. In addition, some portions of the Build Alternatives would require the construction of embankments, which includes cutting, excavation and grading into existing subsurface materials at varying depths as well as vegetation removal. With the implementation of standard engineering design measures, it would be anticipated that the potential impacts to soil and geologic conditions from the Build Alternatives would not be adverse.

Table 17: Soil Characteristics and Area of Potential Impacts by Build Alternative

Characteristic		Area of Potential Impacts (acres)					
		ALT A	ALT B	ALT C	ALT D	ALT E	ALT F
LOD Area		10,136.2	10,229.8	10,264.9	10,119.2	10,212.7	10,247.8
Shrink-Swell Potential	Moderate	1,416.4	1,400.7	1,447.7	1,416.4	1,400.7	1.447.7
	High	2,698.0	2,780.7	2,761.3	2,675.7	2,758.4	2,739.0
	Very High	3,140.2	3,161.5	2,902.8	3,145.6	3,166.9	2,908.2
Erosion Potential	Moderate	3,605.6	3,699.8	3,589.8	3,506.4	3,600.6	3,490.6
	High	2,605.9	2,533.5	2,485.9	2,605.9	2,533.5	2,485.9
Corrosion Potential	Moderate	2,318.3	2,265.6	2,779.9	2,318.3	2,265.6	2,779.9
	High	7,666.0	7,799.3	7,321.8	7,649.2	7,782.4	7,304.9
Prime Farmland Soils		5,832.0	5,941.9	5,308.3	5,800.9	5,910.8	5,277.3
Surface Mines		0*	0*	0*	0	0	0

Source: NRCS, 2013 and NRCS, 2015

* One resource was identified through GIS point data outside of the Study Area. Limits would need to be field-verified to confirm or discount presence in the Study Area.

ES.9.22 Greenhouse Gas Emissions/Climate Change

This assessment identifies potential climate change impacts resulting from construction and operation of the Build Alternatives, as compared to the No Build Alternative, and identifies mitigation measures that may be required to minimize impacts. An assessment of greenhouse gas (GHG) emissions produced by on and off-road equipment necessary for construction of the Build Alternatives was conducted to measure annual GHG. The assessment found that construction emissions would represent 0.02 percent of total annual GHG emissions statewide, representing a negligible impact.

Long-term induced activities that would contribute to GHG emissions for the Build Alternatives would be vehicle and bus travel on roadways, air travel between Dallas and Houston and power generation for the electricity consumed by the HSR trains, stations and TMFs. For vehicle and bus travel, GHG emissions would be generated by passengers traveling to and from the stations, but would be reduced due to passengers using electric trains instead of cars and buses to travel between Dallas and Houston.

Power plant GHG emission factors reflect current and historical data and projected future year emissions that account for more stringent standards and improvements in emissions controls. Compared to the most current (2013) state-level GHG annual emissions estimate of 641 million metric tons, the reduction (.417 million metric tons annually) would be a small percentage. However, this would be a long-term reduction. Therefore, the Build Alternatives would have a small, but long-term positive effect on GHG emissions.

HSR use between Dallas and Houston would also be expected to replace some air travel between the two cities. On average, this would result in approximately a 50 percent reduction when changing travel mode from aircraft to HSR. Overall, net reductions to shifting from the aircraft mode would be small for the Build Alternatives due to the minor percentage (9 percent) of the existing mode share for aircraft between Dallas and Houston.

In total, the Build Alternatives operation emissions would result in a long-term net reduction of GHG that would offset emissions produced during construction in less than two years at full operation and continue to achieve net reduction of GHG for the life of the project. Considering the net reduction and offset, the long-term impact of the Build Alternatives would be beneficial.

Additionally, the assessment examined possible impacts related to the effects of climate change. Potential events include increased precipitation and flooding, increased temperature, extreme heat events, drought and wildfire. Safety features built into the HSR system would mitigate potential impacts from these events.

ES.9.23 Section 4(f)/Section 6(f)

Federal regulations require that projects impacting Section 4(f) resources – publicly owned parks, recreation areas, wildlife or waterfowl refuges and historic sites of significance – make a special effort to avoid or protect those resources. One Section 4(f) resource, Fort Boggy Park, would be impacted by Build Alternatives C and F. However, impacts associated with the Build Alternatives would not adversely affect the activities, features and attributes that qualify this property for protection under Section 4(f). Therefore, after considering measures to minimize harm (such as avoidance, minimization, mitigation or enhancement measures) the preliminary determination is that the impacts associated with the use of this Section 4(f) property would be *de minimis* pursuant to 23 C.F.R § 774(b). Therefore, a discussion of avoidance alternatives is not required. In accordance with 23 C.F.R §774.5, the public review of this Draft EIS provides an opportunity for public comment concerning the effects of the Build Alternatives to Fort Boggy State Park. Concurrently, subsequent to the release of this Draft EIS, FRA will coordinate with TPWD, as the official with jurisdiction over this resource, to discuss the preliminary findings and receive TPWD's determination and/or concurrence in compliance with the Section 4(f) consultation process.

The Build Alternatives would require the use of seven historic resources: Cadiz Street Underpasses and Overpasses, Guiberson Corporation (two resources), Honey Springs Cemetery, Smith Family Cemetery, Linfield Elementary School and HA.004a. All of these historic resources would be located on common segment. The impacts associated with the Build Alternatives would have direct adverse effects on the properties which are protected under Section 4(f). Therefore, after preliminary determination, the impacts to these Section 4(f) properties would constitute a *use* pursuant to 23 C.F.R § 774(b).

In addition, one resource, Dallas Floodway Historic District, located within the LOD of Segment 1 and common to all of the Build Alternatives, was considered to have no adverse effects. Therefore, after considering measures to minimize harm (such as avoidance, minimization, mitigation or enhancement measures) the preliminary determination is that the impacts associated with the use of this Section 4(f) property would be *de minimis* pursuant to 23 C.F.R § 774(b). In accordance with 36 C.F.R §800, THC must concur with the findings concerning the effects of the Build Alternatives to the Dallas Floodway Historic District. Concurrently, subsequent to the release of this Draft EIS, FRA will continue to consult with the THC, the official with jurisdiction over this resource.

The Industrial Site Terminal Option in Houston would require the use of the Tex-Tube Complex, a historic resource in Harris County. The preliminary determination is that the construction of the Industrial Site Terminal Station option would result in a Section 4(f) use of this resource pursuant to 23 C.F.R § 774(b) because the entire 38.95 acres are considered a full acquisition for the construction of the Industrial Site Terminal option, which would consist of parking, transportation alterations, pedestrian accessibility and landscaping improvements. Because there are two feasible and prudent alternative terminal station options in Harris County— the Northwest Mall Terminal Station option and the Northwest Transit Center Terminal Station option —FRA may not approve the use of the Industrial Site Terminal Station option.

Section 6(f) resources are properties acquired under the Land and Water Conservation Fund for use as a public outdoor recreation resource. These resources cannot be converted to another use without approval of the Department of Interior. There is one resource within the Study Area protected under Section 6(f), the City of Dallas' Trinity River Greenbelt. The Trinity River Greenbelt is owned by the City of Dallas. The City of Dallas received the Land and Water Conservation Fund Grant in 1971 for an amount of $256,360.28 that was used to acquire the greenbelt. The project was completed in 1972. At its closest point, the greenbelt is 700 feet from the Segment 1 and common to all Build Alternatives. This property is not within the LOD; therefore, no conversion of Section 6(f) property would occur. There are no other Section 6(f) properties within a quarter-mile of the Build Alternatives.

ES.10 FRA's Preferred Alternative

All Build Alternatives would impact USACE-owned property in Dallas County and require Section 408 authorization from the USACE. Either Segment 2A or 2B, located in Ellis County, would be selected for all Build Alternatives. While both would cross the Lake Bardwell flowage easement, Segment 2B would cross fee land and would require Section 408 authorization. Further coordination with USACE determined that per the USACE National Non-Recreation Outgrant Policy, the segment proposed to cross fee land would be denied and not carried forward in the USACE evaluation criteria as there is a viable alternative not on federal property. This would result in the removal of Build Alternatives D, E and F, which include Segment 2B, from further consideration as the preferred alternative.

Section 4(f) prohibits a Federal agency from approving a project that would result in the use of significant parks, recreation areas, wildlife and waterfowl refuges, or historic sites if there is a feasible and prudent alternative to the use of the resource. FRA has determined that the Preferred Alternative would result in the use of seven historic sites protected by Section 4(f). However, because all of the affected sites are located on common segments, Section 4(f) was not a factor in distinguishing among the Build Alternatives.

For most resource areas, there are no distinguishable differences among the Build Alternatives. For example, the difference in estimated emissions from both the construction and operation for each of the Build Alternatives would be negligible due to similar length and location. Likewise, the benefits of reduced emissions from automobiles would be the same across all Build Alternatives because ridership would not vary under each Build Alternative.

Environmental resources that have a negligible difference in the identification of a preferred alternative include:

- Air Quality
- Water Quality
- Hazardous Materials
- Utilities and Energy
- Aesthetic and Scenic Resources
- Elderly and Handicapped
- Electromagnetic Fields
- Public Safety and Security
- Recreational Facilities
- Environmental Justice
- Soils and Geology
- Greenhouse Gas Emissions and Climate Change

Environmental resources that differentiate Build Alternatives A, B, and C are presented in **Table 18**. These resources are not weighted, meaning that no one criterion is more meaningful than another.

Table 18: Comparison of Build Alternatives A, B and C

Evaluation Criteria	Measure	Alt A	Alt B	Alt C
Noise				
Severe Noise Impacts to Residences	Count	17	19	15
Natural Resources				
Protected Species Habitat - Temporary	Acres	341	341	337
Protected Species Habitat - Permanent	Acres	1,334	1,334	1,669
Waters of the U.S.				
Stream Crossings – Temporary	Feet	14,719	15,375	15,842
Stream Crossings – Permanent	Feet	48,710	51,909	46,110
Wetlands – Temporary	Acres	19.3	10.8	13.2
Wetlands – Permanent	Acres	102	104	106
Waterbodies – Temporary	Acres	7.4	7.3	6.7
Waterbodies – Permanent	Acres	38.0	34.3	26.6
Total Acres of Intersected Floodplain	Acres	653	612	648

Table 18: Comparison of Build Alternatives A, B and C				
Evaluation Criteria	**Measure**	**Alt A**	**Alt B**	**Alt C**
Transportation				
Length added to Public Roads	Miles	18.0	20.0	47.9
Length removed from Public Roads	Miles	11.0	11.1	26.9
Land Use				
LU Conversion – Temporary	Acres	2,176.6	2,185.6	2,035.6
LU Conversion – Permanent	Acres	7,957.4	8,042.1	8,217.3
Special Status Farmland – Temporary	Acres	1,563.8	1,561.6	1,546.1
Special Status Farmland – Permanent	Acres	4,268.2	4,380.4	4,003.9
Special Status Farmland – Indirect	Acres	896.5	924.9	825.8
Displacement – Business	Count	49	49	68
Displacement – Residence	Count	283	293	272
Estimated Permanent Parcel Acquisitions	Count	1,970	2,025	1,980
Estimated Temporary Parcel Acquisitions	Count	191	200	169
Estimated Structure Acquisitions – Agriculture	Count	133	139	117
Estimated Structure Acquisitions – Commercial	Count	8	8	12
Estimated Structure Acquisitions – Cultural Resources	Count	1	1	0
Estimated Structure Acquisitions – Residence	Count	65	69	56
Estimated Structure Acquisitions – Transportation and Utilities	Count	1	1	0
Cultural Resources				
Adverse Impacts to Historic Properties	Count	10	10	9

Source: AECOM, 2017

FRA's federal action related to the Project focuses on the evaluation of the safety of the system. The introduction of 45 miles of adjacent rail and highway frontage roads as a result of Build Alternative C would require a safety barrier to prohibit vehicular drivers from impacting the track infrastructure. Due to this added safety component, FRA does not recommend Build Alternative C as the preferred alternative.

Build Alternatives A and B do not require the added safety barriers. When the environmental impacts of each Build Alternatives is compared, Build Alternative A would have fewer permanent impacts to the socioeconomic, natural, physical and cultural resources environment as noted in **Table 18** and described in the text above. Therefore, FRA identifies Build Alternative A as the preferred alternative.

FRA has not identified a preferred alternative for the Houston Terminal Station at this time. FRA will continue to analyze all Build Alternatives and Houston station options through the Final EIS. Focused analysis on the preferred alternative and Houston station options will be completed in coordination with federal agencies to support permit applications, biological opinions and Section 106 consultation. The preferred alternative will be vetted during the public and agency review period of the Draft EIS. These comments will inform FRA's preparation of the Final EIS and its selection of a preferred alternative in the Record of Decision.

ES.11 Next Steps in the Environmental Process

The EIS has been prepared with public and agency involvement, which is summarized in **Chapter 9.0, Public and Agency Involvement.**

FRA is circulating the Draft EIS to affected local jurisdictions, state and federal agencies, tribes, community organizations and other interested groups, interested individuals and the public. FRA will circulate the Draft EIS for a 60-day comment period, which will include public hearings, to accept agency and public comment on the contents of the document, including FRA's Preferred Alternative.

After taking into account comments received on the Draft EIS, FRA will prepare a Final EIS that will include responses to comments. As part of the Final EIS, the public will have another opportunity to comment on the Project.

Upon completion of the Final EIS, FRA expects to issue a Record of Decision (ROD) for compliance with NEPA.

Dallas to Houston High-Speed Rail
Draft Environmental Impact Statement

TABLE OF CONTENTS

Appendices

List of Tables

List of Figures

List of Acronyms

ACGIH	American Conference of Governmental Industrial Hygienists
ACS	American Community Survey
ADA	Americans with Disabilities Act of 1990
AMSL	above mean sea level
ANSI	American National Standards Institute
APE	Area of Potential Effect
AST	aboveground storage tanks
AU	Assessment unit
AU ID	Assessment Unit identification
AVE	Area of Visual Effect
BA	Bardwell
BMP	Best Management Practices
BO	biological opinion
BTU	British Thermal Units
BVCOG	Brazos Valley Council of Governments
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation and Liability
CESQG	Conditionally Exempt Small Quantity Generator
CFR	Code of Federal Regulations
CH4	methane
CM	Compliance Measure
CO	carbon monoxide
CO_2	carbon dioxide
CO2e	Carbon Dioxide equivalents
CORRACTS	Corrective Actions
CR	Corsicana
CSA	Combined Statistical Area
CWA	Clean Water Act
CWR	continuously welded rail
CWS	Community Water System
DAL	Dallas Love Field
dB	decibels
dBA	A-weighting system
DFIRM	Digital Flood Insurance Rate Map
DFW	Dallas-Fort Worth International Airport
DH	Downtown Houston
DHS	Department of Homeland Security
DNPL	Delisted National Priorities List
DOT	U.S. Department of Transportation
ECOS	Environmental Conservation Online System

EIA	Energy Information Administration
EIS	Environmental Impact Statement
EJ	Environmental Justice
ELF	extremely low frequency
EM	electromagnetic
EMF	electromagnetic field
EMI	electromagnetic interference
EMS	emergency medical services
EMST	Ecological Mapping Systems of Texas
EMU	Evaluation Mapping Units
EO	Executive Order
EOR	Elements of Occurrence
ERCOT	Electric Reliability Council of Texas
F	Fahrenheit
FBI	Federal Bureau of Investigation
FCC	Federal Communications Commission
FEMA	Federal Emergency Management Agency
FHWA	Federal Highway Administration
FIRM	Flood Insurance Rate Maps
FM	Farm to Market
FOS	Final Operating Scenario
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
G	gauss
GCD	Groundwater Conservation Districts
GHG	Green House Gas
GHz	gigahertz
GIS	Geographic Information Systems
GLO	Texas General Land Office
GNIS	Geographic Names Information Service
GPS	Global Positioning System
GTD	Global Terrorism Database
GW	Groundwater
GWP	Global Warming Potential
Has	habitat suitability analysis
HC	Hockley
HCFC	hydrochlorinated fluorocarbons
HCM	Highway Capacity Manual
HDM	Hydraulic Design Manual
HEC	Hydraulic Engineering Circular
H-GAC	Houston-Galveston Area Council
HGB	Houston-Galveston-Brazoria
HGSD	Harris-Galveston Subsidence District

HMTA	Hazardous Materials Transportation Act
HOTCOG	Heart of Texas Council of Governments
HOU	Houston Hobby Airport
HSIPR	High Speed Intercity Passenger Rail
HSR	high-speed passenger rail
HTC	Historic Texas Cemeteries
HUC	Hydrologic Unit Code
HUD	Housing and Urban Development
Hz	Hertz
Hz	hertz
IAH	Houston George Bush Intercontinental Airport
ICNIRP	International Commission on Non-Ionizing Radiation Protection
IEEE	Institute of Electric and Electronics Engineers
IH	Interstate Highway
IHW	Industrial Hazardous Waste
IOP	Innocent Owner/Operator
IPaC	Information for Planning and Conservation
IR	infrared
ISA	Initial Site Assessment
JRC	Central Japan Railway Company
kHz	kilohertz
Kns	Nacatoch Sand Formation
Ko	Ozan geological formation
kV	kilovolt
KVP	Key viewpoint
Kwc	Wolfe City geological formation
Ldn	Day-Night Sound Level
LEP	limited English proficiency
LI	low income
LOD	Limit of Disturbance
LOS	Level of Service
LPST	Leaking Petroleum Storage Tank
LQG	Large Quantity Generator
LT	long-term noise monitoring sites
LU	Landscape unit
LWCF	Land and Water Conservation Fund
MAP ID	map identification number
MBTA	Migratory Bird Treaty Act of 1918
MD	Middle
µg/m3	micrograms per cubic meter
µT	microTesla
mg/m3	milligrams per cubic meter
MHz	megahertz

MM	mitigation measures
MMBTU	Million BTUs
MMI	Modified Mercalli Intensity
MOW	Maintenance-of-Way
MPE	maximum permissible exposure
mph	miles per hour
MPO	Metropolitan Planning Organization
MS4	Municipal Separate Storm Sewer System
MSAT	mobile source air toxics
MSD	Municipal Setting Designations
MTP	Metropolitan Transportation Plan for North Central Texas
mW/cm2	milliwatts per square centimeter
N2O	nitrous oxide
NAAQS	National Ambient Air Quality Standards
NCA	U.S. National Climate Assessment
NCHRP	National Cooperative Highway Research Program
NCTCOG	North Central Texas Council of Governments
NEPA	National Environmental Policy Act
NHD	National Hydrography Dataset
NHL	National Historic Landmarks
NHPA	National Historic Preservation Act
NIEHS	National Institute of Environmental Health Sciences
NIH	U.S. National Institutes of Health
NO_2	nitrogen dioxide
NOA	Notice of Availability
NOAA	National Oceanic Atmospheric Association
NOV	Notice of Violation
NO_x	nitrogen oxide
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NPS	National Park Service
NRCS	Natural Resources Conservation Service
NRHP	National Register of Historic Places
NT	neutral temperature
NTNCWS	Non-Transient Non-Community Water System
NWI	National Wetlands Inventory
O_3	ozone
OET	Office of Engineering and Technology
OSHA	Occupational Safety and Health Administration
OTHM	Official Texas Historic Markers
PA	Programmatic Agreement
PAH	Polycyclic Aromatic Hydrocarbons

Pb	lead
PCB	Polychlorinated Biphenyl
PM	particulate matter
ppm	parts per million
PST	Petroleum Storage Tank
Ql	Lissie geological formation
Qw	Willis geological formation
RCC	Railroad Commission of Texas
RCRA	Resource Conservation and Recovery Act
RF	radio frequency
ROD	Record of Decision
ROW	right-of-way
RPZ	Runway Protection Zone
RTEST	Rare, Threatened and Endangered Species of Texas
RTHL	Recorded Texas Historic Landmarks
RTP	Regional Transportation Plan
SAL	State Antiquities Landmarks
SFHA	Special Flood Hazard Areas
SH OSR	State Highway – Old San Antonio Road
SHPO	State Historic Preservation Office
SIP	State Implementation Plan
SO_2	sulfur dioxide
SP	sectioning posts
SQG	Small Quantity Generator
SSP	sub-sectioning posts
SSURGO	Soil Survey Spatial and Tabular Data
ST	short-term noise monitoring sites
START	Study of Terrorism and Responses to Terrorism
STATSGO2	U.S. General Soil Map by State
STB	Surface Transportation Board
SVOC	Semi Volatile Organic Compound
SWA	Southwest Airlines
SWPPP	Storm Water Pollution Prevention Plan
T	tesla
TAC	Texas Administrative Code
TARL	Texas Archeological Research Laboratory
TCEQ	Texas Commission on Environmental Quality
TCP	Texas Central Partners
TCR	Texas Central High-Speed Railway, LLC
TCRR	Texas Central Railroad
TDEM	Texas Division of Emergency Management
TDS	Total dissolved solids
TEXU	Texas Utilities General Company

THC	Texas Historical Commission
THPO	Tribal Historic Preservation Office
TMDL	Total Maximum Daily Load
TMF	Trainset Maintenance Facility
TNCWS	Transient Non-Community Water System
TPDES	Texas Pollutant Discharge Elimination System
TPH	Total Petroleum Hydrocarbon
TPSS	Traction Power Substation
TPWD	Texas Parks and Wildlife Department
TRE	Trinity Railway Express
TSD	Hazardous Waste Treatment, Storage and Disposal facilities
TSHA	Texas State Historical Association
TUEX	TU Electric Big Brown Steam Electric Station Rail
TWDB	Texas Water Development Board
TxDOT	Texas Department of Transportation
TXNDD	Texas Natural Diversity Database
TxWRAP	Texas A&M Wildlife Risk Assessment Portal
UCR	Uniform Crime Reporting
UPRR	Union Pacific Railroad
USCB	U.S. Census Bureau
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
USGS	United States Geological Survey
UST	Underground Storage Tanks
V/m	volts per meters
VdB	vibration decibels
VMT	vehicle miles traveled
VOC	volatile organic compounds

1.0 INTRODUCTION

The United States Department of Transportation's (DOT) Federal Railroad Administration (FRA) is preparing this Environmental Impact Statement (EIS) in compliance with the National Environmental Policy Act (NEPA) (42 U.S.C. § 4231 et seq) to assess the potential beneficial and detrimental effects of implementing the proposed Dallas to Houston High-Speed Rail Project (Project). This EIS documents FRA's evaluation of Texas Central Railway's, LLC (TCR) and its affiliates' proposal to construct and operate a 240-mile, for-profit, high-speed passenger rail (HSR) system connecting Dallas and Houston using the Japanese N700 Tokaido Shinkansen technology.

FRA initiated this EIS to evaluate and document the possible environmental impacts of the Project as required by NEPA, Council on Environmental Quality (CEQ) NEPA regulations (40 Code of Federal Regulations (C.F.R.) Parts 1500-1508), and the FRA's *Procedures for Considering Environmental Impacts* (64 Fed. Reg. 28545 (May 26, 1999) as updated in 78 Fed. Reg. 2713 (Jan. 14, 2013)). FRA is the lead agency for the preparation of this EIS, in cooperation with Environmental Protection Agency (EPA), Federal Highway Administration (FHWA), Federal Transit Administration (FTA), the Surface Transportation Board (STB), United States Army Corps of Engineers (USACE) and United States Fish and Wildlife Service (USFWS). More detail regarding the permitting role of specific cooperating agencies is discussed in **Chapter 8.0, Applicable Federal, State and Local Permits and Approvals**. The Texas Department of Transportation (TxDOT) provided technical assistance to FRA in the preparation of the EIS. Other federal, state and local agency stakeholders directly involved in implementation of the Project include a wide range of entities that were identified and coordinated with during this EIS process, as detailed in **Chapter 9.0, Public and Agency Involvement**.

FRA has jurisdiction over every area of railroad safety and is authorized to prescribe regulations and issue orders as necessary for railroad safety (49 U.S.C. § 20101 et seq.; 49 C.F.R. § 1.89, Parts 200-299). Current FRA regulations do not comprehensively address safety requirements for train operations above 150 miles per hour (mph), such as the Project's proposed operations. Therefore, FRA may issue a Rule of Particular Applicability (regulations that apply to a specific railroad or a specific type of operation (RPA)), impose requirements or conditions by order(s) or waiver(s), or take other regulatory action(s) to ensure the Project is operated safely. This regulatory action(s) constitutes a major federal action and triggers the environmental review under NEPA. Additionally, one or more companies affiliated with TCR may apply to DOT for credit assistance through the Railroad Rehabilitation and Improvement Financing (RRIF) (45 U.S.C. § 821 et seq.) or Transportation Infrastructure Finance and Improvement Act (TIFIA) (23 U.S.C. Parts 601-609) programs to finance a portion of the Project. Should DOT provide credit or other financial assistance, this activity would also constitute a major federal action.

TCR, Texas Central Railroad (TCRR) and Texas Central Partners (Texas Central or TCP) are affiliated companies involved in the development of the Project. TCR is responsible for planning and coordinating with FRA for the NEPA regulatory approvals for the Project, which would include a Record of Decision for the EIS and related permits. TCRR submitted a petition for a Rule of Particular Applicability to FRA. Texas Central is the parent company of TCRR, and other corporate entities that are responsible for Project development and implementation (i.e., design, construction, financing, and operation). As the entity responsible for the petition for a Rule of Particular Applicability, TCRR is identified as the Project Proponent throughout this EIS.

In addition to the purpose and need for the Project, this chapter discusses the Project background and history, and outlines the organization of this EIS.

1.1 Project History and Federal Involvement

1.1.1 Project History

The United States-Japan High-Speed Rail was created on behalf of the Central Japan Railway Company (JRC) to conduct a corridor analysis to identify viable HSR corridors for development within the United States (U.S.). JRC's investment corridor analysis, completed in 2009, evaluated 97 city pairs nationwide to determine an optimal location for implementation of the N700 Tokaido Shinkansen HSR system within the U.S. JRC's privately funded analysis identified Dallas/Fort Worth (DFW) to Houston as the most viable HSR city pair in the U.S. These results were based primarily on the strength of the combined size and projected growth of the two metropolitan areas, economic vitality of the state and regions and a demonstrated need for airway and highway congestion relief within the Interstate Highway 45 (IH-45) corridor. The approximately 240-mile Dallas to Houston corridor is within what JRC identified as the optimal range for HSR service compared to air travel. Furthermore, the Dallas to Houston corridor stretches across a relatively flat and mostly rural terrain that provides what JRC identified as ideal grades for HSR construction and operation.

Upon completion of the investment corridor analysis in 2009, the Texas-based TCR was formed to promote the development and operation of a private, for-profit, reliable HSR system connecting Dallas to Houston. TCR developed preliminary engineering reports and other studies to evaluate technical challenges, practicability and the extent of any environmental "fatal flaws." Based on this analysis, TCR determined that the Project was viable and initiated preparatory work with respect to system safety in in order to submit a request to FRA for regulatory action.

In May 2011, FRA awarded a $15 million High Speed Intercity Passenger Rail (HSIPR) grant to TxDOT to complete preliminary engineering and project level environmental studies for a new HSR core express service between DFW Metroplex and Houston. Prior to initiating the work, TCR approached TxDOT with a proposal to privately implement HSR in this corridor. TxDOT conferred with FRA and both agencies agreed to suspend any federally funded studies in the Dallas to Houston corridor. Subsequently, FRA amended TxDOT's grant to only include the evaluation of the Dallas to Fort Worth Core Express Service Project as a separate environmental review.

1.1.2 U.S. Department of Transportation

1.1.2.1 Rule of Particular Applicability

As stated previously, FRA does not currently have comprehensive regulations for the safety of train operations above 150 mph – the Project's proposed train operating speeds. To establish such minimum safety requirements for the Project, TCRR is requesting FRA adopt a regulation that applies to its specific railroad operation, called a Rule of Particular Applicability. In April 2016, after extensive consultation with FRA's Office of Railroad Safety, TCRR submitted a petition for a Rule of Particular Applicability to FRA. FRA is currently evaluating TCRR's petition for a Rule of Particular Applicability (Docket Number FRA-2016-0044). In order to issue any regulation, including a Rule of Particular Applicability, FRA follows basic steps that include:

1. Identifying the need for the rule (e.g., to address a safety issue or a U.S. Congressional mandate).
2. Developing the proposed rule and supporting documentation.
3. Publishing the proposed rule , called a Notice of Proposed Rulemaking, in the *Federal Register* and soliciting public comment.
4. Evaluating written comments from the public and, if a public hearing is requested, comments made during a public hearing on the Notice of Proposed Rulemaking.
5. Developing the Final Rule and supporting documentation.
6. Publishing the Final Rule in the *Federal Register*.

Information on FRA's rulemaking process, including Notices of Proposed Rulemaking, can be found online at: https://www.fra.dot.gov/Page/P0084.

As of this writing, FRA has not issued a Notice of Proposed Rulemaking for TCRR's proposed Rule of Particular Applicability. Because the proposed Rule of Particular Applicability constitutes a major federal action and triggers the environmental review under NEPA, FRA cannot publish a Final Rule prior to the issuance of the agency's Record of Decision, which is the final step in the NEPA environmental review process. Further, TCRR cannot operate the Project without FRA's Final Rule or other FRA regulatory action.[1]

1.1.2.2 DOT Credit or Financial Assistance

As noted above, one or more companies affiliated with TCR may apply to the DOT for credit assistance through the RRIF or TIFIA programs to finance a portion of the Project. These are the two primary credit programs maintained by the DOT and are overseen by the Build America Bureau. Should DOT provide credit or financial assistance, this activity would constitute a major federal action.

Through the TIFIA program, DOT provides credit assistance in the form of direct loans, loan guarantees, and standby lines of credit to projects of national or regional significance. State and local governments, state infrastructure banks, special authorities, Transportation Improvement Districts, and private firms are eligible applicants. Eligible projects include passenger rail vehicles and facilities, among others. Eligibility requirements include creditworthiness and fostering partnerships that attract public and private investment in the project. Under the RRIF program, DOT provides credit assistance in the form of direct loans and loan guarantees to finance acquisition, improvement, rehabilitation, and development of intermodal or railroad equipment or facilities and some types of related infrastructure. Eligible RRIF applicants include state and local governments, government sponsored authorities and corporations, railroads, and joint ventures that include an eligible entity. In addition to its credit programs, DOT has authority to allocate private activity bonds for qualified surface transportation projects. A DOT private activity bond allocation provides private developers and operators with access to tax-exempt interest rates for bonds issued for these types of projects.

[1] A Rule of Particular Applicability alone is insufficient for the Project to begin operations. TCRR would also need to demonstrate to FRA that the Project meets the minimum requirements identified in the RPA to begin operations. Likewise, TCRR would also need to demonstrate to FRA that the Project meets the minimum conditions or requirements FRA imposes by order(s) or waiver(s), or through other regulatory action(s), to ensure the Project is safely operated.

1.1.3 Roles of Cooperating Agencies

1.1.3.1 U.S. Army Corps of Engineers

The USACE is not a proponent or opponent of the Project. As a cooperating agency and as part of their permitting process, the USACE intends to use FRA's EIS to the maximum extent practicable to address the USACE's evaluation of a Department of Army (DA) permit and decision regarding impacts to wetlands and waters of the U.S. in accordance with Section 404 of the Clean Water Act of 1972 (33 U.S.C. § 1344) and Section 10 of the Rivers and Harbors Act of 1899 (33 U.S.C. § 403). In addition to its public interest evaluation and determination, the USACE is required to conclude whether the applicant's proposal is the Least Environmentally Damaging Practicable Alternative (LEDPA) in association with the 404(b)(1) guidelines. The USACE shall use this EIS and its appendices as a base document for their review and supplemental analysis of USACE impacts. For example, the USACE shall evaluate the Project for potential impacts to USACE federally authorized civil works projects under Section 14 of the Rivers and Harbors Act of 1899 and codified in 33 U.S.C. 408 (commonly known as Section 408). Chapter 8.0, Applicable Federal, State and Local Permits and Approvals provides more information on the USACE's permitting role on the Project. TCRR will complete the permit application and submit it to the USACE for review. This is a separate federal action from FRA's determination on the safety of the system. The USACE will complete additional analyses to support their review of TCRR's permit application. This includes the preparation of environmental analysis for compliance with NEPA and may involve a separate process under Section 106 and the National Historic Preservation Act.

Additional USACE analyses and associated environmental documentation will be completed in conjuction with FRA's NEPA review. The public notice for the USACE's review of TCRR's permit application is available for review at http://www.swf.usace.army.mil/Media/Public-Notices/.

1.1.3.2 Surface Transportation Board

The Surface Transportation Board (STB) regulates and resolves disputes involving railroad rates, railroad mergers or sales, and certain other transportation matters involving railroads under its jurisdiction. In April 2016, Texas Central International, also an affiliate of Texas Central, submitted two petitions to STB for the Project: 1) a Petition for Exemption, asking STB to assert jurisdiction over the Project; and 2) a Petition for Clarification, asking STB to provide expedited clarification related to the early acquisition of property supporting the Project. Prior to the review of Texas Central's petitions, STB accepted FRA's invitation to serve as a cooperating agency. At the time of their acceptance, both STB and FRA were unclear if STB's engagement would be as a cooperating agency or if they would not participate in FRA's EIS process. In the event that STB took jurisdiction of the Project, this EIS would have served as the base document to support their evaluation. On July 18, 2016, STB dismissed Texas Central's proceedings for lack of jurisdiction. Therefore, implementation of the Project does not require STB's approval, though STB remains a cooperating agency. STB's decision[2] can be found online at: www.stb.gov under docket number: FD_36025_0.

[2] Surface Transportation Board, "Surface Transportation Board Decision Document," July 18, 2016

1.1.3.3 Other Cooperating Agencies

EPA has special expertise in regard to the Clean Water Act of 1972 (33 U.S.C. § 1344), Rivers and Harbors Act of 1899 (33 U.S.C. § 403) and the Clean Air Act of 1970 (42 U.S.C. § 7401).

FHWA may have an approval role related to certain road crossings or construction within federal right-of-way (ROW).

FTA has special expertise in intermodal passenger service. No approvals or permits from FTA are anticipated.

USFWS may have an approval role related to protected and endangered species and suitable habitat under the Endangered Species Act of 1973 as amended (16 U.S.C. § 1531 et seq.), Migratory Bird Treaty Act of 1918 (16 U.S.C. § 703-712; 50 C.F.R. 1) and Bald and Golden Eagle Protection Act of 1972 (16 U.S.C. § 668).

1.2 Purpose and Need for the Dallas to Houston High-Speed Rail Project

The following sections describe the purpose and need for the Project. The purpose and need provides the basis for identifying, evaluating and comparing corridor and alignment alternatives (known as the Build Alternatives in **Chapter 2.0, Alternative Analysis**), and is one of the factors considered in selecting a preliminary preferred alternative.

1.2.1 Purpose

The purpose of the privately proposed Project is to provide the public with reliable and safe high speed passenger rail transportation between Dallas and Houston.[3]

1.2.1.1 FRA Objectives

FRA’s mission, “to enable the safe, reliable, and efficient movement of people and goods for a strong America, now and in the future,” supports the development of safe and reliable intercity passenger rail. FRA’s objectives are to:

- Ensure that the system operates safely in accordance with federal requirements
- Provide safe connectivity to existing transportation modes (i.e., heavy rail, light rail and bus) present throughout the DFW Metroplex and the greater Houston area
- Ensure the Project does not preclude future rail expansion opportunities on adjacent corridors
- Avoid, minimize and mitigate impacts to the human and natural environment

[3] An initial version of the Project Purpose included economic viability. As the Project developed and through coordination with cooperating agencies, FRA determined that economic viability is an objective of TCRR, not a component of the Project Purpose.

1.2.1.2 TCRR Objectives

TCRR identified the Dallas to Houston corridor as an ideal distance to implement high-speed intercity passenger rail that is financially sustainable, constructible and connects two of the largest urban centers in the country.

To achieve TCRR's financial and ridership objectives, TCRR has identified the following functional criteria for the Project:

- Technological: bullet train vehicle and operating procedures based on the N-700I Tokaido Shinkansen system
- Operational: approximate 90-minute travel time between Dallas and Houston, with achievable speeds exceeding 200 mph in a fully sealed corridor
- Environmental: minimal impacts to the natural and built environments by maximizing adjacency to existing infrastructure ROW

1.2.2 Need

The need for HSR service is a result of increasing travel demand and the deficiencies of the existing and proposed transportation infrastructure to accommodate this growing demand between Dallas and Houston. Current direct route transportation options between Dallas and Houston are limited to vehicular and air travel.[4] Due to increasing congestion on IH-45, automobile travel times between the two regions are projected to increase as travel speeds decrease. Flight time between the two regions is relatively short; however, the overall trip duration when considering pre-arrival time more than doubles. Additionally, flights are more sensitive to inclement weather and other delay-causing events from inside and outside of Texas compared to HSR.

In order to meet the needs of growing travel demand spurred by population growth and a decrease in the level of service of existing transportation systems, as discussed below, both Dallas and Houston are addressing much needed infrastructure improvements. Intercity and intracity transportation infrastructure will require significant expansion and maintenance in the future, but it is critical to provide an alternative modal option to alleviate the strain on this infrastructure.

The need for HSR as an alternative transportation mode is supported by several factors including planning studies, population growth, congestion of the state transportation system, and safety. Each of these factors is described in detail below.

1.2.2.1 Planning Studies

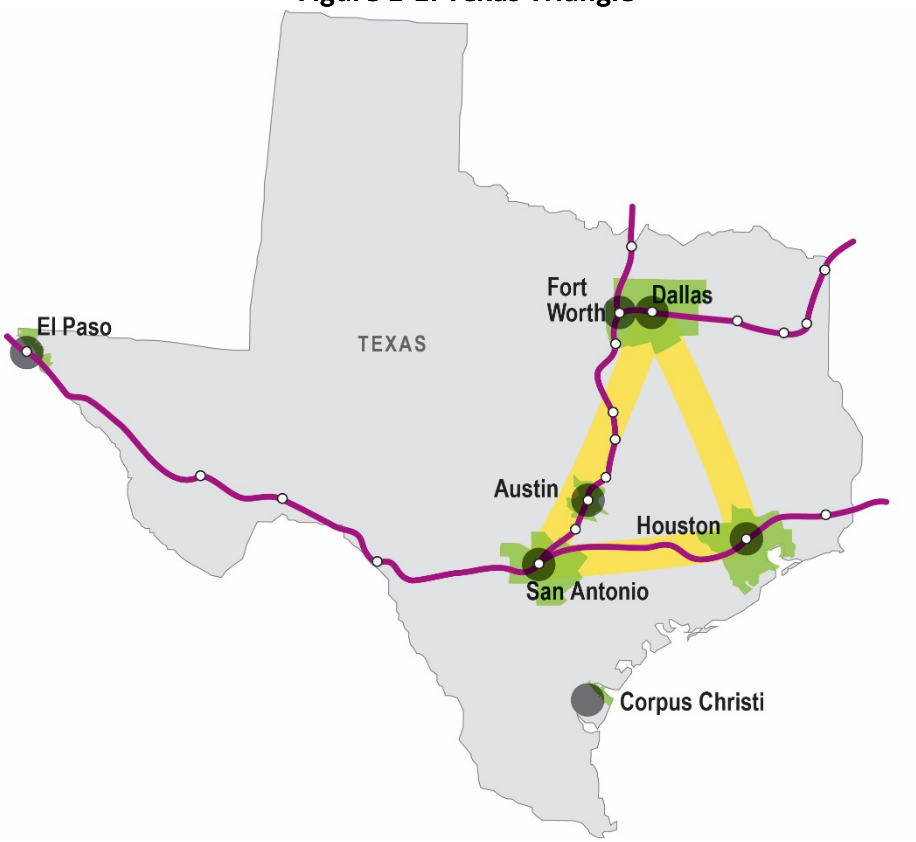
Previous studies completed by FRA and TxDOT,[5, 6] as well as past legislation, recommend HSR as a reliable transportation option to respond to the growing population within the State of Texas and to ease the stress on the existing transportation network. In 1987, the Texas Legislature directed the Texas

[4] According to TCRR's 2013 market analysis, 89 percent of the traveling public use private automobiles to travel between Dallas and Houston; 9 percent use air; and 2 percent use bus.
[5] Texas Department of Transportation, "Texas Rail Plan," May 2016, http://www.txdot.gov/government/reports/texas-rail-plan.html.
[6] U.S. Department of Transportation, Federal Railroad Administration, "Vision for High-Speed Rail in America," April 1, 2009, http://www.fra.dot.gov/eLib/Details/L02833.

Turnpike Authority to study the feasibility of developing a HSR system in the Texas Triangle, an area bound by the cities of Dallas, Houston and San Antonio as depicted in **Figure 1-1**. The Texas Turnpike Authority reported to the legislature in 1989 that an HSR system (with speeds over 150 miles per hour [mph]) would be feasible.[7]

In 1990, the Texas Legislature authorized the creation of the Texas High Speed Rail Authority. The Texas High Speed Rail Authority determined that the pursuit of HSR was in the public's interest and in 1991 the Texas High Speed Rail Authority evaluated two proposals seeking the single franchise – Texas High-Speed Rail Joint Venture (later renamed Texas FasTrac) and the Texas TGV Consortium. These proposals were reviewed by an independent panel of representatives from six firms hired by the Texas High Speed Rail Authority. Hearings opened on March 25, 1991, and it was determined that high-speed rail was in the public interest and that Texas TGV, a consortium of high-speed rail operators and financial institutions also known as the Texas High Speed Rail Corporation, was the most qualified. They were awarded the franchise in June of 1991.[8]

Figure 1-1: Texas Triangle



Source: AECOM, 2016

In 1992, the governing board of the Texas High Speed Rail Authority initiated an EIS for at-grade HSR service. By 1994, opponents of the project created legal barriers to inhibit the Texas High Speed Rail Corporation's ability to meet the technical and financial deadlines required by the Texas High Speed Rail

[7] Burns, Marc H. High-speed rail in the rear-view mirror: a final report of the Texas High-Speed Rail Authority. Austin, TX: M.H. Burns, 1995.
[8] Ibid.

Authority. Ultimately, the project was cancelled in 1994 when the State of Texas withdrew the franchise.[9]

In 2008, the U.S. Congress passed the Passenger Rail Investment and Improvement Act (PRIIA), which established the framework for developing HSR corridors. Building on this framework, the *American Reinvestment and Recovery Act of 2009* (ARRA) appropriated $8 billion to strengthen the U.S. passenger rail network and increase focus on intercity passenger rail, including the development of HSR corridors. This was supported by the April 2009 U.S. DOT High-Speed Rail Strategic Plan[10] *Vision for High-Speed Rail in America*, which reintroduced the potential for development of HSR across the U.S., including Texas.

Early planning efforts in Texas also identified potential high-speed rail corridors, including the Dallas to Houston Corridor. In 2010, TxDOT issued the *Texas Rail Plan*[11] as required by PRIIA as a prerequisite to applying for federal funding. The plan addressed the need for a long-term plan to implement statewide passenger rail. The Texas Rail Plan was developed in coordination with the Texas Transportation Commission's Strategic Plan, which focuses on promoting congestion relief strategies, enhancing safety and facilitating multimodal transportation alternatives. HSR connecting the state's most populous areas was one of the identified strategies. The State Rail Plan also included the potential implementation of HSR within the Dallas to Houston corridor. As previously noted, TxDOT received a $15 million HSIPR grant to study HSR between the DFW metroplex and Houston. The grant was amended to focus on core express service between Fort Worth and Dallas after TCRR submitted their project proposal for the Dallas to Houston corridor.

Additionally, the Regional Plan Association, an independent non-profit regional planning organization, issued a study in 2011 entitled *High Speed Rail in America*[12], which identified intercity "mega-regions" as having the highest potential for HSR service in the U.S. based on ridership potential. The Dallas to Houston corridor was the highest ranking Texas-based corridor identified for prioritizing investment in HSR.

These early planning efforts identified potential high-speed rail corridors, including the Dallas to Houston HSR Corridor, but no detailed evaluation of corridors or alignments between Dallas and Houston had been prepared by FRA or TxDOT pursuant to NEPA.

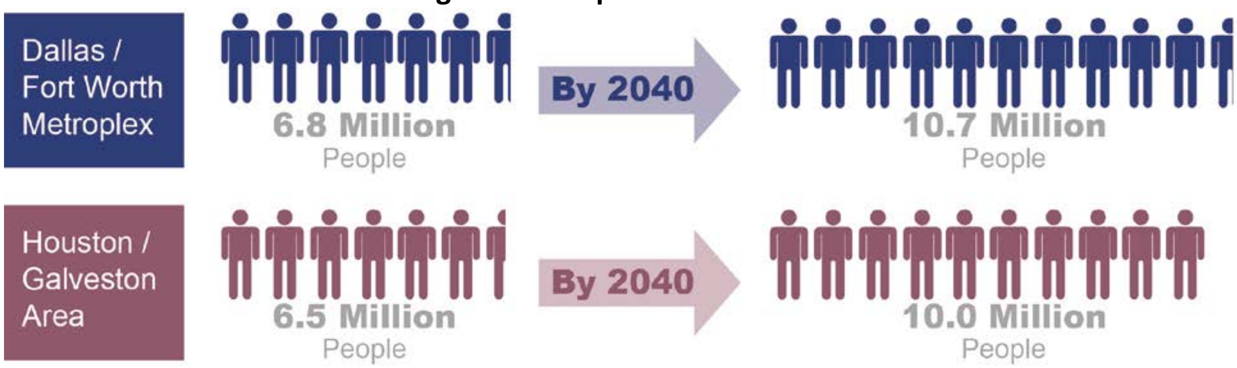
In the context of these early planning efforts, after completing its own analysis, TCRR identified an opportunity to develop a profitable, privately financed and operated HSR system for the Dallas to Houston corridor. The Project would transport thousands of passengers every day and provide an alternative transportation mode for travelers between the two cities, consistent with previous plans and studies.[13]

[9] Burns, Marc H. High-speed rail in the rear-view mirror: a final report of the Texas High-Speed Rail Authority. Austin, TX: M.H. Burns, 1995.
[10] Federal Railroad Administration. Vision for High-Speed Rail in America. U.S. Department of Transportation. April 1, 2009
[11] Texas Department of Transportation. Texas Rail Plan. November 2010
[12] Todorovich, Petra, and Yoav Hagler. High Speed Rail in America. Report. 2011
[13] According to TCRR's 2043 ridership forecast, HSR would account for 21 percent of the traveling public market share between Dallas and Houston. This HSR market share would derive from a 16 percent decrease in vehicular traffic market share and a 6 percent decrease in air travel market share (numbers rounded).

1.2.2.2 Population Growth

The demographics of the State of Texas are changing quickly. According to the Office of the State Demographer, the State of Texas will add 7.5 million people in the next 15 years, increasing the population of Texas to 32.7 million.[14] The more urban counties – Bexar, Dallas, Harris, Tarrant and Travis – and their surrounding suburban counties, including Ellis and Waller, will account for the majority of this growth. As depicted in **Figure 1-2** the Metropolitan Planning Organization (MPO), North Central Texas Council of Governments (NCTCOG), projects that the 12 counties surrounding and including the DFW Metroplex will grow from 6.8 million to more than 10.7 million people by 2040.[15] The Houston-Galveston Area Council (H-GAC), MPO for this region, presents a similar population forecast, rising from more than 6.5 million to 10.0 million people by 2040.[16]

Figure 1-2: Population Forecasts



Source: AECOM, 2016

The current job climate is attracting many people to Texas. According to the *Dallas Business Journal*, Texas added more jobs in 2014 (3.6 percent) than the national average (2.1 percent) and will continue to grow.[17] There are currently 52 Fortune 500 companies headquartered in Texas, of which the DFW Metroplex is home to 18 and Houston is home to 26.[18] The growing job market, affordable housing and the lack of state income tax continue to make both regions highly attractive to people from within and outside the state. Employment data from the NCTCOG indicates more than 6.7 million people will be employed in the DFW Metroplex by 2040, which is 2.8 million more people than in 2010 (a 72 percent increase).[19] Similarly, the H-GAC forecasts more than 4.8 million people will be employed by 2040, which is 1.9 million more people than in 2010 (a 65 percent increase).[20]

In addition to continued population growth, a growing workforce trend is the increasing prevalence of the "super-commuter." In their 2012 publication, "The Emergence of the Super-Commuter," the New York University Rudin Center for Transportation defines super-commuters as individuals who live

[14] Lloyd Potter, Ph.D. and Nazrul Hoque, Ph.D., "Texas Population Projects, 2010 to 2050.*"* The Office of the State Demographer*,* November 2014, Accessed March 2016, http://osd.texas.gov/Resources/Publications/2014/2014-11_ProjectionBrief.pdf.
[15] NCTCOG Regional Data Center. Accessed March 2016, http://rdc.nctcog.org/Members/ServiceGroup.aspx?id=4.
[16] H-GAC Regional Growth Forecast Data Query. Accessed March 2016, http://2040forecast.h-gac.com.
[17] Hethcock, Bill, "Fed Economist: Texas, DFW growth will slow but won't stall in 2015."*Dallas Business Journal,* January 29, 2015, http://www.bizjournals.com/dallas/news/2015/01/29/fed-economist-texas-dfw-growth-will-slow-but-wont.html.
[18] Feser, Katherine, "Houston is home to half of the Fortune 500 companies in Texas," *Houston Chronicle*, June 2 2014, http://www.houstonchronicle.com/business/economy/article/Houston-is-home-to-half-of-the-Fortune-500-5523181.php.
[19] NCTCOG Regional Data Center. Accessed March 2016, http://rdc.nctcog.org/Members/ServiceGroup.aspx?id=4.
[20] H-GAC Regional Growth Forecast Data Query. Accessed March 2016, http://2040forecast.h-gac.com/.

beyond the census-defined Combined Statistical Area (CSA) of their workplace.[21] This includes commutes of more than 90 minutes or 180 miles from home. As of 2009, Harris (Houston) and Dallas (DFW Metroplex) counties ranked first and second, respectively, as the top U.S. counties for super-commuting. Super-commuters accounted for 13 percent of the workforce in both counties. Of this super-commuting population, approximately 97,000 super-commuters traveled between Dallas and Houston, which represented more than a 50 percent increase in super-commuting since 2002. Since the 2012 publication, the number of super-commuters has increased as businesses prioritize talent over location and regular office presence.[22, 23] While super-commuters are not a specifically targeted group of riders for the Project, they exemplify the more interconnected state economy that HSR could support.

As the populations of both the DFW Metroplex and greater Houston Area continue to increase, super-commuting and automobile traffic between these two areas will also continue to increase, placing an even greater demand on the existing travel infrastructure.

1.2.2.3 Reliability of the State Highway System

There are many causes of decreased highway reliability, such as accident bottlenecks, roadway construction, cars abandoned on roadway shoulders or routine traffic violation stops. Additionally, inclement weather (rain, wind and early morning fog) can adversely impact the reliability of highway travel times and contribute to increasing accident rates. As delays on the roadways increase, the overall reliability of the system decreases.

According to the Texas Transportation Institute's 2010 report, even taking into account forecasted improvements, vehicular traffic on IH-45 between Dallas and Houston will increase more than 200 percent by 2035, resulting in average speeds decreasing from 59 to 39 mph.[24] This decrease in speed is due to an increasing volume-to-capacity ratio that will result in increased trip durations. An increase in volume-to-capacity ratio could result in an increase in automobile accidents,[25] which would also decrease traffic speeds, making highway travel increasingly less reliable.

TxDOT has identified their top 100 congested segments of roadway across the state for 2015, which include roadways in the DFW Metroplex, Houston, Austin, San Antonio, Laredo, Brownsville, Corpus Christi, El Paso and their surrounding areas.[26] Eight segments of IH-45 are on the list, six of which are in Harris County. According to TxDOT, the average delay for those six segments is 1.54 times the expected travel time at optimum conditions, which means that an average 30-minute trip in light traffic would take more than 46 minutes to complete in heavier traffic. Additionally, the average planning time index, which takes into account the time differentials between peak and non-peak traffic, for these six

---

[21] Mitchell L. Moss and Carson Qing, "The Emergence of the Super-Commuter," New York University Rudin Center for Transportation, Wagner School of Public Service, February 2012.

[22] Ibid.

[23] Mount, Ian, "Here's why Super-commuters are traveling 5 hours to work," *Fortune*, September 16 2015, http://fortune.com/2015/09/16/super-commuters-work/.

[24] Curtis A. Morgan, Benjamin R. Sperry, Jeffery E. Warner, Annie A., Protopapas, Jeffrey D. Borowiec, Laura L. Higgins, and Todd B. Carlson. "Potential Development of an Intercity Passenger Transit System in Texas – Final Project Report," Texas Transportation Institute, February 2010.

[25] Per Texas Department of Transportation Glossary, October 2013, accidents may be any of the following: traffic crash, stalled vehicle, load spillage, or other action that affects one or more lanes of traffic. An incident typically involves a collision of a moving vehicle with another vehicle, person, or object.

[26] Texas Department of Transportation, "100 Congested Roadways," last updated October 29, 2015, http://www.txdot.gov/inside-txdot/projects/100-congested-roadways.html.

segments is 2.35 times greater than optimum conditions, which means that a driver may need to allot more than an hour to make the same 30-minute trip. These same six segments account for 2.2 million hours in delayed travel and $425.5 million in congestion costs, which is the economic cost in lost time and wasted fuel.

On Texas highways, freight travel accounts for 12 percent of annual vehicle miles traveled (VMT), further adding to congestion. As of 2014, approximately 1,000,000 tons, or 60 percent of all freight in Texas, was transported by truck. Four of the top 25 U.S. highway freight bottlenecks are associated with IH-45 in Houston (5th: IH-45 at U.S. 59, 13th: IH-10 at IH-45, 22nd: IH-45 at IH-610) and Dallas (12th: IH-45 at IH-30). By 2040, congestion on the Texas highway system, particularly within the Texas Triangle (Dallas-Houston-Austin), is anticipated to further increase as tonnage transported by truck is projected to increase by 110 percent. This increase in tonnage would lead to additional daily truck trips and truck VMT; which, in turn, would further limit reliable interstate travel.[27]

Figure 1-3: Congestion on IH-45 in Houston north of IH-610

Source: *Houston Chronicle*, 2010

As detailed in **Chapter 3.11, Transportation**, multiple expansion projects are currently planned by TxDOT along IH-45 through 2040. However, even with these substantial planned investments, significant decreases in congestion would not be anticipated to occur given the continued population and travel demands. As a result, planned highway improvements are not expected to make highway travel more reliable. Adding additional highway capacity, particularly in the already congested urban areas, would require ROW beyond the existing limits, which would increase costs of expansion and impact communities along the IH-45 corridor. In addition, adding highway capacity would not allow for a

[27] Texas Department of Transportation, "Texas Freight Mobility Plan," January 25, 2016, http://ftp.dot.state.tx.us/pub/txdot-info/freight/plan/2015/mobility-plan.pdf.

dedicated transportation ROW so travel times would still be subject to congestion and other delays such as accident bottlenecks and inclement weather, all of which would adversely affect reliability.

1.2.2.4 Safety

Nationally, transit travel (which includes heavy rail/subway, light rail and automated guideway) has the lowest rate of passenger fatalities when compared to highway, air travel and railroad.[28] As detailed in **Table 1-1**, the average fatalities on national highways from 2004-2013 was 37,360, which is more than 45 times higher than travel by air, rail and transit.[29] Accidents result from environmental (e.g., roadway hazards or wet conditions), operational (e.g., equipment and/or maintenance related failures) or human-factor causes; with over 70 percent of highway crashes involving passenger vehicles determined to be caused by driver error and/or risky behavior (e.g., distracted driving, driving under the influence and/or fatigue). The leading cause of these highway accidents has been linked to speeding, followed by driving impairment (in passenger vehicles) and distracted driving (in larger trucks).[30] In the State of Texas, TxDOT documents the traffic accidents for the entire state roadway system. For the IH-45 corridor between Dallas and Houston, TxDOT reports an increase in accident rates between 2010 and 2014. Between 2010 and 2012, total yearly accident rates increased 13 percent, and then increased another 21 percent between 2012 and 2014, equating to a 31 percent increase over this four-year period.

Table 1-1: National Transportation Fatalities by Mode

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013*	AVG.
Highway	42,836	43,510	42,708	41,259	37,423	33,883	32,999	32,479	33,782	32,719	**37,360**
Railroad	891	884	903	851	804	695	734	691	677	706	**784**
Air Travel	637	603	774	540	568	548	476	489	449	429	**551**
Transit	177	149	162	188	172	226	221	228	264	266	**205**

* Projected 2013 values
Sources: US DOT, National Transportation Statistics, Transportation Fatalities by Mode, October 2015

National fatalities reported for rail included train accidents and incidents – involving trespassers and highway-grade crossings. Rail fatalities in Texas are similar to national rates, in that most fatalities primarily involve highway-rail grade crossings and trespassing pedestrians on railroad property (**Table 1-2**).[31]

Table 1-2: National Railroad Fatalities by Accident Type

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013*	AVG.
Train Accidents	13	33	6	9	27	4	8	6	9	11	**13**
Other Accident	35	34	17	33	30	27	25	30	25	32	**29**

[28] Per the Federal Railroad Administration, rail is defined as any form of non-highway ground transportation that travels on rails or electromagnetic guideways, and does not include rapid transit systems that operate in urban areas and that are not connected to the general railroad system of transportation

[29] U.S. Department of Transportation, Bureau of Transportation Statistics, "Transportation Fatalities by Mode," October2015. Accessed March 2016, http://www.rita.dot.gov/bts/sites/rita.dot.gov.bts/files/publications/national_transportation_statistics/html/table_02_01.html_mfd .

[30] U.S. Department of Transportation, Bureau of Transportation Statistics, "Transportation Statistics Annual Report 2013," Washington, DC, 2014. Accessed March 2016, https://www.rita.dot.gov/bts/sites/rita.dot.gov.bts/files/TSAR_2013.pdf.

[31] Texas Department of Transportation, "Texas Rail Plan," November 2010. Accessed March 2016, http://www.txdot.gov/government/reports/texas-rail-plan.html.

Table 1-2: National Railroad Fatalities by Accident Type											
	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013*	AVG.
Highway -Railroad Crossing	371	359	369	339	290	248	261	250	230	231	**295**
Trespassers	472	458	511	470	457	416	440	405	413	432	**447**
RAILROAD TOTAL	891	884	903	851	804	695	734	691	677	706	**784**
ADJUSTED RAILROAD	**48**	**67**	**23**	**42**	**57**	**31**	**33**	**36**	**34**	**43**	**41**

* Projected 2013 values
Sources: US DOT, National Transportation Statistics, Transportation Fatalities by Mode, October 2015

Rail infrastructure improvements, such as this project, with heightened security measures more stringent than typical for existing rail (i.e., fenced rail lines) that avoid active highway crossings, would reduce these specific safety concerns. Therefore, while transit has the lowest average fatality rate among transportation modes, when rail data is adjusted to remove trespassers and highway-rail crossing fatalities (as depicted in Adjusted Railroad values, **Table 1-2**), rail has the lowest fatality rate with a 10-year annual average of 41. The decrease in all railroad fatalities is primarily due to FRA's grade crossing action plan and the continuous research efforts into addressing fatalities and injuries at grade crossings.[32]

1.2.2.5 Limitations of Existing Transportation Modes

The current transportation network for the State of Texas is discussed to illustrate deficiencies that contribute to the need for HSR.

The State of Texas has over 80,000 miles of highways,[33] more than 380 public and private use airports[34] and 10,469 miles of railroad.[35] Direct passenger rail service between Dallas and Houston has not existed since the mid-1950s. As shown in **Figure 1-4**, there is no current direct intercity passenger rail service between Dallas and Houston. Currently, Amtrak provides passenger rail service to the State of Texas via the long distance *Texas Eagle* service (Chicago to San Antonio rail line with connections to Los Angeles) and the long distance *Sunset Limited* service (New Orleans to Los Angeles rail line). Rail passengers must use both of these services to get from Dallas to Houston. Amtrak service includes a segment from Dallas to San Antonio via the *Texas Eagle*. Passengers then must transfer to Amtrak's *Sunset Limited* to complete the trip from San Antonio to Houston. This trip takes more than 17 hours due to circuitous routing, passenger rail service operating on shared freight rail lines and maximum train speeds of approximately 80 mph. Additionally, while the *Texas Eagle* has a daily trip, the *Sunset Limited* only runs three trips per week, limiting the frequency of passenger rail trips between Dallas and Houston.[36] Lastly, the most common cause for delays of passenger trains (such as the *Texas Eagle*) that share rail lines

[32] U.S. Department of Transportation, Federal Rail Association, "Highway-Rail Grade Crossings Overview." Accessed March 2016, https://www.fra.dot.gov/Page/P0156.
[33] Texas Department of Transportation, Transportation Planning and Programming Division, Standard Reports, "Mileage by Highway Status by Highway System," September 25, 2014.
[34] Texas Transportation Commission Aviation Division, "2015 Texas Airport Directory," December 2015. Accessed March 2016, http://www.txdot.gov/inside-txdot/division/aviation/airport-directory-list.html.
[35] Texas Department of Transportation, "Texas Rail Plan," November 2010. Accessed March 2016, http://www.txdot.gov/government/reports/texas-rail-plan.html.
[36] Amtrak, "Amtrak Train Schedules," January 25, 2015. Accessed March 2016, https://www.amtrak.com/train-schedules-timetables.

owned by freight rail is interference with freight trains.[37] Priority status is often given to the freight trains over passenger trains, even though federal law grants dispatching priority to Amtrak. Amtrak acknowledges that passenger train on-time performance adversely impacts businesses and commuters, and is working with freight operators to resolve these delays.[38]

Figure 1-4: Amtrak Rail Map

Source: Amtrak, 2011

Bus service is another transportation mode that currently operates between Dallas and Houston. Greyhound operates approximately 14 routes each day between the two cities, but the trip takes more than four hours. Additionally, Megabus, a bus service within the corridor, transports riders via 12 routes with an estimated travel time of approximately four hours. Vonlane, a luxury bus company, transports riders between Dallas and Houston via four routes with an average travel time of 3.5 hours. These bus services will experience similar traffic congestion compared to private vehicles, as IH-45 is the primary route for service between the two cities, which means travel times by bus will only increase over time without significant highway expansion. With an increase in intercity highway vehicular traffic that will directly impact bus services, an alternative mode of transportation that does not depend on IH-45 is needed.

In addition to the public highway system, commercial aviation has historically been a primary means of travel for most Texans. There are four commercial airports available to travelers in Dallas and Houston – Dallas/Fort Worth International Airport (DFW), Dallas Love Field (DAL), Houston George Bush Intercontinental (IAH) and Houston Hobby (HOU). Air transportation has long been an accessible mode for many who need to reach points near and far from both cities. According to the U.S. Department of Transportation (DOT) Bureau of Transportation Statistics, current air ridership (580 million passengers) has increased above pre-9/11 rates (505 million in 2000), but varying fuel costs, limited gate/airport expansion, smaller planes and fees have impacted the airline industry and their operation strategies, creating a shift toward more long-haul service and less short-haul service.[39]

On average there are 100 non-stop flights between Dallas and Houston each day, most of which operate between DAL and HOU. Southwest Airlines (SWA) is the primary carrier of passengers along this route. The Dallas to Houston market was once the most travelled route for SWA, but the SWA CEO has

[37] Amtrak, "On-Time Performance Testimony to the STB," *Amtrak Ink: A Monthly Publication for and by AMTRAK Employees*, October 2014, 5.
[38] Amtrak, 2015, "A Message from AMTRAK Regarding On-time Performance," *All Aboard: The Official Blog of Amtrak*. Accessed March 2016, http://blog.amtrak.com/2015/02/message-amtrak-regarding-time-performance/.
[39] U.S. Department of Transportation, "National Transportation Statistics, U.S. Passenger Miles (Millions)," January 2015. Accessed March 2016, http://www.rita.dot.gov/bts/sites/rita.dot.gov.bts/files/publications/national_transportation_statistics/index.html.

reported a 50 percent decrease in that route as they move to more versatility with long-haul flights.[40] Short-haul traffic is more elastic and price sensitive compared to long-haul service. As short-haul costs have increased for both the airlines and the passengers, the airlines and travelers have opted for alternatives. This is compounded by the "perceived hassles" of increased security, which adds time to the total travel experience.

Nationally, short-haul traffic for SWA is down more than 35 percent since 2000.[41] SWA, like other carriers, has focused on growing their long-haul service. For SWA, that proved challenging from its hub airport, DAL. However, in October 2014, the Wright Amendment , a law that prohibited SWA from flying non-stop from Dallas to any of the states beyond those that bordered Texas, with the exception of Kansas and Missouri, expired. As a result, SWA has expanded their domestic long-haul service from DAL. Since April 2015, SWA has added 35 routes to 16 states to their flight schedule. SWA currently operates in 84 other domestic markets, but their non-stop service from DAL only reaches 50 of those possible markets, leaving 34 additional entry points to consider as they expand their operations.[42]

The City of Dallas recently completed a renovation of DAL, but that did not include adding more gates. The Wright Amendment capped the number of gates at 20 and SWA currently operates from 18 of them.[43] The limited expansion options at DAL have thus increased the need for SWA to diversify their short-haul operations. Additional carriers may choose to enter the Dallas to Houston market, but carriers across the industry have scaled back their short-haul routes in order to offer longer, more profitable, non-stop service. Therefore, an increase in short-haul routes between Dallas and Houston is not expected.

1.3 Scope of this Document

The EIS identifies, evaluates and documents the potential environmental and socioeconomic effects of implementing HSR service between Dallas and Houston. The subsequent chapters contain the following information:

- Chapter 2.0 – Describes the alternatives analysis, proposed technology, Build Alternatives and No Build Alternative
- Chapter 3.0 – Establishes the environmental baseline (affected environment), environmental consequences and outlines mitigation strategies for the Project
- Chapter 4.0 – Analyzes and describes indirect and cumulative effects of the Build Alternatives
- Chapter 5.0 – Assesses the relationship between local short-term impact and/or use of resources with the maintenance and enhancement of long-term productivity
- Chapter 6.0 – Analysis of the irreversible and irretrievable commitment of natural, physical, human and fiscal resources
- Chapter 7.0 – Identifies and describes the potential impacts to Section 4(f) and 6(f) resources
- Chapter 8.0 – Details applicable federal, state and local permits and approvals

[40] Brezosky, Lynn, "Southwest Airlines is evolving, CEO says." *Houston Chronicle,* May 19, 2014. Accessed March 2016, http://www.houstonchronicle.com/business/article/Southwest-Airlines-is-evolving-CEO-says-5490322.php.
[41] Brezosky, Lynn, "Southwest Airlines is evolving, CEO says." *Houston Chronicle,* May 19, 2014. Accessed March 2016, http://www.houstonchronicle.com/business/article/Southwest-Airlines-is-evolving-CEO-says-5490322.php.
[42] Southwest Airlines, "Southwest Airlines One Report," 2014. Accessed March 2016, http://southwestonereport.com/2014/pdfs/2014SouthwestAirlinesOneReport.pdf.
[43] Ibid.

- Chapter 9.0 – Provides a list of stakeholders and agencies, and details the public participation activities
- Appendices include a list of document preparers, mapbooks, engineering documents and detailed studies

2.0 ALTERNATIVES CONSIDERED

2.1 Introduction

As a private railroad company, TCRR has identified the basic components of the Project it is proposing to build and operate. FRA then identified and independently evaluated a range of potential corridors and alignment alternatives for the Project.

This chapter describes the basic components of the Project TCRR is proposing to build and operate. It also describes the process through which the Proposed Action (Build) Alternatives and the No-Build Alternative for the Project were identified and evaluated, and provides a detailed description of the alternatives evaluated in this EIS. The environmental impacts of each of the alternatives that were carried forward from this screening process are discussed in **Chapter 3.0, Affected Environment and Environmental Consequences**. Lastly, this chapter identifies the preliminary preferred alternative based on the analysis contained in this EIS.

2.2 Proposed HSR Infrastructure and Operations

2.2.1 Technology

The Project includes the deployment of an electric-powered HSR passenger rail system based on Central Japan Railway Company's N700 Tokaido Shinkansen. Since its inception in 1964, the N700 Tokaido Shinkansen HSR system has had no operational accidents that resulted in a fatality or injury.[1, 2] This safety history includes the operation of 27 trains during Japan's 9.0 magnitude earthquake on March 11, 2011, as earthquake sensors with anti-derailment and braking technology successfully halted operations. The N700 Tokaido Shinkansen HSR system is operated by a control center that can halt or delay trains in the event of environmental factors (e.g., heavy rains or strong winds) further down the rail line. Additionally, the Shinkansen Electric and Track Inspection Train (the "yellow train") runs regularly down the extent of the rail line to inspect the track and equipment for operational issues.[3]

In coordination with the FRA Office of Railroad Safety, the train technology would be adapted to meet the regulatory requirements and environmental conditions between the DFW and Houston metropolitan areas, as established by an FRA Rule of Particular Applicability or other regulatory action(s) to ensure the Project is operated safely. To minimize risk and enhance passenger safety, the Project is proposed to be operated in a fully sealed corridor. A fully sealed corridor is one that is not interconnected with any other railroad system and the HSR train operations are separated from existing roadways and other infrastructure. The lack of crossings and other non-HSR traffic would enable trains to safely achieve speeds exceeding 200 mph and attain an approximate 90-minute travel time between Dallas and Houston. Additionally, the Project would only provide passenger rail service. Goods and other freight would never be transported on the trains or within the HSR ROW. The HSR system would be exclusively for N700 Tokaido Shinkansen passenger rail service.

[1] The only injuries and/or fatalities reported in association with the Tokaido Shinkansen HSR system was a self-inflicted immolation by an individual on June 30, 2015. This instance is unrelated to the design, operation, and overall safety of the system. "Japan bullet train passenger starts fire injuring eight." BBC News Online. Accessed August 2016.

[2] http://english.jr-central.co.jp/about/safety.html

[3] "SHINKANSEN Fact Book," International High-Speed Rail Association. October 22, 2014. Accessed March 2016, http://www.ihra-hsr.org/_pdf/factbook_en_1018.pdf.

As part of the project development process, TCRR developed the conceptual engineering to support the Project Purpose and Need. This conceptual engineering (included as **Appendix F, TCRR Conceptual Engineering Design Report** and **Appendix G, TCRR Conceptual Engineering Plans and Details**) completed as of September 15, 2017 is the basis for the evaluation included in this document. The design of the system includes a double-track with dedicated northbound and southbound operations, as depicted in **Figures 2-1 through 2-5**. The HSR ROW would vary in width. Minimum ROW would be 100 feet and would include the track, overhead catenary system (catenary), access road and security fencing. Based on existing infrastructure (e.g. roadways, well pads, transmission lines, etc.) and changes in topography, combined with the need to minimize vertical changes along the HSR line, the double-track system would be constructed using a combination of at-grade (**Figures 2-1 and 2-2**), retained fill/ embankment (**Figure 2-3**) and bridge-like structure, called viaduct (**Figure 2-4**). Approximately 60 percent of the HSR line would be constructed on viaduct.

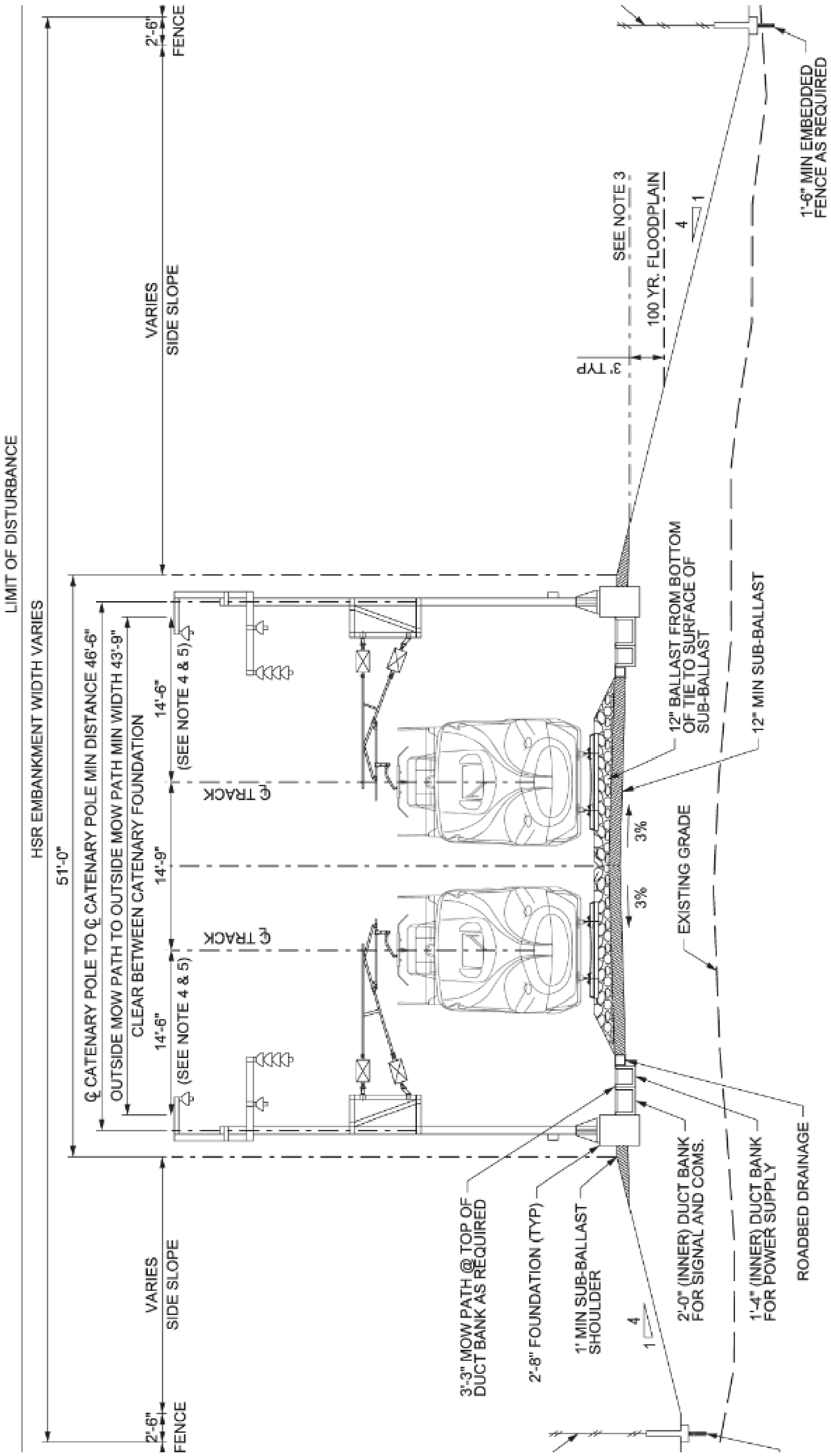
A typical trainset would consist of 8 cars at a total length of 672 feet. The end cars would be nearly 90 feet in length, 11 feet in width and 11.5 feet in height. The intermediate cars would be approximately 82 feet in length, 11 feet in width and 11.8 feet in height. The total 8-car train would carry up to 400 seated passengers.

Power would be distributed to each train car via the catenary, which is the electrical wiring that runs above each track and conducts electricity from the Traction Power Substation (TPSS) to the train, as depicted in **Figures 2-2, 2-3 and 2-4**. The HSR system would be monitored and controlled from a system-wide Operations Control Center located at the Trainset Maintenance Facility (TMF) in Dallas, while each trainset would have an independent train control system.

Figure 2-1: N700 Tokyo to Osaka Tokaido Shinkansen Trainset

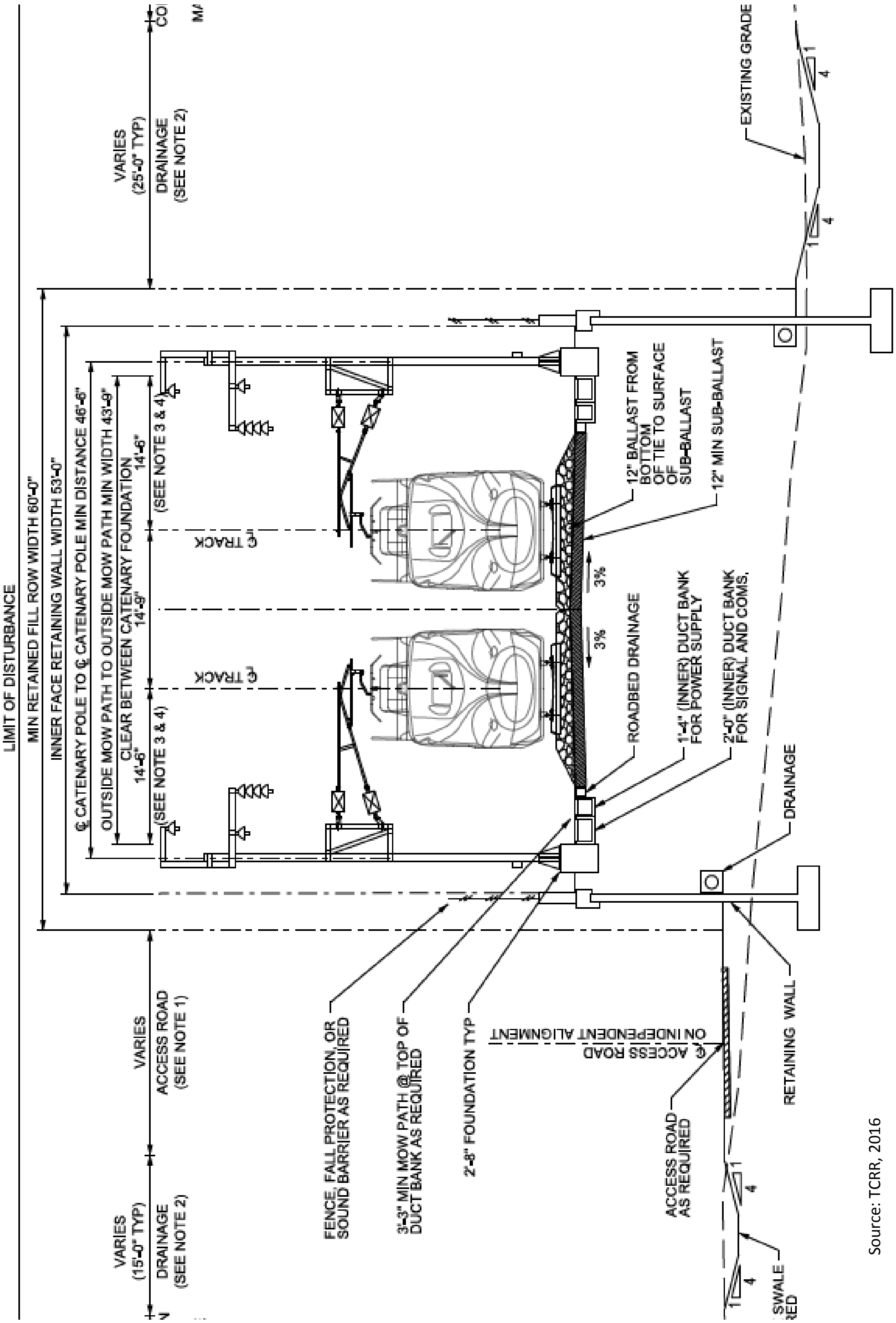
Source: TCRR, 2014

Figure 2-2: At-grade Typical Section

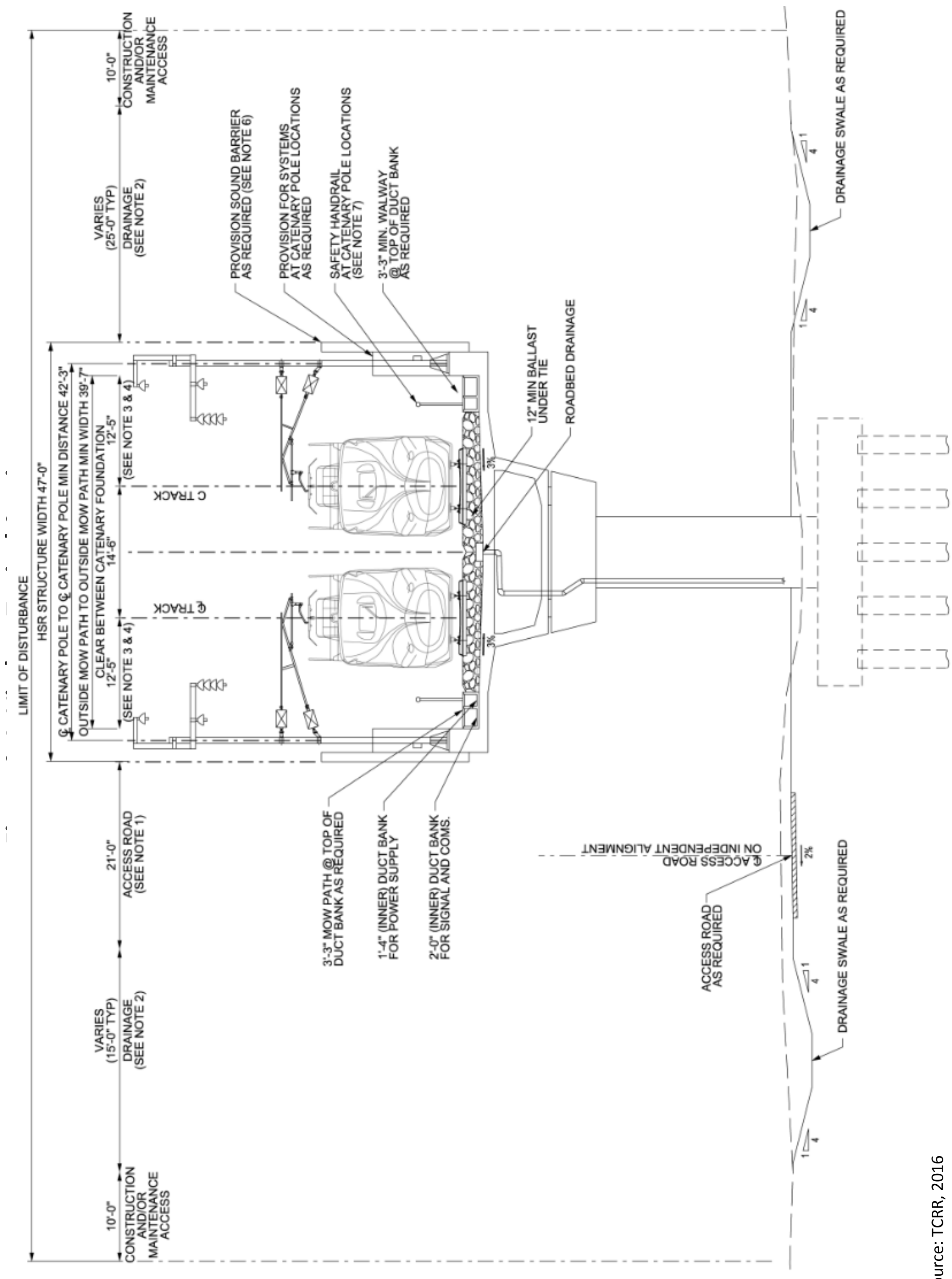


Source: TCRR, 2016

Figure 2-3: Retained Fill Typical Section



Source: TCRR, 2016



Source: TCRR, 2016

2.2.2 Stations

TCRR is proposing three stations as part of the Project: two terminal stations, including an approximately 90-acre terminal in Dallas, and a 60-acre terminal in Houston; and a 115-acre intermediate Brazos Valley Station in Grimes County, near the town of Roan's Prairie, Texas. Each terminal station could accommodate 6 tracks and 3 island platforms that would measure 30 feet wide and 705 feet long. The Dallas Terminal would also include tail track. This track would accommodate future expansions by Dallas Area Rapid Transit should they decide to extend or relocate their commuter rail, Trinity Railway Express (TRE), or light rail service to the HSR station. Neither service could operate on the HSR tracks or along HSR station platforms. Additional infrastructure to support either service would be required at or near the HSR station. The intermediate Brazos Valley Station would have 2 mainline tracks with side platforms, measuring 20 feet wide and 705 feet long, as well as 2 side station tracks (one on each side of the mainline tracks). The side station tracks would allow for express service trains to bypass the station.

Station and platform design would accommodate anticipated customer volume associated with the planned frequency of service. The Initial Service Level for "opening day," the anticipated Final Service Level and Peak Service Level are discussed in **Section 2.2.5**. Station amenities would include passenger drop-off areas, parking, rental car facilities, ticketing and support services and an indoor station area for passengers to wait. The stations would provide the infrastructure for intermodal transportation connections, including bus bays, passenger drop-off and pick-up, and taxi and ride sharing services. **Figure 2-5** through **Figure 2-11** illustrate current infrastructure in Japan that could influence the station designs. The station locations and alternatives are described in **Section 2.6.3.**

Figure 2-5: Exterior of a Japanese HSR Station

Source: TCRR, 2016

Figure 2-6: Interior Station Concourse in Taiwan

Source: TCRR, 2016

Figure 2-7: Interior Station Concourse in Japan

Source: TCRR, 2016

Figure 2-8: Japanese Station Concourse

Source: TCRR, 2016

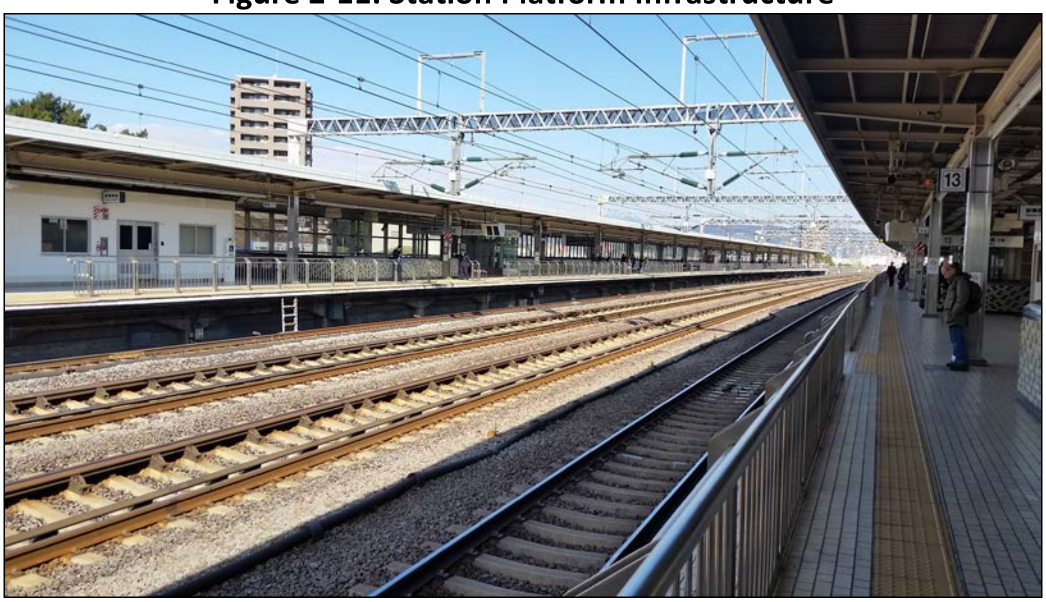
Figure 2-9: Taiwan Station Concessions

Source: TCRR, 2016

Figure 2-10: Japanese Station Platform

Source: TCRR, 2016

Figure 2-11: Station Platform Infrastructure



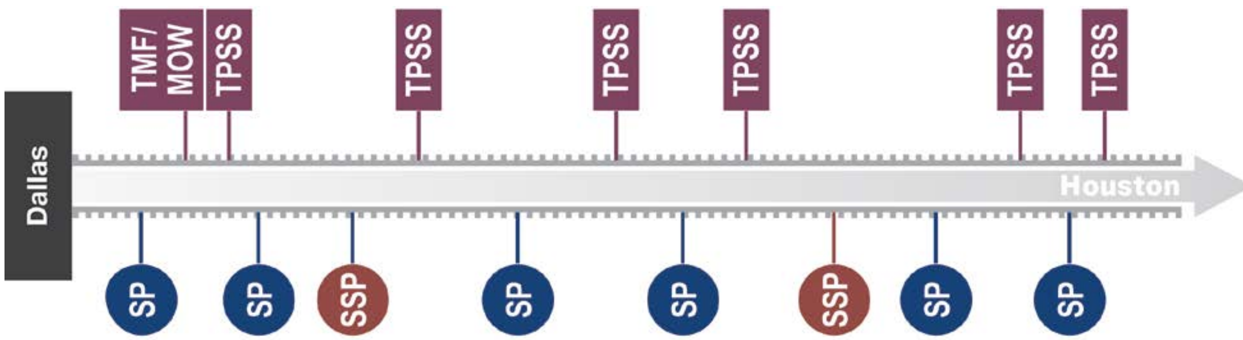
Source: TCRR, 2016

2.2.3 Facilities

The operation of the HSR Project would be supported by a collection of maintenance facilities to repair and maintain the N700 Tokaido Shinkansen trainset and track that work within a pre-determined sequence. These facilities include TMFs, Maintenance-of-Way Facilities (MOWs), TPSSs, sectioning posts, sub-sectioning posts, etc., and they require certain spacing between facilities of the same type to operate the system. **Figure 2-12** shows the general relationship between TPSSs, sectioning posts and sub-sectioning posts.

The program, layout and sizing of these facilities are generally based on similar systems located in Japan (see **Figures 2-13 to 2-15**). TMFs would be located in proximity to the terminal stations to serve as cleaning and maintenance facilities of the HSR trainsets. The TMFs would provide for all periodic inspections, scheduled maintenance and unexpected repairs, as well as serve as the location for delivery and assembly of the trainsets. Each facility would accommodate the ultimate configuration of the Project and occupy approximately 100 acres. Each TMF would include sidings for train storage, paint shop, train sheds, wash facilities and other facilities. As previously mentioned, the Dallas TMF would house the Operations Control Center for the system.

Figure 2-12: Facility Configuration



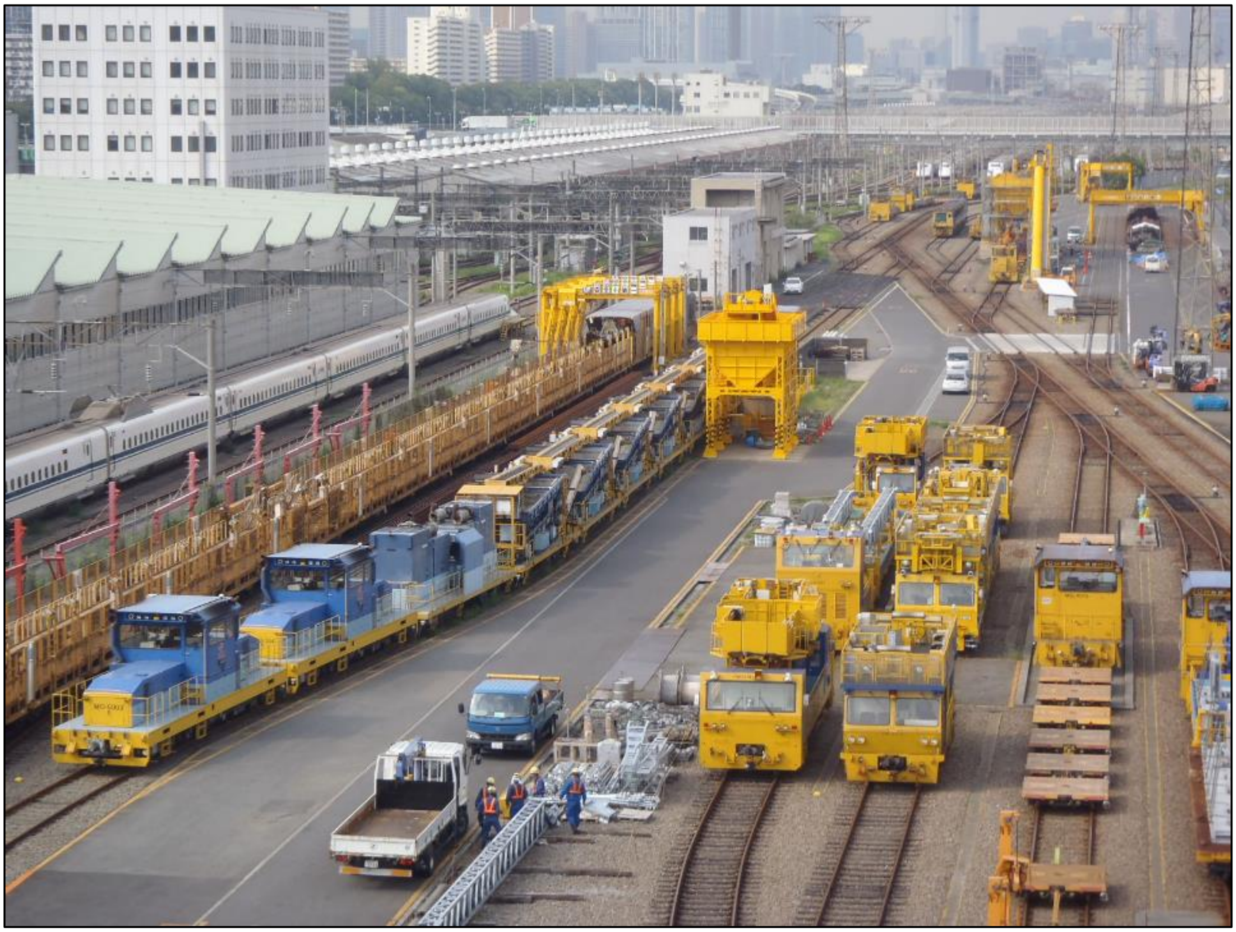
Source: AECOM, 2016
Note: TMF – Trainset Maintenance Facility, MOW – Maintenance-of-Way Facility, TPSS – Traction Power Substation, SP – Sectioning Post, SSP – Sub-sectioning Post

Figure 2-13: Trainset Maintenance Facility

Source: TCRR, 2017

In addition to the TMFs, seven MOW facilities (see **Figure 2-14**) would be located every 30 to 40 miles along the HSR ROW. Each MOW facility would be approximately 20 acres and have sidings for equipment and sweeper vehicles and additional tracks for shunting MOW equipment. Sweeper vehicles are self-propelled inspection vehicles that would be used at the end of the nightly maintenance and inspection period to confirm the tracks are clear for daily operations. Shunting equipment contains small diesel engines and would be used to push or pull train cars or maintenance equipment to move them in the other direction. Additionally, one track of at least 1,500 feet, with catenary, would be included to be able to fix disabled trainsets that require immediate service.

Figure 2-14: Maintenance-of-Way Facility



Source: TCRR, 2017

2.2.4 Traction Power Supply

The HSR system would require a reliable supply of power. Power for this system would originate from the existing Electric Reliability Council of Texas (ERCOT) power grid. Electricity would be distributed to the trainsets via a traction power supply system comprised of a series of TPSSs, sectioning posts and sub-sectioning posts.

To provide a seamless power supply for train operation, approximately 11 TPSSs would be required. **Figure 2-15** illustrates a typical TPSS facility. These evenly spaced TPSSs would receive power from an interconnection with existing 138 kilovolts (kV) transmission lines from the local utility provider near each TPSS. These TPSSs would reduce the electric voltage from 138 kV to 25 kV. Each TPSS would include monitoring devices and switches that would allow remote control and monitoring of the traction power system from the centralized Operations Control Center, as well as localized control at the individual TPSS. In general, the TPSSs would be located adjacent to or within one mile of existing 138kV transmission lines; however, there are instances where the connection would be greater than one mile. New transmission lines would be required to connect the TPSSs to the existing ERCOT grid.

Figure 2-15: Typical HSR TPSS

Source: Shinkansen HSR Power Plant, RailNews Media India LTD, 2015

The TPSSs would be the largest of the electric traction power system's facilities and each typically would have a footprint of approximately 11 acres (1,000 by 500 feet), including allowance for parking and other site features. The substation footprint excluding site features would be approximately 3.5 acres (450 by 350 feet). This area would include space for utility substations and all of the required traction power distribution equipment. There would be one additional TPSS facility at both TMF locations.

The sectioning posts would be located between adjacent TPSSs and would be responsible for several important functions in the traction power system. The sectioning posts would be the junction point where the traction power circuits from adjacent TPSSs meet and allow the train to seamlessly transition between adjacent circuits with minimal interruption to power the train. The sub-sectioning posts would be placed between TPSSs and sectioning posts where the distance is long, but not long enough to demand an additional TPSS. The sectioning posts in conjunction with the sub-sectioning posts would provide a seamless power supply for the system. It is anticipated that there would be 9 sectioning posts and 15 sub-sectioning posts.

The secondary traction power facilities, the auto transformer posts, sectioning post and sub-sectioning post would have similar footprints of approximately 0.4 acre (150 by 120 feet) each, including allowance for parking, a small electrical building and other site features. The footprint for each facility could vary depending on the site conditions.

Additionally, the system would require the installation of signaling infrastructure. Signal houses would enclose monitoring systems, train traffic and automatic control devices, signaling cables and power supply devices for signaling equipment. These facilities would typically be between 0.2 and 0.8 acre (8,000 and 37,000 square feet) depending on the complexity of the track location that would be controlled. These structures would be spaced no more than 25 miles apart along the alignment and would be close to each interlocking (controlled switching locations) and other main infrastructure, such as MOW facilities, TMFs and stations.

The communication system would require the implementation of various infrastructure components that would primarily consist of communication housing and towers that vary in size depending on site-specific needs. Macro radio towers approximately 50 feet tall would be spaced at approximately 6-mile intervals. Where practicable, communication systems would be integrated with other proposed facilities.

2.2.5 Proposed HSR Operations

TCRR developed a basic service plan to support conceptual engineering for the Project (see **Appendix F, TCRR Conceptual Engineering Design Report**). Three levels of service have been identified: an initial service level proposed for "opening day;" a projected final service level; and a peak service level, which represents the ultimate configuration of the system. The transition of service levels from initial to final to peak would depend upon demand. Additionally, service levels would vary to respond to demand during weekends, special events and peak/off-peak periods.

A travel time simulation conducted by TCRR on the alternatives presented in **Section 2.6** resulted in an average run time of 80 minutes using the proposed maximum speed of 205 mph. When a 5 percent schedule margin, which more accurately reflects achievable, real world operations, was added, the average travel time increased to 84 minutes.

Operational assumptions under initial service level include:

- Two terminal stations: Dallas and Houston
- Two trains per hour during peak and off-peak hours
- Train service every 30 minutes between terminal stations in Dallas and Houston
- Hours of operation would be 5:30 AM to 11:30 PM. Daily maintenance and fleet movement within the TMF would occur when the HSR line would not be in operation
- Anticipated service would be 7 days a week, 365 days a year
- Turn-around time at each terminus station is anticipated to be 30 to 40 minutes
- A total of 15 trainsets may be used – a minimum of 8 trainsets would be in operation

In addition to the operational assumptions for initial service level, the final service level would include:

- A Brazos Valley Station that would serve as a midpoint station located in Grimes County near Roans Prairie. With the addition of a midpoint station, some trains may run an express (non-stop) service between Dallas and Houston.
- Two trains per hour during off-peak and during AM and PM peak service hours, one additional train (three total) would be operating and train service could occur as often as every 20 minutes between terminal stations in Dallas and Houston
- A total of 20 trainsets may be used – a minimum of 13 trainsets would be in operation

Peak service level would represent the ultimate configuration of the Project and would include:

- Six trains per hour during peak hours and four trains per hour during off peak
- During AM and PM peak service hours, train service could occur as often as every 10 minutes between terminal stations in Dallas and Houston
- A total of 30 trainsets may be used – a minimum of 24 trainsets would be in operation

2.3 Alternatives Development Process

TCRR developed several feasible alternatives that would achieve its operational criteria for FRA's consideration and evaluation. TCRR identified the initial group of potential alternatives, alignment plans, preliminary profile concepts and cross sections. TCRR also considered public comments received during FRA's EIS scoping process in its development of initial alternatives for the screening evaluation. In accordance with 40 C.F.R. 1502.14, FRA independently evaluated and assessed those alternatives developed and presented by TCRR. This process is depicted in **Figure 2-16**.

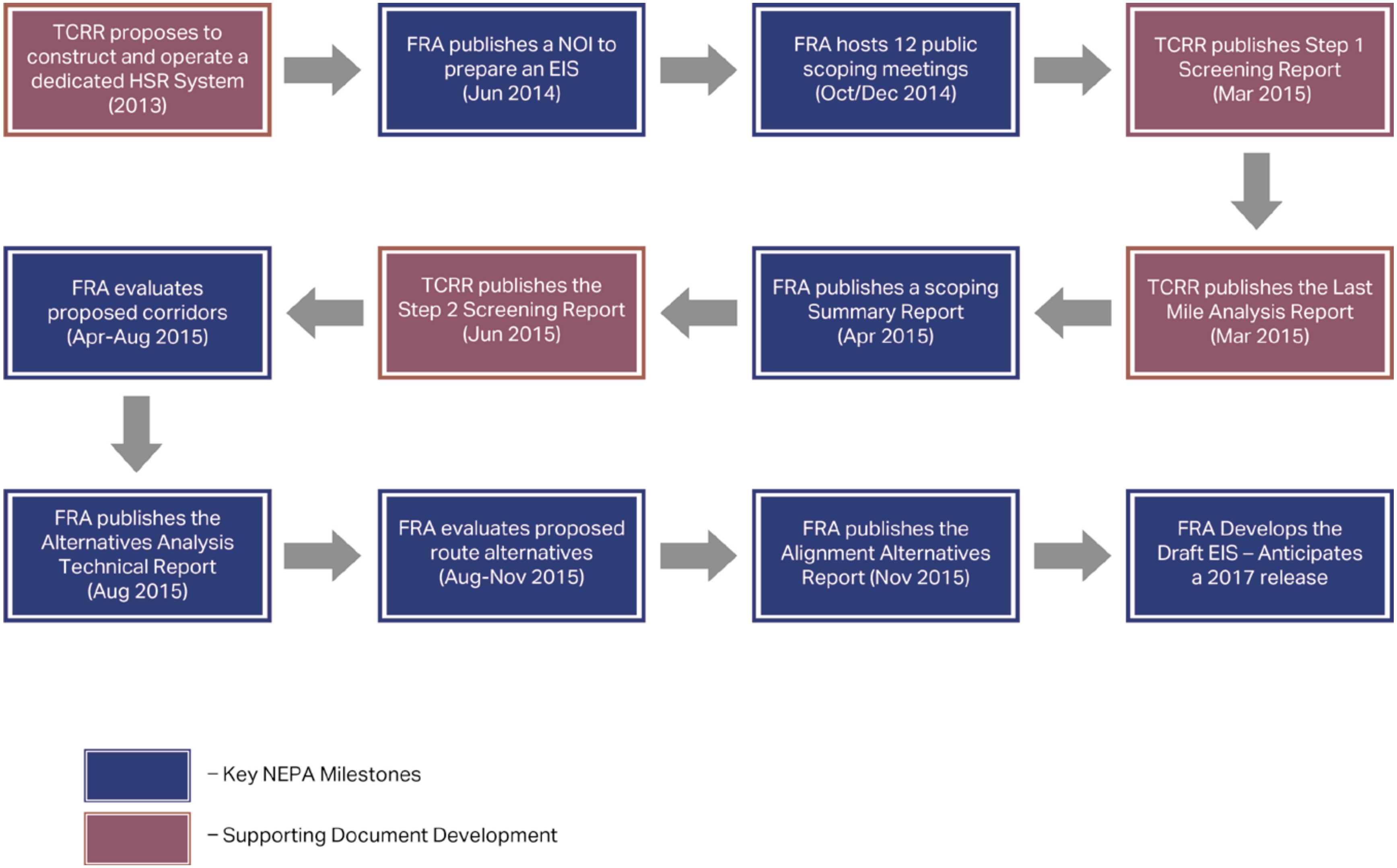
TCRR is proposing to construct and operate the Tokaido Shinkansen N700 HSR system between Dallas and Houston. The Tokaido Shinkansen N700 has been in operation in Japan for over 50 years with no collisions or fatalities due to derailments. TCRR is proposing to import the Tokaido Shinkansen N700 system to the U.S. with minimal modifications. Alternative forms of HSR passenger rail service would have different infrastructure and operating system requirements. Therefore, FRA would not expect an alternative HSR trainset could operate within the tracks and ROW proposed by TCRR. Modifications to the Project would be required should a different type of HSR system intend to operate within the alignment alternatives evaluated herein. Such a change may require additional review and approval to comply with NEPA. In addition, TCRR's proposed Rule of Particular Applicability is specific to the Tokaido Shinkansen N700 system. Should an alternative form of HSR passenger rail service be proposed, by TCRR or another proponent, TCRR's petition for a Rule of Particular Applicability would not apply. An alternative form of HSR passenger rail service may require its own FRA order(s), waiver(s), Rule of Particular Applicability or other regulatory action(s) to ensure that the system would operate safely.

The alternatives analysis presented in this chapter summarizes FRA's independent evaluation and judgment in its capacity as the lead federal agency. In addition, FRA conducted multiple interagency meetings with the cooperating agencies to present the scope of the Project, discuss the methodology to identify and evaluate feasible alternatives and receive feedback and concurrence on the alternatives screening process and results.

As described in the following sections, FRA undertook a two-stage alternatives analysis screening process. The first stage identified corridor alternatives for the proposed HSR system from which potential alignment alternatives within corridors could be developed. The second stage of the screening process evaluated the potential alignment alternatives. The results of this alternatives analysis provide the basis for the selection of the alternatives described in **Section 2.5**.

Reasonable alternatives carried forward only include those that meet the Project's Purpose and Need, as described in **Chapter 1.0. Purpose and Need**. FRA's screening process advanced six end-to-end Build Alternatives (Alternatives A-F) and the No Build Alternative. The operation of the Build Alternatives requires the implementation of a specific HSR technology and associated infrastructure. The No Action Alternative, as required by NEPA, serves as the basis for comparison of the environmental impacts of the Build Alternatives.

Figure 2-16: Alternatives Development Process



2.4 Development and Evaluation of Proposed Corridors

The first step in the alternatives development process for this EIS was to evaluate proposed corridor alternatives. This section summarizes the process that FRA undertook to identify corridor alternatives.

The *Dallas to Houston High-Speed Rail Project, Corridor Alternatives Analysis Technical Report*, including the detailed screening methodology, is available on the FRA project website: https://www.fra.dot.gov/eLib/Details/L16978.

2.4.1 Description of Corridor Alternatives

In accordance with the Passenger Rail Investment and Improvement Act, TxDOT prepared an annual state rail plan in 2010 and completed subsequent updates. The *Texas Rail Plan* recognizes strategic planning efforts for high-speed rail development, as well as existing freight and passenger rail services and potential areas for investment and improvement. Using TxDOT's *Texas Rail Plan* as a framework, TCRR identified three general corridors (**Figure 2-17**) that could be considered for future development of HSR between Dallas and Houston, in order to minimize impacts to private property from the development of a new transportation corridor.

BNSF Railway – BNSF operates a freight line from downtown Dallas to downtown Houston. In order to create a more direct path for the HSR, numerous corridor alternatives were developed between Dallas and Teague resulting in a wider corridor that would extend as far west as IH-35E and east of IH-45. From Teague, south to downtown Houston, the corridor would generally follow the BNSF Teague line.

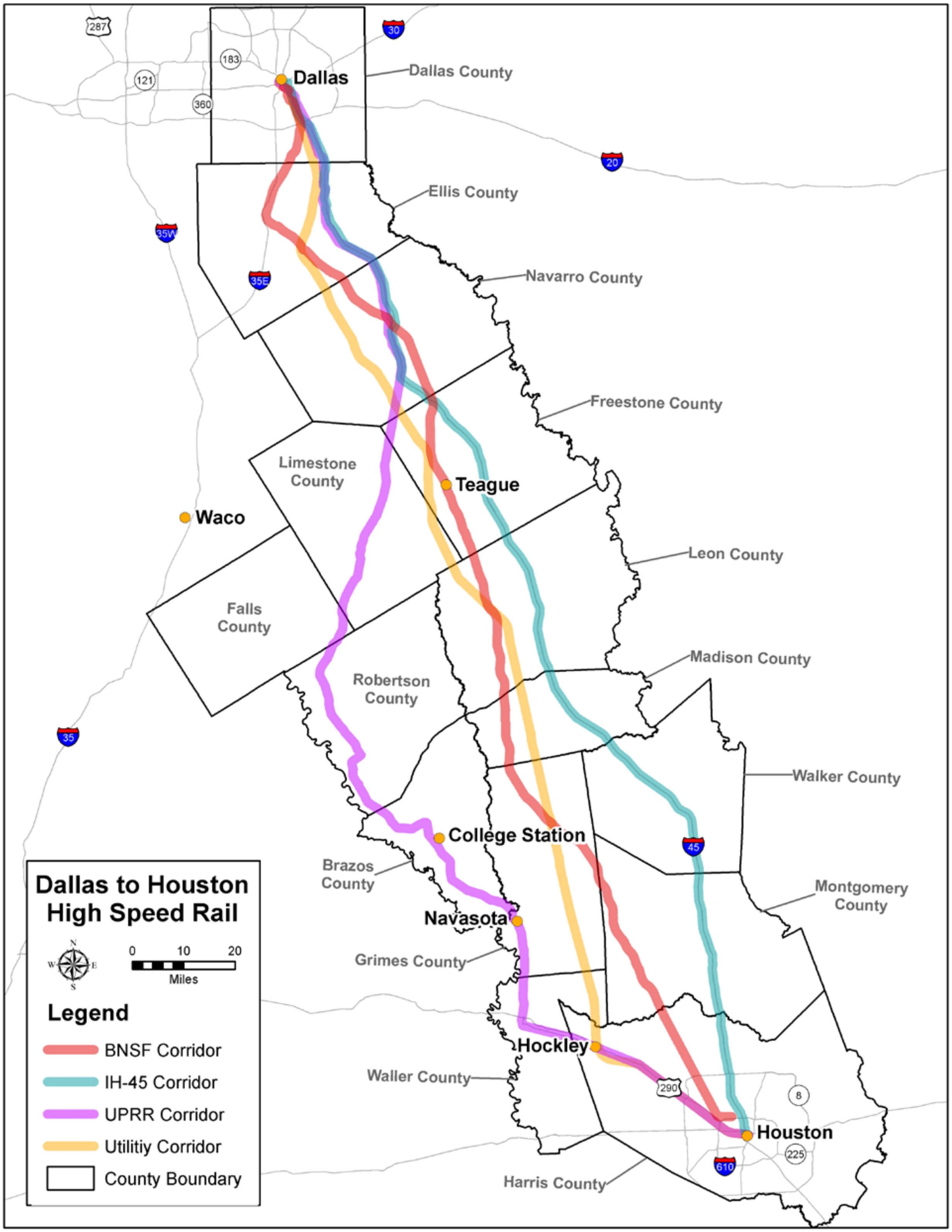
IH-45 – The IH-45 Corridor would extend from the vicinity of Dallas Union Station in downtown Dallas and would generally follow the freeway through southern Walker County. In this vicinity, the corridor would generally follow the Union Pacific Railroad's (UPRR) Hardy Subdivision to reach downtown Houston.

UPRR – The UPRR Corridor would extend from the vicinity of Dallas Union Station in downtown Dallas south through College Station, Navasota and Hockley to the Houston Amtrak Station in downtown Houston. It would generally follow the UPRR freight rail line.

In addition to the potential corridors identified in the *Texas Rail Plan*, TCRR proposed to FRA the "Utility Corridor." TCRR identified this corridor to take advantage of the existing, relatively straight, long, linear infrastructure easements between Dallas and Houston, also as a way to minimize impacts to private property from the development of a new transportation corridor.

Utility Corridor – The Utility Corridor would predominately follow the CenterPoint Energy and Oncor Electric Delivery high-voltage electrical transmission lines (345 to 500 kV). However, since the existing utility corridors do not extend into Dallas and Houston, railroad ROW would be needed to complete the corridor connectivity.

Figure 2-17: Potential HSR Corridors



Source: AECOM, 2016

2.4.2 Description of Other Modes Considered

Based on public comments received during the scoping period asking FRA to consider other forms of transportation, FRA also evaluated alternatives to HSR between Dallas and Houston, including other types of passenger rail service and other modes of transportation. These other potential transportation alternatives are described below.

Higher-Speed and Conventional Service – HSR at the Project's proposed speeds requires a fully-sealed and grade-separated ROW and two separate new tracks for passenger rail service. Higher-speed (90 to 150 mph) and conventional speed (up to 90 mph) rail service can be implemented in existing railroad ROW and can operate through at-grade railroad crossings at passenger train speeds up to 125 mph.[4] This alternative uses the BNSF Teague freight line or the UPRR Hempstead freight rail line to provide different travel speeds.

Direct Bus Service – Direct bus service operated by Greyhound, MegaBus and Vonlane uses IH-45 to travel between the two metropolitan regions and the trip takes approximately four hours depending on traffic and road conditions. This alternative proposes construction of a new dedicated bus lane that would be required in order to maintain the existing automobile travel lane capacity.

IH-45 Expansion – Congestion on IH-45 is increasing and is projected to further increase automobile travel times between Dallas and Houston. To offset congestion, TxDOT is in the process of widening IH-45 from four to six travel lanes along approximately 21.1 miles from Corsicana to south of Richland in Navarro County. TxDOT is also planning to widen IH-45 from four to six travel lanes for 6.25 miles from north Huntsville to south Huntsville and another 12.4 miles from south Huntsville to the Montgomery County Line.

2.4.3 Corridor Screening Methodology

FRA completed an independent review of the four corridors that are illustrated in **Figure 2-17**, using a desktop evaluation of publicly available resources. As discussed in **Section 2.4.2**, FRA also evaluated conventional speed passenger rail service, direct bus service and expanding IH-45 travel lanes. FRA's alternatives analysis screening process is described in full in the *Corridor Analysis Technical Report* and the *Alternatives Analysis Report* available on FRA's website. For analysis purposes, a general centerline within each corridor was established as a representative alignment for comparative purposes. FRA did not complete any detailed engineering or design work as part of the corridor analysis. For the corridor screening, FRA conducted a two-part analysis.

The first part, the Coarse Screening Analysis evaluated if the corridor alternatives met the Project Purpose and Need, as required by NEPA. FRA conducted a pass/fail analysis and determined that an alternative "failed" if it did not meet Purpose and Need or "passed" if it did. FRA carried all potential corridor alternatives and other potential transportation alternatives that "passed" into the second part, the Fine Screening Analysis.

As part of the Coarse Screening Analysis, FRA determined that higher-speed and conventional speed passenger rail service, direct bus service and expansion of travel lanes on IH-45 would not meet the Project purpose to provide the public with reliable and safe high-speed passenger rail transportation between Dallas and Houston. Although higher-speed and conventional rail service may be able to use

[4] In addition, FRA approval is required for train operations through highway-rail crossings at speeds between 110 and 125 mph. See 49 C.F.R. § 213.347.

existing railroad ROW on either the BNSF or UPRR corridors, these potential corridor alternatives would not be able to employ the N700 Tokaido Shinkansen HSR system as proposed in TCRR's petition for a Rule of Particular Applicability or reach travel speeds of 200 mph, one of TCRR's identified objectives for the Project.

Direct bus service or expanding IH-45 may temporarily relieve congestion on IH-45, meeting the transportation need of the Project. However, these alternatives rely on vehicular travel as the primary means of transportation between the Dallas and Houston metropolitan regions and would not offer a long-term alternative to travel on IH-45 and they would not offer a one-way trip in 90 minutes or less. Additionally, these other potential transportation alternatives would not provide passenger rail service, as per TCRR's objectives for the Project. Therefore, FRA eliminated these alternatives from further consideration based on failure under the Purpose and Need criterion.

The second part of the corridor analysis consisted of a Fine Screening Analysis. FRA evaluated the four HSR corridor alternatives based on three screening criteria: physical characteristics, operational feasibility or environmental constraints, specifically:

Physical characteristics – endpoints, length of the corridor, number of curves, number of at-grade crossings, physical obstructions or encroachments onto the ROW

Operational feasibility – ownership, travel time, number of bridges, implementability

Environmental constraints – direct impacts to residential and commercial properties; wetlands, floodplains, waterways and waterbodies; historic properties, Section 4(f) resources; Section 6(f) resources; and threatened and endangered species

FRA eliminated the BNSF and UPRR corridors predominantly because BNSF and UPRR declined consent to share ROW for the majority of distance between Dallas and Houston, which made them operationally infeasible, and the immediate adjacency to the corridors would require a cost-prohibitive barrier wall along the 240-mile length of the corridor. Additionally, the physical characteristics of the BNSF and UPRR would not be suitable for high-speed operations because curvature of the existing freight rail line would not permit the HSR trainsets to safely operate through the curves at the speeds necessary to meet the travel time objectives. To address curvature constraints and the need for a barrier wall, these alternatives would need to be located farther from the existing freight rail infrastructure and would result in greater property impacts.

FRA eliminated the IH-45 Corridor because sufficient sized ROW does not exist throughout the entirety of the interstate corridor and would result in greater direct impacts to residential and commercial properties. Also, the IH-45 corridor was the only corridor alternative that would directly impact the Sam Houston National Forest, resulting in impacts to recreation resources and managed habitat. Additionally, the physical characteristics of the highway ROW would not be suitable for HSR operations because of the existing curvature and eliminating the curves to safely permit the train operating speeds necessary to meet the travel time objectives would result in greater environmental constraints in the form of increased direct impacts to residential and commercial properties. Roadway interchanges would require extensive reconstruction above or below the HSR tracks and would result in increased direct impacts to residential and commercial properties.

2.4.4 Selected Corridor Alternative

FRA determined that the Utility Corridor, in its entirety, would be retained for further investigation as it would best meet both the Project's Purpose and Need and also the technical requirements to implement safe and reliable HSR passenger rail service between Dallas and Houston. FRA determined that there were no major physical characteristics, operational feasibility or environmental constraints that would eliminate the Utility Corridor from further consideration. While the BNSF and UPRR corridors were eliminated from further evaluation as part of the Corridor Alternatives Analysis, opportunities may exist for TCRR to negotiate with BNSF and UPRR to locate the HSR track adjacent to or within the ROW of the host railroad for short distances in order to minimize potential adverse impacts in certain areas along the route. FRA also determined that portions of the IH-45 Corridor should be retained for further investigation in the event that constraints arise along the Utility Corridor.

2.5 Development and Evaluation of Initial Alignment, Station and TMF Alternatives

Based on FRA's selection of the Utility Corridor, TCRR developed 21 potential alignment alternatives for FRA consideration. This section details the process that FRA undertook to identify the alignment alternatives that are evaluated in this EIS.

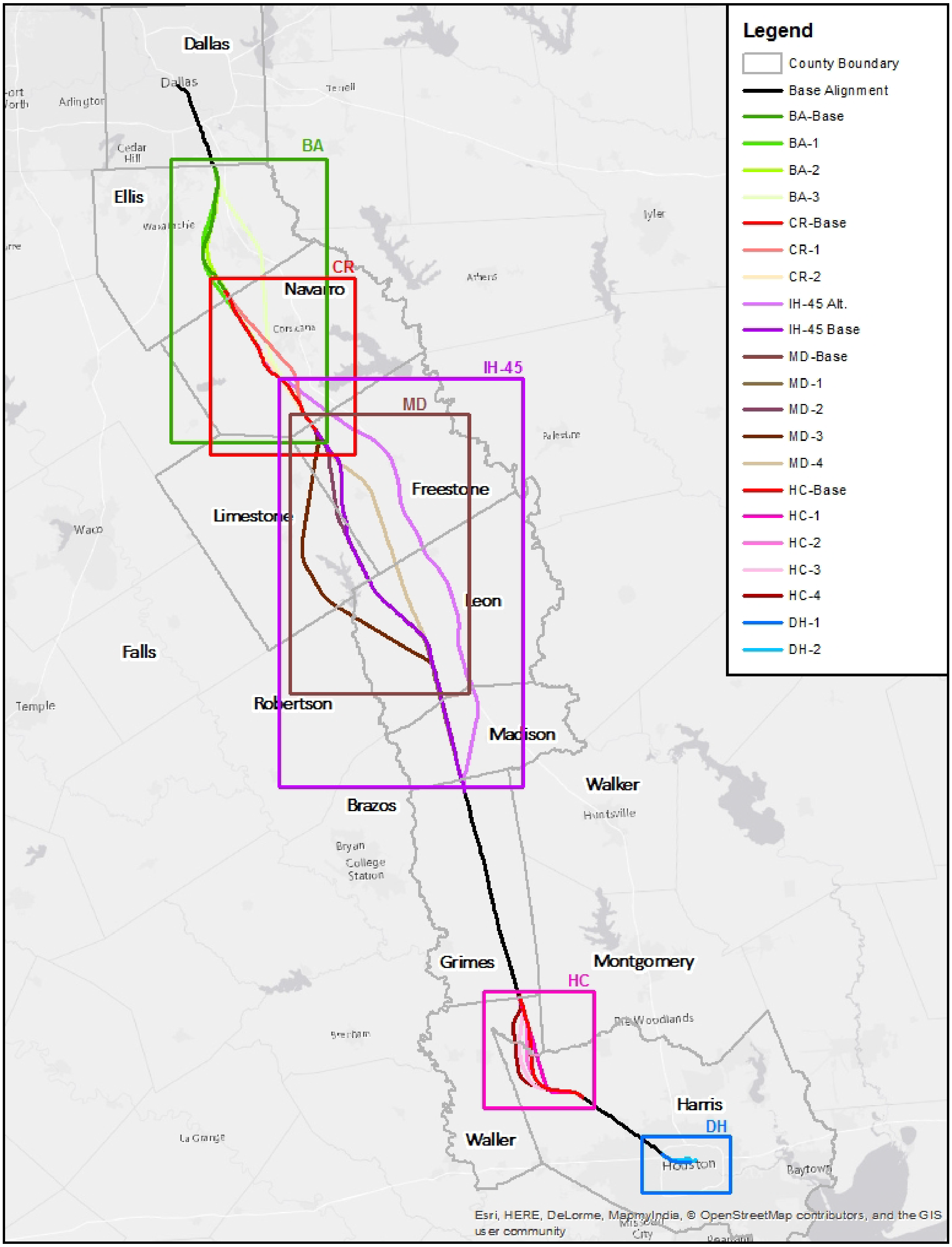
FRA's full *Dallas to Houston High Speed Rail Project, Alignment Alternatives Analysis Report*, is available on the FRA project website: https://www.fra.dot.gov/eLib/Details/L17203.

2.5.1 Initial Alignment Alternatives

As illustrated in **Figure 2-18**, TCRR recommended 21 potential alignment alternatives. TCRR identified constraints, including "areas of environmental concern, construction complexity, geometric challenges, economic impact and other major concerns," in six geographic areas from which it identified the potential alignment alternatives. These potential alignment alternatives were created using the alignment objectives and design guidelines developed by TCRR. The six geographic areas include:

- Corsicana (CR)
- Bardwell (BA)
- IH-45
- Middle (MD)
- Hockley (HC)
- Downtown Houston (DH)

Figure 2-18: Potential Alignment Alternatives



Source: AECOM, 2016

2.5.1.1 Level I Screening

FRA completed an independent review of the 21 alignment alternatives by geographic group using a desktop evaluation of publicly available resources. This evaluation consisted of a two-level process. The Level I Screening evaluated the potential alignment alternatives based on Project Purpose and Need, TCRR's alignment objectives (i.e., maximizing grade separation and minimizing environmental impacts and constructability concerns) and TCRR's design guidelines (i.e., maximum operating speed and minimum alignment curvature). For the Level I Screening, FRA conducted a pass/fail analysis and determined that an alternative "failed" if it did not meet the Level I Screening Criteria or "passed" if it did. FRA carried all potential alignment alternatives that "passed" into Level II Screening Analysis for further evaluation, as summarized in **Section 2.5.1.2**. Three alignment alternatives (DH-1, DH-2, and HC-1) were eliminated from further consideration based on the Level I pass/fail analysis, as summarized below and in **Table 2-1**.

The Level I screening eliminated two alternatives for the DH geographic group, DH-1 and DH-2, as they would have potential to create significant environmental impacts and prohibitive construction costs.[5] DH-1 would have the potential to create significant environmental impacts to six areas of concern – National Historic District Heights Boulevard Esplanade, the U.S. Healthworks Hospital, Houston and Texas Central Railroad archeology site and Cottage Grove Park. Additionally, DH-1 would have the potential to disproportionately impact minority populations. DH-2 would also have the potential to create significant environmental impacts to nine areas of concern – National Historic District Heights Boulevard Esplanade, U.S. Healthworks Hospital, Houston and Texas Central Railroad archeology site, Cottage Grove Park, Stude Park, White Oak Park, and Hogg Park. Given the prohibitive construction costs[6] to build the DH potential alignment alternatives and the environmental impacts noted above, FRA eliminated DH-1 and DH-2 from further consideration for this Project.

Additionally, FRA determined that HC-1 would not meet the design guidelines for the Project. Based on conceptual engineering as of June 25, 2015, HC-1 contains two curves that would require a speed restriction of 160 mph, which would fail to meet the minimum alignment curvature necessary to achieve the intended maximum travel time of 90 minutes.[7]

[5] Texas Central High-Speed Railway, "Last Mile Analysis Report," March 27, 2015. http://www.texascentral.com/wp-content/uploads/2015/11/Last-Mile-Analysis.pdf
[6] Ibid.
[7] Texas Central High-Speed Railway, "Step 2 Screening of Alignment Alternatives Report," November 5, 2015. http://www.texascentral.com/wp-content/uploads/2015/11/Step_2_Screening_of_Alignment_Alternatives_Report.pdf

Table 2-1 Development and Evaluation of Potential Alignment Alternatives

Geographic Group	Route Alternative	Level I	Level II, Stage I	Level II, Stage II	EIS
		Purpose and Need, Alignment Objectives and Design Guidelines	Environmental Criteria	Combined Environmental Criteria, Cost and Construction Factors	Advanced for Detailed Analysis
Bardwell	BA-Base	Meets Level I Criteria	Meets Level II, Stage I Criteria	Meets Level II, Stage II Criteria	Advanced to EIS
	BA-1	Meets Level I Criteria	Meets Level II, Stage I Criteria	Does not meet Level II, Stage II Criteria	--
	BA-2	Meets Level I Criteria	Meets Level II, Stage I Criteria	Meets Level II, Stage II Criteria	Advanced to EIS
	BA-3	Meets Level I Criteria	Does not meet Level II, Stage I Criteria, but advanced to next level per TCRR request	Does not meet Level II, Stage II Criteria	--
Corsicana	CR-Base	Meets Level I Criteria	Meets Level II, Stage I Criteria	Meets Level II, Stage II Criteria	Advanced to EIS
	CR-1	Meets Level I Criteria	Does not meet Level II, Stage I Criteria, but advanced to next level per TCRR request	Meets Level II, Stage II Criteria	Advanced to EIS
	CR-2	Meets Level I Criteria	Does not meet Level II, Stage I Criteria	--	--
IH-45	IH-45 Base	Meets Level I Criteria	Meets Level II, Stage I Criteria	Meets Level II, Stage II Criteria	Advanced to EIS
	IH-45 Alt	Meets Level I Criteria	Meets Level II, Stage I Criteria	Meets Level II, Stage II Criteria	Advanced to EIS
Middle	MD-Base	Meets Level I Criteria	Meets Level II, Stage I Criteria	Meets Level II, Stage II Criteria	Advanced to EIS
	MD-1	Meets Level I Criteria	Meets Level II, Stage I Criteria	Does not meet Level II, Stage II Criteria	--
	MD-2	Meets Level I Criteria	Does not meet Level II, Stage I Criteria	--	--
	MD-3	Meets Level I Criteria	Does not meet Level II, Stage I Criteria	--	--
	MD-4	Meets Level I Criteria	Does not meet Level II, Stage I Criteria, but advanced to next level per TCRR request	Does not meet Level II, Stage II Criteria	--
Hockley	HC-Base	Meets Level I Criteria	Does not meet Level II, Stage I Criteria	--	--
	HC-1	Did not meet design guidelines (minimum alignment curvature)	--	--	--
	HC-2	Meets Level I Criteria	Meets Level II, Stage I Criteria	Does not meet Level II, Stage II Criteria	--
	HC-3	Meets Level I Criteria	Does not meet Level II, Stage I Criteria	--	--
	HC-4	Meets Level I Criteria	Meets Level II, Stage I Criteria	Meets Level II, Stage II Criteria	Advanced to EIS
Downtown Houston	DH-1	Did not meet environmental criteria (direct impacts)	--	--	--
	DH-2	Did not meet environmental criteria (direct impacts)	--	--	--

Source: AECOM, 2016

2.5.1.2 Level II Screening

FRA's Level II Screening Analysis consisted of two stages. In the Level II, Stage I Environmental Constraints Screening, FRA quantitatively evaluated 18 potential alignment alternatives that were carried forward from Level I Screening using a Geographic Information Systems (GIS)-based analysis of environmental constraints. In order to determine areas of potential environmental impact as required by NEPA, FRA conducted the GIS analysis on 16 environmental evaluation criteria using readily available state and federal databases, as shown in **Table 2-2**. These criteria are defined and the methodology used is described in full within the *Dallas to Houston High Speed Rail Project, Alignment Alternatives Analysis Report*, which is available on the FRA project website: https://www.fra.dot.gov/eLib/Details/L17203.

Table 2-2: Level II, Stage I Environmental Criteria

Criterion	Description	Data Sources
Urban Land Cover	Low-intensity, medium-intensity and high-intensity developed lands compared to undeveloped lands	National Land Cover Database
Structures and Parcel Takes	A count of rooftops, as seen on aerial photography that are within 62.5 feet of the route alternative; and Total of parcels with affected structures and parcels (without affected structures) where at least 40 percent of area is impacted	Aerial Photography and Appraisal Districts
Parks	Acreage of state and local parkland impacted by the alignment alternatives	Texas Parks and Wildlife Department and Dallas, Houston and Bryan/College Station Metropolitan Planning Organizations (MPO)
Prime Farmland	Acreage of prime farmland impacted by the alignment alternatives	National Resources Conservation Services
Wetlands	Acreage of NWI mapped wetlands impacted by the alignment alternatives	National Wetlands Inventory
Waterways	Number of direct waterway crossings by the alignment alternatives	National Hydrography Dataset
Floodplains	Acreage of 100- and 500-year floodplain impacted by the alignment alternatives	Federal Emergency Management Agency
Road Crossings	Number of direct roadway crossings by the alignment alternatives	TxDOT
Infrastructure Adjacency	Percentage of the route alternative that parallels roads, transmission lines, or existing railroads	TxDOT (roads), Platts (transmission lines), U.S. National Transportation Atlas (railroads)
Minority Population	Estimated minority population affected based on census tract data	Census Bureau (Census 2010)
Cemeteries	Acreage of cemeteries impacted by the alignment alternatives	Texas Historical Commission
Ecology	Acreage of mapped Texas Natural Diversity Database (TXNDD) Element occurrences impacted by the alignment alternatives	Texas Natural Diversity Database
Historic Properties*	Number of NRHP properties and districts within 62.5 feet of the alignment alternatives	National Register of Historic Places

Table 2-2: Level II, Stage I Environmental Criteria

Criterion	Description	Data Sources
Community Facilities*	Number of public buildings, churched, hospitals, post offices, and schools within 62.5 feet of the alignment alternatives	Geographic Names Information Service (GNIS) Dataset
Hazardous Materials*	Number of municipal setting designations, municipal solid waste landfills, radioactive sites, Superfund sites, municipal water wells, and underground petroleum storage tanks within 62.5 feet of the alignment alternatives	Texas Commission on Environmental Quality
Population below Poverty Line*	Estimated population below the poverty level affected based on census tract data	US Census Bureau (2013 5-year ACS)

Source: AECOM, 2016

*Data collected for these environmental criteria did not create any differentiation between the scoring of the potential alignment alternatives at this level of analysis.

Based on the data collected, scoring for each of the environmental evaluation criteria was based on the lowest score (best) having the least potential to create an environmental impact. A ratio method was used to distribute the scores among potential alignment alternatives within each geographic group. The scores for each criterion were totaled for each potential route alternative within its geographic group. FRA determined that the lowest scoring potential route alternative would move forward to Level II, Stage II Cost and Construction Screening for further evaluation. After the scores were totaled, the standard deviation was then calculated for each geographic group. The potential alignment alternatives that fell within one standard deviation (indicating no statistical difference) of the lowest score were carried into the Level II, Stage II Cost and Construction Screening.

FRA advanced 10 potential alignment alternatives to the Level II, Stage II Screening. A summary of the results from the Level II, Stage I are included in **Table 2-1**.

In addition, FRA carried forward three additional potential alignment alternatives (MD-4, BA-3 and CR-1) that were eliminated in the Level II, Stage I Environmental Constraints Screening that TCRR had identified as preferred alignments that best met its cost and construction goals in its *Step 2 Screening of Alignment Alternatives Report*. FRA further evaluated these 13 alignment alternatives in the Level II, Stage II Cost and Construction Screening using a combination of environmental, cost and construction factors developed to address TCRR's primary criteria of cost and constructability.

In order to complete the Level II, Stage II Cost and Construction Screening, the cost and construction factors provided by TCRR were averaged together to create a single factor that could be compared to the environmental factor. From the Level II, Stage II Screening, FRA carried forward the potential alignment alternatives with the lowest score in each geographic group. Additionally, FRA carried forward potential alignment alternatives within each geographic group that were very close to the lowest score in the geographic group such that there was no distinguishable difference between the scores using a "natural break" approach.[8]

Based on the Level II, Stage II Screening Analysis, eight alignment alternatives were carried forward for further evaluation. A summary of the results from the Level II, Stage II are also included in **Table 2-1**. These alignment alternatives, in combination with the common segments, were then pieced together to

[8] The "natural break" point clusters data to determine the best arrangement of values into different classes. For this analysis, FRA identified classes of high and low scores, with low scores representing a lower potential for impact.

create six end-to-end alignment alternatives (Build Alternatives A through F) described in **Section 2.6**. These are the Build Alternatives that are the subject of this EIS.

2.5.2 Initial Station Alternatives

2.5.2.1 Station Alternatives Analysis

Three station alternatives were evaluated in Dallas and seven station options were evaluated in Houston. No intermediate station alternatives were evaluated during the alternatives analysis because it was too early in the planning and conceptual design process to identify potential intermediary station locations without the alignment alternatives. The station options were evaluated by TCRR[9] and independently confirmed by FRA using the following the criteria: access to existing transportation and roadway networks, availability of property and development opportunities. During the station alternatives analysis, specific parcels were not identified. In this early phase of planning and conceptual design, the design parameters for the terminal stations were not known. Therefore, the station alternatives analysis considered general locations that might be able to accommodate a terminal station.

Dallas Station Alternative Location A: This station area is bound by the Trinity River, IH-35E and IH-30 and S Lamar Street. It was identified for consideration because it is the area in which the BNSF ROW and the Utility Corridor converge south of Dallas. This area also provides access to the former Reunion Area site, Dallas Union Station and the Dallas Convention Center. The Dallas Station Alternative Location A area contains a mix of light industrial and commercial land uses, as well as the Trinity River floodplain.

Dallas Station Alternative Location B: This station area considered the intersection of IH-45 and Loop 12, approximately 6 miles south of Downtown Dallas. It was identified for consideration because it is the area in which the UPRR and BNSF ROWs cross Loop 12, making it accessible from the highway and rail ROW. The Dallas Station Alternative Location B area contains a mix of rural, light industrial and commercial land uses.

Dallas Station Alternative Location C: This station area considered the intersection of IH-45 and IH-20, approximately 10 miles south of downtown Dallas. It was identified for consideration because it is the area in which the UPRR and BNSF ROWs cross IH-20, making it accessible from the highway and rail ROW. The Dallas Station Alternative Location C area is predominantly rural, and also includes light industrial and commercial land uses and a correctional facility.

Houston BNSF Station Alternative Location A: This station area considered the intersection of SH 249 and Beltway 8 in the northwest area of Houston. It was identified for consideration because SH 249 is located parallel to the BNSF ROW in an area outside of Beltway 8 where undeveloped land is available. It would provide proximity to Houston George Bush Intercontinental Airport.

Houston BNSF Station Alternative Location B: This station area considered the intersection of US 290 and IH-610 in the central/northwest area of Houston. It was identified for consideration because SH 290 is located in proximity to the BNSF ROW and Hempstead Road. Houston BNSF Station Alternative Location B includes the Northwest Mall site, which provides the opportunity for redevelopment with transit-oriented uses. It also contains the Northwest Transit Center, a multi-modal transit center.

[9] Texas Central High-Speed Railway, "Last Mile Analysis Report," March 27, 2015. http://www.texascentral.com/wp-content/uploads/2015/11/Last-Mile-Analysis.pdf

Houston BNSF Station Alternative Location C: This station area is located between TC Jester Boulevard and Oak Forest Drive where they intersect with the BNSF ROW in the northwest area of Houston. It was identified for consideration because the area is located in proximity to the BNSF ROW and IH-610. Houston BNSF Station Alternative Location contains primarily residential land uses.

Houston BNSF Station Alternative Location D: This station area is the former UPRR Hardy Yards, a 50-acre area located north of IH-10 in downtown Houston. The area is currently identified for a mixed-use development. It would provide access to IH-45 to the west, SH 59 to the east, and IH-10 to the south. Houston BNSF Station Alternative Location D was identified for consideration because of its proximity to the Houston central business district and the area is served by light rail transit.

Houston UC Station Alternative Location A: This station area includes the intersection of US 290 and Beltway 8 along the Utility Corridor in the northwest area of Houston. It was identified for consideration because undeveloped land is located in proximity to Beltway 8 and US 290 connects Houston to Hempstead, Prairie View, College Station and Austin.

Houston UC Station Alternative Location B: This station area includes the intersection of US 290 and IH-610 along the Utility Corridor in the central/northwest area of Houston. It was identified for consideration for its proximity to US 290, which connects Houston to Hempstead, Prairie View, College Station, and Austin. It would also be located in the northwest Houston with access to central Houston.

Houston UC Station Alternative Location C: This station area is located in downtown Houston and is bound by IH-10 to the north, IH-45 to the west, and US 59 to the east. It includes light rail transit service stops and is a key employment center in the Houston region.

The Utility Corridor would support all three Dallas Station Alternatives; however, the Dallas Station Alternative Location A would offer connectivity to existing Dallas Area Rapid Transit light rail and bus service. Additionally, it would allow for potential expansion of the TRE commuter rail service and/or Amtrak service. Therefore, FRA selected Dallas Station Alternative Location A for further evaluation in this EIS.

As discussed in **Section 2.4.1**, the BNSF Corridor was eliminated from further consideration as part of FRA's *Corridor Alternatives Analysis*. With the selection of the Utility Corridor and six Build Alternatives based on the Utility Corridor, the Station Area Alternatives on the BNSF line were automatically eliminated from further consideration because none of the alignment alternatives would connect to them.

Additionally, as discussed in **Section 2.5.1**, alternative alignments connecting to Downtown Houston (DH) were eliminated from further consideration as part of FRA's *Alignment Alternatives Analysis*. This eliminated Houston UC Station Alternative Location C, which would support downtown Houston.

In Houston, two station alternative locations remained to be screened: Houston UC Station Alternative Location A and Houston UC Station Alternative Location B. Both of these locations provided equal access to area highways and contained developable areas of land that could accommodate a station building and the HSR ROW. However, only Houston UC Station Alternative Location B provided potential connections to expanded transit services or existing transit facilities with their proximity to the Northwest Transit Center and the existing bus rapid transit service from the Metropolitan Transit

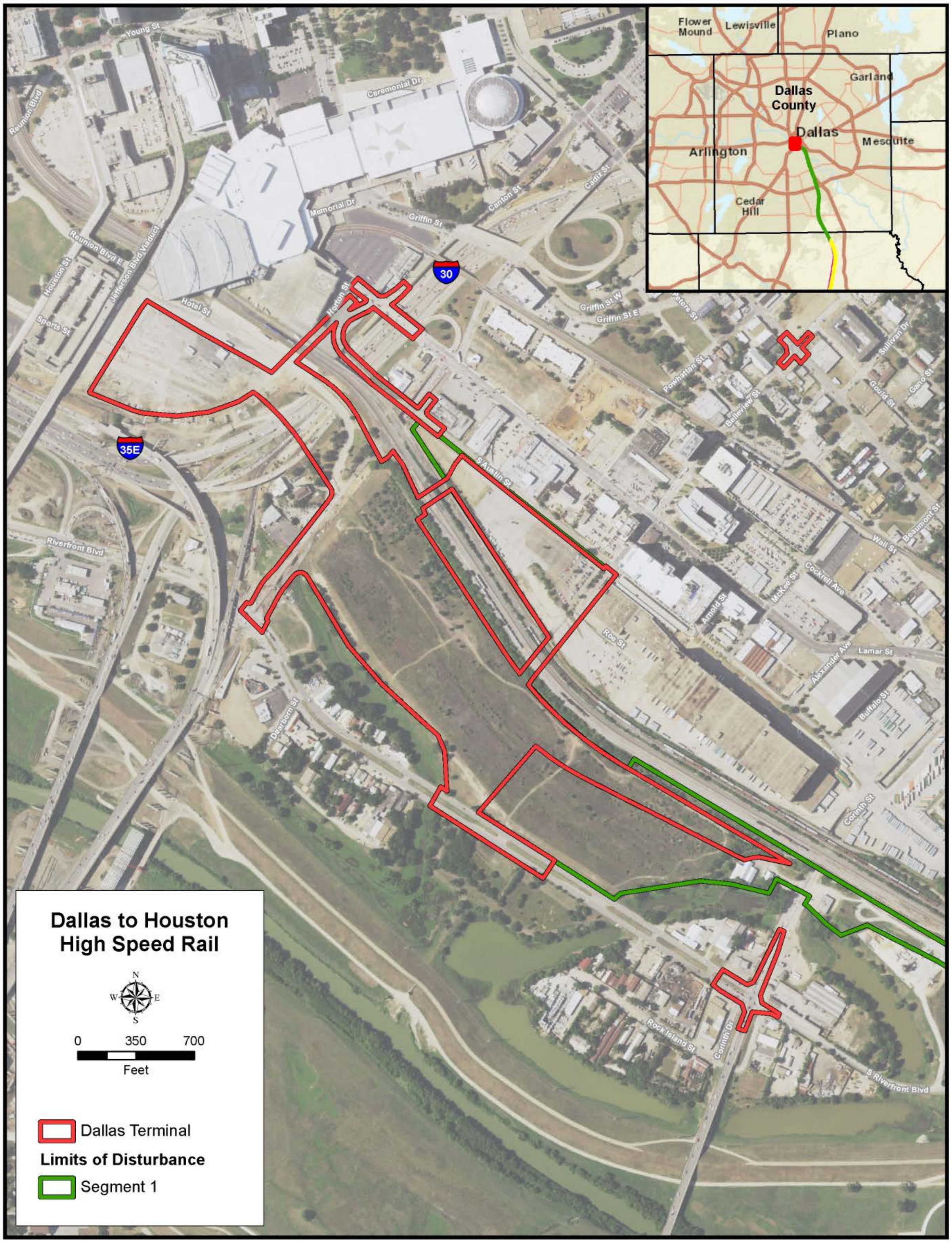
Authority of Harris County. Therefore, FRA selected Houston UC Station Alternative Location B for further evaluation in this EIS. As part of the development of the Houston UC Station Alternative Location B, TCRR identified three potential station sites within the area. These three sites – Industrial Site Terminal Option, Northwest Mall Terminal Option and the Northwest Transit Center Terminal Option – are discussed in more detail in **Section 2.5.2.3**.

2.5.2.2 Dallas Terminal Station

One station alternative is proposed at the Dallas Terminal and would be common to all six Build Alternatives. The proposed Dallas Station would be located south of IH-30 (south of downtown Dallas), between South Riverfront Boulevard and the UPRR ROW west of Lamar Street, in an area known as the Cedars District. **Figure 2-19** shows the station location and footprint. The overall footprint includes the station building (ticketing, concessions, security, platforms, etc.) parking facilities, storage track, pedestrian access and roadway improvements (see **Appendix F, TCRR Conceptual Engineering Design Report**).

The terminus station would serve the Kay Bailey Hutchison Convention Center, which is located north of IH-30 and Lamar Street. The proposed station is in proximity to two DART light-rail stations (Convention Center and Cedars). DART may consider an extension of the TRE commuter rail service, which currently terminates at Union Station, to the HSR station area.

Figure 2-19: Dallas Terminal



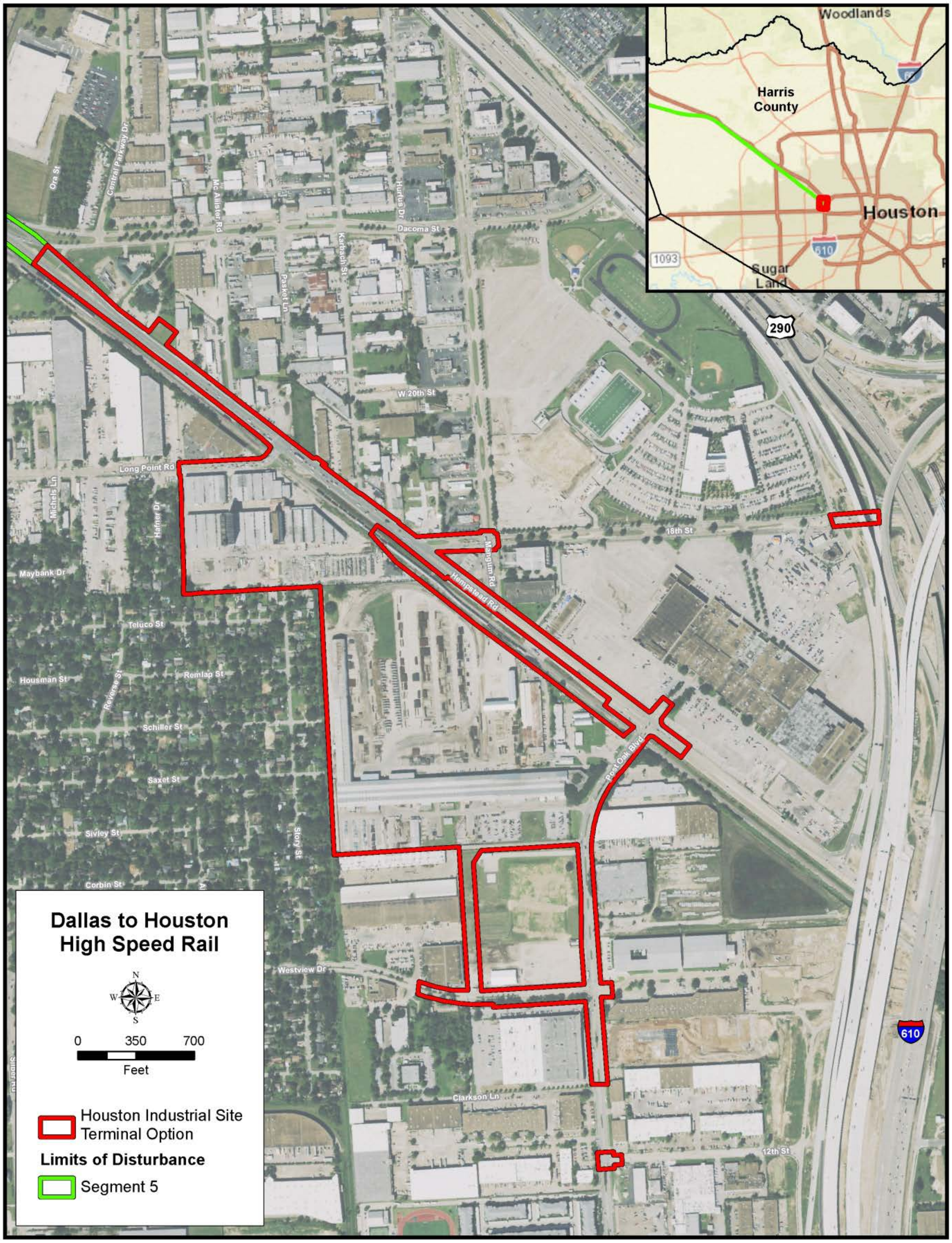
Source: AECOM, 2017

2.5.2.3 Houston Terminal Options

Three station alternatives are proposed at the Houston terminus and would be common to all six Build Alternatives. A Houston station would be located in northwest Houston within the vicinity of US 290, IH-10 and IH-610. **Figures 2-20 through 2-22** show the proposed station locations and footprint. Each overall footprint includes the station building (ticketing, public and secured concourses with concessions, security screening, train platforms, etc.) parking facilities, rental car facilities, storage track, pedestrian access and roadway improvements (see **Appendix F, TCRR Conceptual Engineering Design Report**).

Industrial Site Terminal Option - The first proposed location would use an industrial site located south of Hempstead Road, west of Post Oak Road and north of Westview Drive.

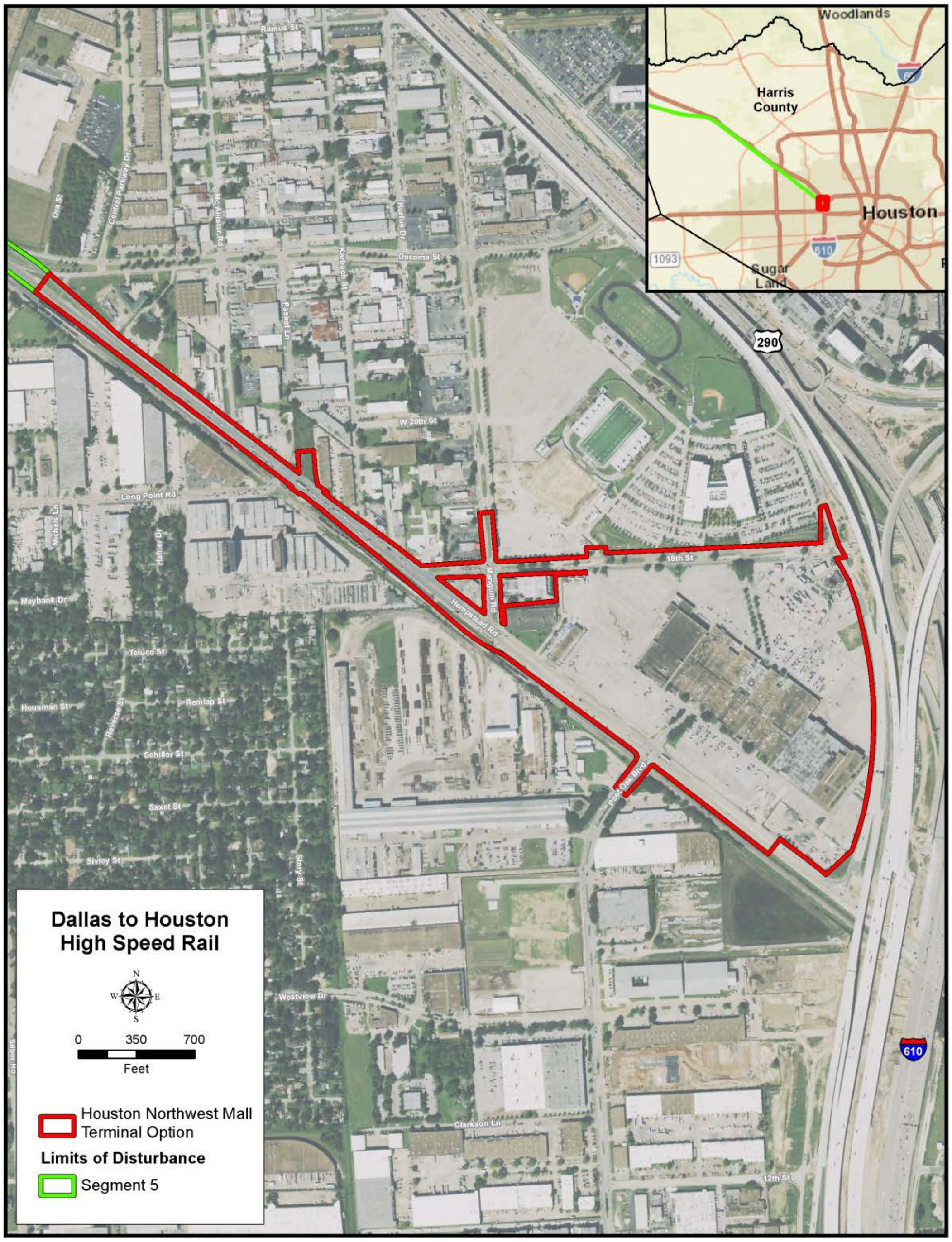
Figure 2-20: Industrial Site Terminal Option



Source: AECOM, 2017

Northwest Mall Terminal Option - A second proposed station location in Houston would use the abandoned site of the Northwest Mall at US 290 and IH-610. The station would be located west of IH-610, north of Hempstead Road and south of W 18th Street.

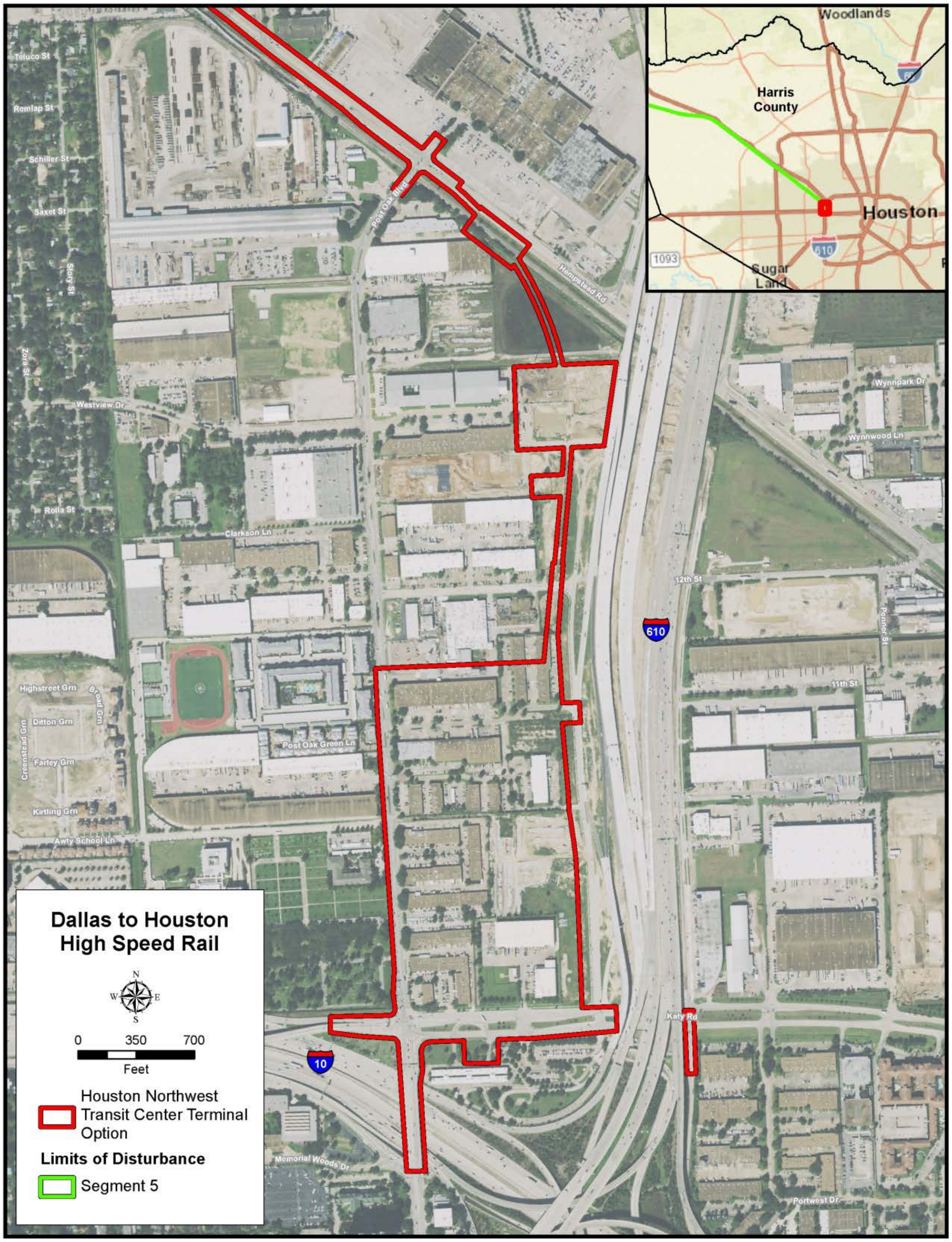
Figure 2-21: Northwest Mall Terminal Option



Source: AECOM, 2017

Northwest Transit Center Terminal Option - The third proposed location would be located north of Old Katy Road, east of Post Oak Road and west of IH-610. This location offers a direct connection to the Houston Metro Northwest Transit Facility located opposite the station.

Figure 2-22: Northwest Transit Center Terminal Option

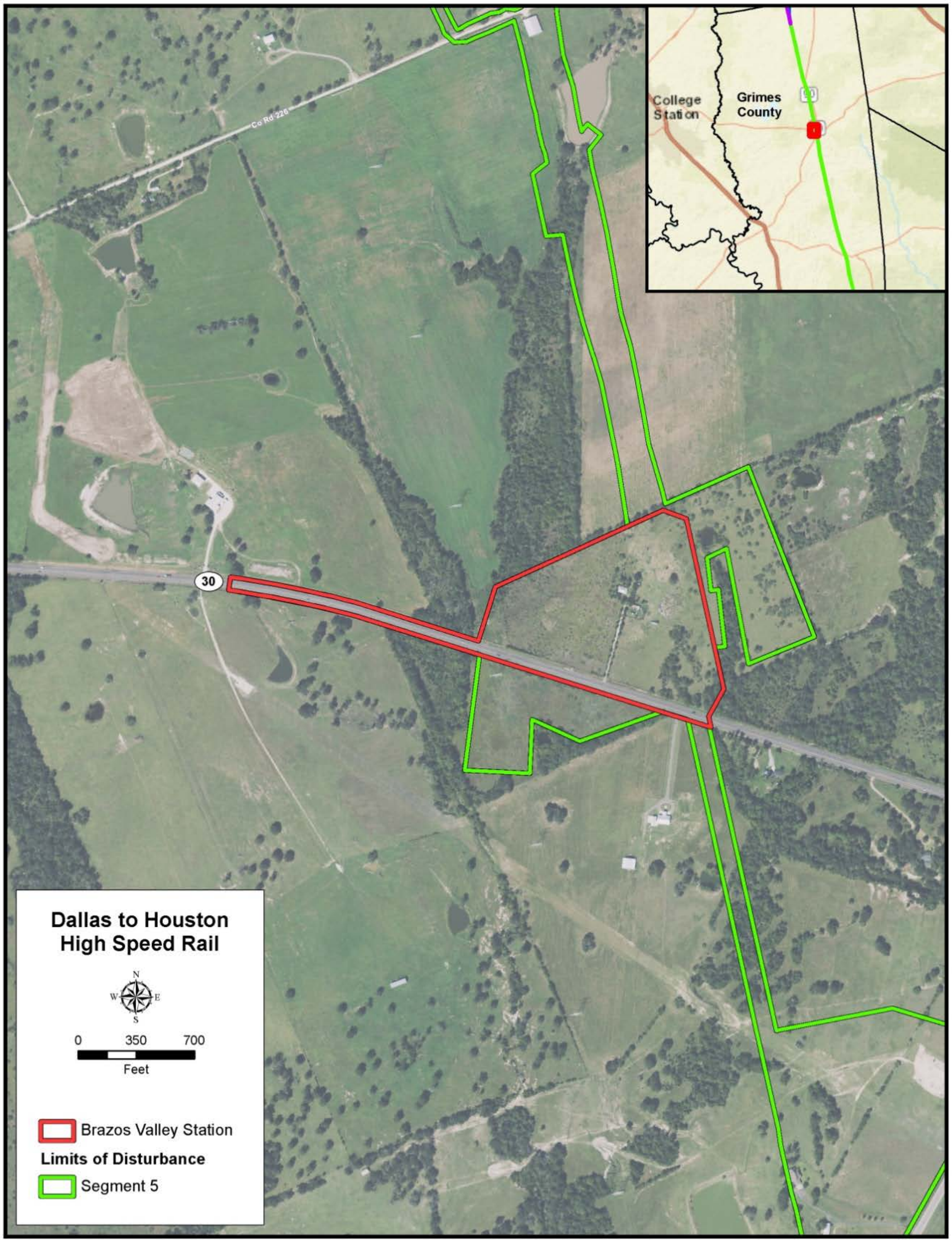


Source: AECOM, 2016

2.5.2.4 Brazos Valley Station

One intermediate station is proposed in Grimes County, near Roan’s Prairie, and would apply to Alternatives A through F. The intermediate station would be located on SH 30 between Huntsville and College Station, primarily serving Texas A&M University. **Figure 2-23** shows the proposed station location and footprint. Each overall footprint includes the station building (ticketing, concessions, security, platforms, etc.) parking facilities, storage track, pedestrian access and roadway improvements (see **Appendix F, TCRR Conceptual Engineering Design Report**).

Figure 2-23: Brazos Valley Station



Source: AECOM, 2017

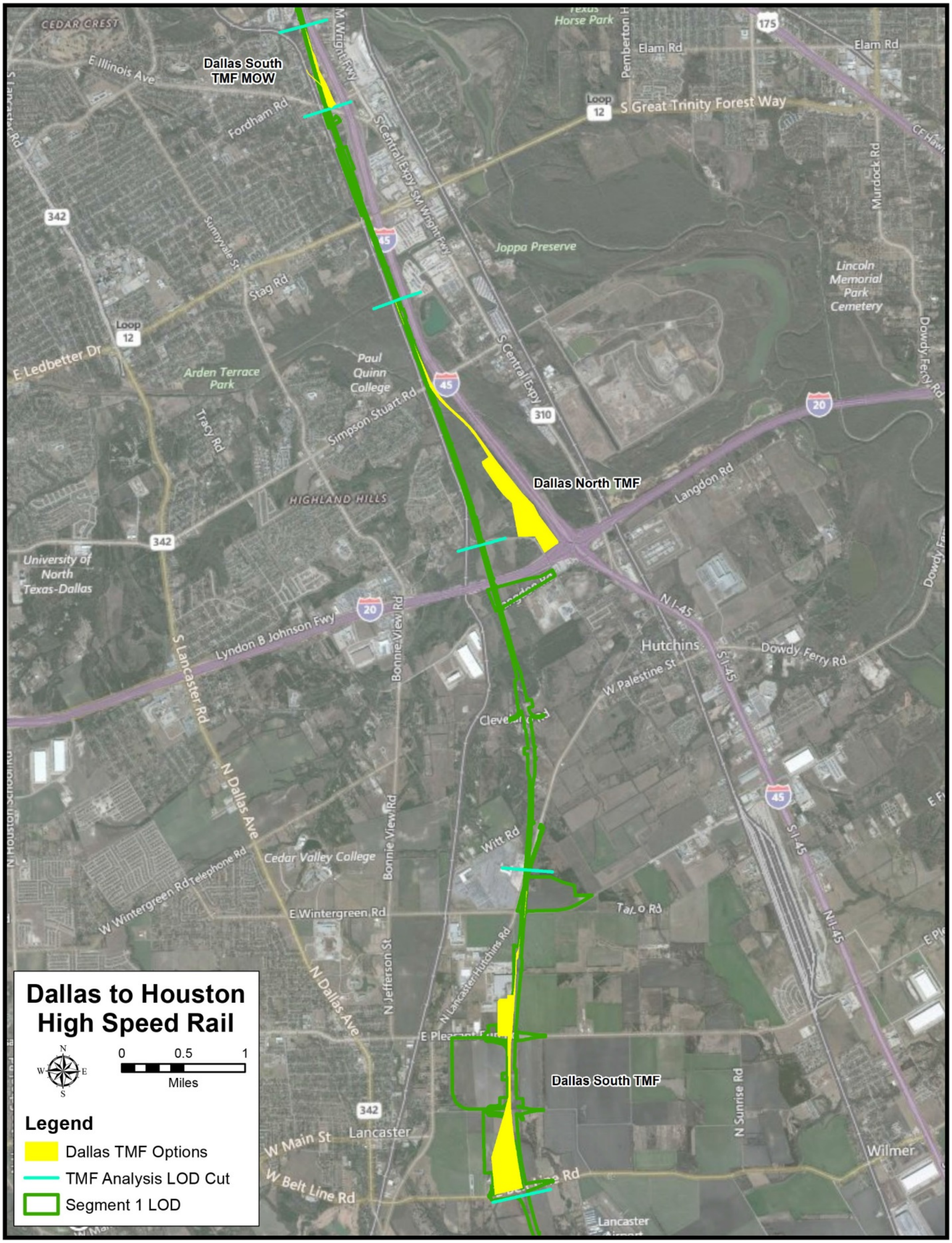
2.5.3 Initial Trainset Maintenance Facility Alternatives

Based on FRA's initial review and screening of the most feasible alignment alternatives, TCRR proposed four potential TMF sites (**Figures 2-24** and **2-25)**. This section summarizes the process that FRA undertook to identify the TMF sites that are evaluated in this EIS. FRA's full report is included in **Appendix D, *Dallas to Houston High-Speed Rail Project, Trainset Maintenance Facilities Alternatives Analysis Technical Memorandum***.

TCRR proposed two TMF locations in Dallas County and two TMF locations in Harris County. Two of the sites (one in each county) would also require an additional MOW facility to support the operation of the HSR system. FRA completed an independent review of the four sites using a desktop evaluation of publicly available resources similar to the Level II Screening discussed in **Section 2.5.1.2**. FRA conducted a GIS analysis on 16 environmental evaluation criteria using readily available state and federal databases. The environmental criteria included prime farmland, wetlands and floodplains, community facilities, historical properties, threatened and endangered species, and road crossings. FRA's independent review included fieldwork, modeling and detailed technical evaluation of the recommended sites.

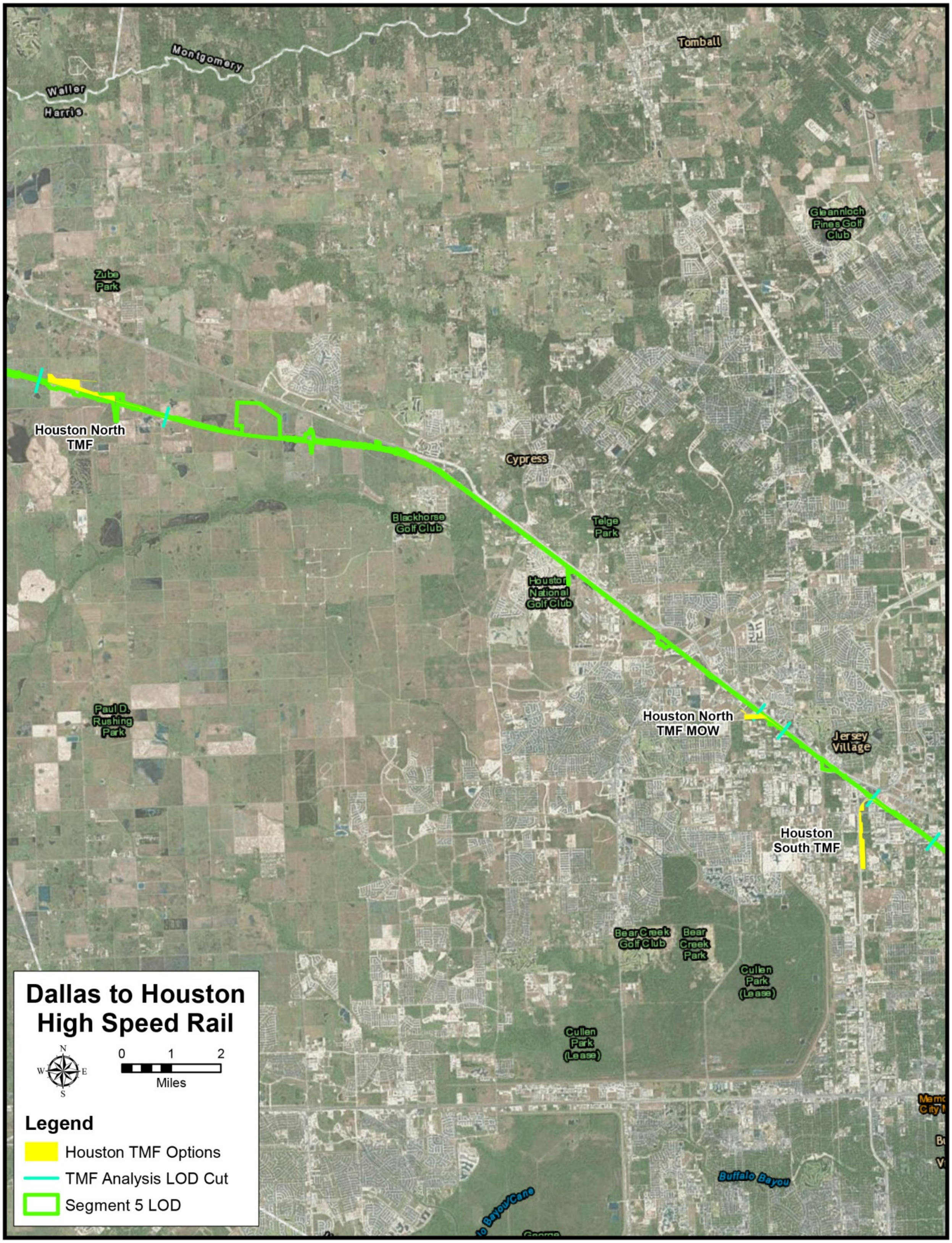
FRA evaluated the two TMF locations in Dallas County against one another to determine which site had the potential for the fewest environmental impacts. Environmental criteria that resulted in no impact or the same impact between the two sites were removed from consideration. FRA completed a more detailed analysis based on the remaining criteria - acquisition and/or displacement of parcels and structures, wetlands, waterway crossings and floodplains –to determine which site had the fewest impacts. FRA applied the same approach to the two sites in Harris County. The results of this assessment are summarized in **Tables 2-3** and **2-4**.

Figure 2-24: Dallas TMF Site Options



Source: AECOM, 2017

Figure 2-25: Houston TMF Site Options



Source: AECOM, 2017

Table 2-3: Dallas TMF Results								
	Land Use	**Structures**	**Parcel Takes**	**Prime Farmland**	**Wetlands**	**Waterways**	**Floodplains**	**Road Crossings**
	Acres	Count	Count	Acres	Acres	Count	Acres	Count
North TMF Site	598.54	11.00	38.00	393.97	11.39	7.00	44.71	15.00
South TMF Site	546.23	14.00	49.00	421.11	8.87	6.00	34.22	19.00
Net Change	52.31	3.00	11.00	27.14	2.52	1.00	10.49	4.00

Source: AECOM, 2017
Note: Hazardous Materials Sites did not differentiate between the two sites and are not included in the Dallas TMF results

Table 2-4: Houston TMF Results									
	Land Use	**Structures**	**Parcel Takes**	**Prime Farmland**	**Wetlands**	**Waterways**	**Floodplains**	**Road Crossings**	**Hazardous Materials Sites (Low Risk)**
	Acres	Count	County	Acres	Acres	Count	Acres	Count	Count
North TMF Site	360.49	14.00	13.00	304.07	12.90	10.00	10.55	10.00	2.00
South TMF Site	258.45	32.00	35.00	185.79	13.81	7.00	16.77	13.00	3.00
Net Change	102.04	18.00	22.00	118.28	0.91	3.00	6.22	3.00	1.00

Source: AECOM, 2017

FRA determined that the Dallas South TMF site near Lancaster/Hutchins Road and E Beltline Road and its accompanying MOW site located E. Illinois Avenue and IH-45 would be carried forward for evaluation in the EIS. Additionally, FRA determined that the Houston North TMF site located at Katy Hockley Road and US 290 and its accompanying MOW site located near West Road and US 290, would be carried forward and are included in the evaluation of the Build Alternatives in this EIS. The Dallas North TMF site and the Houston South TMF site were eliminated from further consideration due to their potential to create greater environmental impacts.

2.5.4 Engineering Refinements

As described in **Section 2.5.1**, FRA identified six Build Alternatives (A through F) through its evaluation of potential alignment alternatives.

As part of the design process, TCRR refined the design of the Build Alternatives to reduce the Project footprint and avoid or minimize impacts to the socioeconomic, natural, cultural and physical environment. Based on input received by TCRR through their stakeholder engagement efforts, these refinements resulted in the use of viaduct on approximately 60 percent of the Build Alternatives, which would allow for greater movement around and under the HSR system. Additionally, TCRR designed 52 percent of the Build Alternatives adjacent to existing infrastructure, which typically includes areas that have previously been disturbed by past development. This design approach would minimize impacts to more environmentally sensitive areas and potentially reduce the fragmentation of existing habitat.

TCRR also engaged in early coordination with the USACE and other stakeholders, including utility providers and the public, to collect feedback and coordinate on other planned projects. TCRR's coordination efforts with USACE focused on fee lands, streams, wetlands and flood plains. Through coordination with utility infrastructure owners TCRR identified expected approaches to maintenance and protection of utilities along the Build Alternatives. Through coordination with electrical supply and transmission providers, such as Oncor and CenterPoint, TCRR developed proposed modifications to electrical transmission infrastructure along the Build Alternatives and proposed connections with the existing power grid to serve the traction power demand of the Project. Early coordination with TxDOT and other agencies, utility suppliers, community groups, and private property owners allowed TCRR to design the Build Alternatives in coordination with other planned projects, such as CenterPoint's Brazos Valley Connection in Grimes, Waller, and Harris counties; the Dallas Floodway Extension, Trinity River Parkway, and the International Inland Port of Dallas projects in Dallas County; the Loop 9 project in Ellis and Dallas counties; and, the US 290 project in Harris County. Coordination with other municipalities, businesses and community groups along the Build Alternatives allowed TCRR to consider and coordinate the design with future corridor development plans. For example, TCRR designed the alignment and profile in Dallas County to accommodate the future long-term plans identified in the Lancaster Regional Airport Master Plan. TCRR also coordinated design development with various transportation providers within the corridor, such as Dallas Area Rapid Transit, Gulf Coast Commuter Rail District and the Metropolitan Transit Authority of Harris County (see **Appendix F, TCRR Conceptual Engineering Design Report**). These planned projects and others are discussed in more detail in **Chapter 4.0, Indirect and Cumulative Impacts**. Over the course of their work, TCRR refined the footprint of the Build Alternatives evaluated in this EIS by approximately 16 percent to minimize potential impacts.

2.6 Description of Alternatives

2.6.1 No Build Alternative

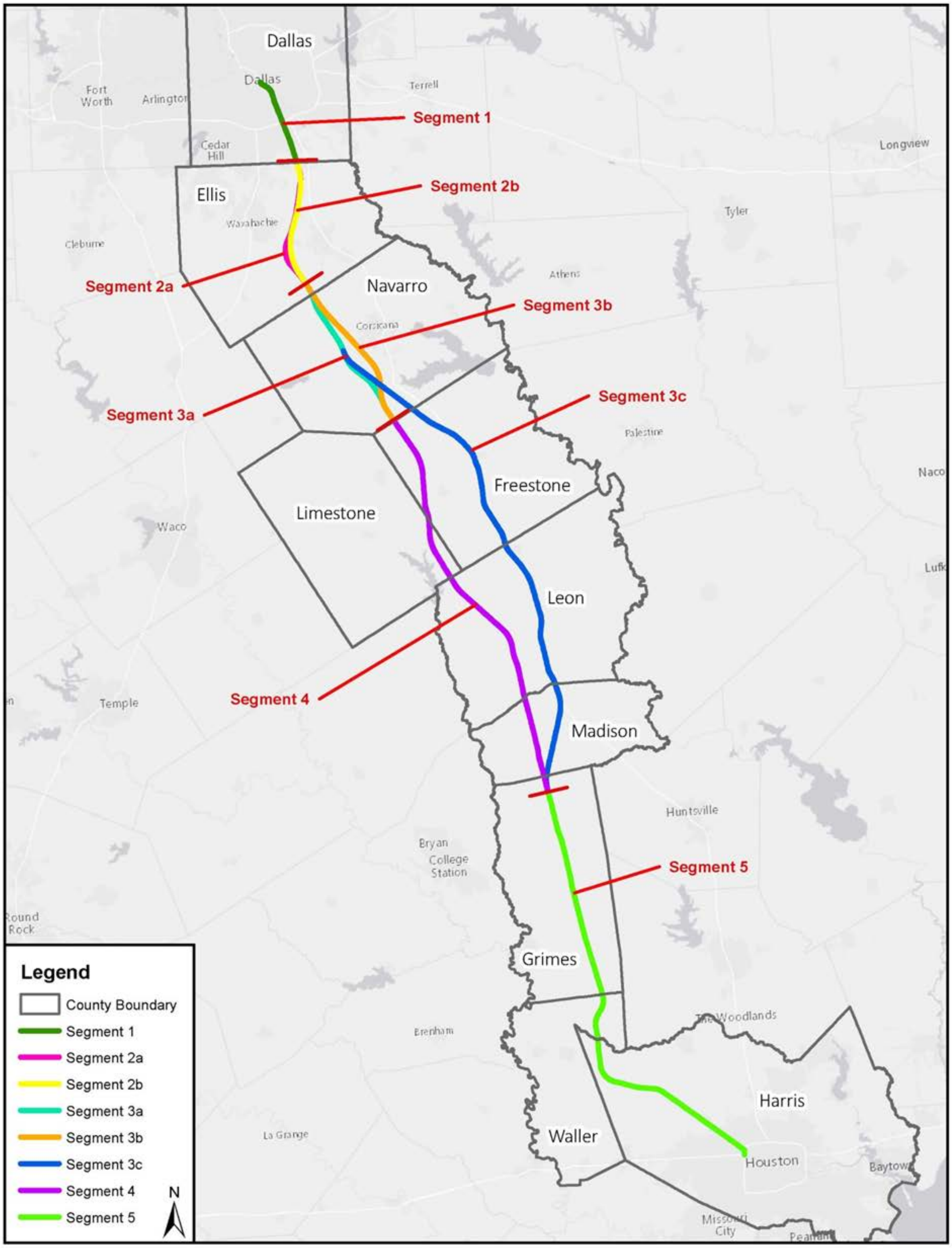
The No Build Alternative is included in this analysis as the baseline for comparison with the Build Alternatives A through F. This is also known as the alternative of no action as required by NEPA. Under the No Build Alternative, FRA would not issue a Rule of Particular Applicability or take other regulatory action necessary for the implementation of this technology within the U.S.; therefore, TCRR would not construct or be able to operate the HSR system and associated facilities. Travel between Dallas and Houston would continue via existing highway (IH-45) and airport (DFW, DAL, IAH and HOU) infrastructure. The No Build Alternative includes all planned and programmed transportation improvements, discussed in **Section 3.11, Transportation**.

The No Build Alternative would not meet the specified Purpose and Need for this Project, but is retained in the EIS as a basis for comparison. The No Build Alternative would not provide congestion relief, improve safety on IH-45, meet current and future transportation needs between Dallas and Houston and would not offer an alternative transportation mode that would connect to existing modes.

2.6.2 Build Alternatives

The Level II Screening process resulted in six end-to-end Build Alternatives (Alternatives A-F) considered in this EIS. For analytical purposes in this EIS, each alternative is divided into segments, as depicted in **Figure 2-26**. Segment descriptions are included to illustrate the differences between the Build Alternatives.

Figure 2-26: Alignment Alternatives Advanced to EIS, by Segment



Source: AECOM, 2016

2.6.2.1 Segment 1 (18.3 miles)

Segment 1 is located in Dallas County (**Appendix D, Project Footprint Mapbook, Sheets 1-23**). The alignment begins on the south side of downtown Dallas near IH-30 and Lamar Street and parallels the existing UPRR freight line towards IH-45. It parallels the west side of IH-45 as it crosses the Trinity River, running between the existing BNSF freight line and the highway as it crosses E. Illinois Avenue, Loop 12 and Simpson Stuart Road. South of Simpson Stuart Road, Segment 1 separates from IH-45 and generally follows the BNSF freight line, crossing IH-20, N. Lancaster/Hutchins Road, E. Pleasant Run Road and W. Beltline Road. South of West Beltline Road, Segment 1 extends west of Lancaster Airport before turning towards the southwest to enter Ellis County and cross Farm to Market (FM) road 664. Segment 1 terminates approximately 1.5 miles south of the Ellis County border.

Segment 1 includes the Dallas Terminal, Dallas TMF, MOW and two TPSSs. The locations of these facilities are outlined in **Table 2-5**.

Table 2-5: Facility Locations on Segment 1

Type of Facility	Proposed Location(s)
Dallas Terminal	IH-30 and Lamar Street
Dallas MOW	E. Illinois Avenue and IH-45
Dallas TMF	Near Lancaster/Hutchins Road and E Beltline Road
TPSS	IH-45 and W Palestine Street
TPSS	E Belt Line Road and N Sunrise Road

Source: TCRR, 2017

2.6.2.2 Segment 2A (23.3 miles)

Segment 2A is located in Ellis County (**Appendix D, Project Footprint Mapbook, Sheets 23-56**). Segment 2A begins approximately 1.5 miles south of the Ellis County line. Near the City of Palmer, Segment 2A parallels the west side of the utility easement and crosses West Jefferson Street, FM 879 and SH 287 and FM 34. It crosses FM 984 north of Rankin and is rejoined by Segment 2B 4 miles south of Bardwell (also 2 miles north of the Navarro County line).

Segment 2A includes one MOW and one TPSS. The locations of these facilities are outlined in **Table 2-6**.

Table 2-6: Facility Locations on Segment 2A

Type of Facility	Proposed Location(s)
MOW	SH 984 and Farmer Road
TPSS	Old Waxahachie Road and Boren Drive

Source: TCRR, 2017

2.6.2.3 Segment 2B (22.7 miles)

Segment 2B is located in Ellis County (**Appendix D, Project Footprint Mapbook, Sheets 57-90**). Segment 2B begins approximately 1.5 miles south of the Ellis County line. Near the City of Palmer, Segment 2B deviates to the east of the utility easement and crosses West Jefferson Street, FM 879, SH 287 and FM 34. It crosses FM 984 north of Rankin and rejoins Segment 2A 4 miles south of Bardwell.
Segment 2B includes one MOW and one TPSS. The locations of these facilities are outlined in **Table 2-7**.

Table 2-7: Facility Locations on Segment 2B	
Type of Facility	**Proposed Location(s)**
MOW	SH 984 and Farmer Road
TPSS	Old Waxahachie Road and Old Boyce Drive

Source: TCRR, 2017

2.6.2.4 Segment 3A (30.8 miles)

Segment 3A is located in Ellis and Navarro counties (**Appendix D, Project Footprint Mapbook, Sheets 90-127**). Segment 3A begins 2 miles north of the Navarro County line and continues south towards Barry, passes to the east of Barry and crosses FM 22. The alignment continues southeast, crossing FM 744 and SH 31 east of Corbet. Segment 3C diverts from Segment 3A at this point. As Segment 3A continues, it crosses Bonner Avenue and FM 1394 before Segment 3B rejoins it 3.5 miles northeast of Wortham.

Segment 3A includes one siding off track and two TPSSs. The locations of these facilities are outlined in **Table 2-8**.

Table 2-8: Facility Locations on Segment 3A	
Type of Facility	**Proposed Location(s)**
Siding Off Tracks	FM 1126 and SH 31
TPSS	SH 22 and NW CR 161
TPSS	SH 709 and FM 3194

Source: TCRR, 2017

2.6.2.5 Segment 3B (31.1 miles)

Segment 3B is located in Ellis and Navarro counties (**Appendix D, Project Footprint Mapbook, Sheets 128-167**). Two miles north of the Navarro County line, Segment 3B veers to the east of Barry and crosses FM 22 and 744. It crosses SH 31 near Oak Valley, east of FM 2452. After crossing Bonner Avenue, Segment 3B heads southwest towards Segment 3A, crossing Segment 3C. After crossing FM 1394, Segment 3B rejoins Segment 3A 3.5 miles northeast of Wortham.

Segment 3B includes one siding off track and one TPSS. The locations of these facilities are outlined in **Table 2-9**.

Table 2-9: Facility Locations on Segment 3B	
Type of Facility	**Proposed Location(s)**
Siding Off Tracks	SH 31 and SW CR 1000
TPSS	SH 709 and SW CR 0030

Source: TCRR, 2017

2.6.2.6 Segment 3C (113.3 miles)

Segment 3C is located in Navarro, Freestone, Leon, Madison and Grimes counties (**Appendix D, Project Footprint Mapbook, Sheets 168-317**). East of Corbet, after crossing SH 31, Segment 3C deviates to the east away from Segment 3A and crosses Bonner Avenue, Segment 3B and FM 1394 following the utility easement. It crosses FM 1051 and 1101 before reaching IH-45 just south of FM 833. It travels along the western side of the highway passing Fairfield as it travels through Freestone County. It enters Leon County and passes Buffalo, Centerville and Fort Boggy State Park. After crossing Waldrip Road, the alignment moves west crossing FM 978 and SH 190 near Cottonwood and rejoins Segment 3A in Grimes County north of FM 1696.

Segment 3C includes two MOW facilities, one siding off track and five TPSSs. The locations of these facilities are outlined in **Table 2-10**.

Table 2-10: Facility Locations on Segment 3C

Type of Facility	Proposed Location(s)
MOW	IH-45 and CR 610
MOW	IH-45 and CR 477
Siding Off Tracks	FM 1394 and SW CR 2120
TPSS	TX 27 and IH-45
TPSS	IH-45 and CR 660
TPSS	IH-45 and CR 314
TPSS	FM 978 and FM 2289
TPSS	TX 709 and FM 3194

Source: TCRR, 2017

2.6.2.7 Segment 4 (77.9 miles)

Segment 4 is located in Freestone, Limestone, Leon, Madison and Grimes counties (**Appendix D, Project Footprint Mapbook, Sheets 318-422**). Segment 4 begins at the Freestone County line and travels southeast crossing over FM roads 246, 27 and 1366. As it runs parallel to FM 80, it crosses FM 930 and SH 84. It travels through an oil and gas field and crosses FM 1365 west of Teague. It crosses into Limestone County just east of Browns Lake and travels south, tracking east of Personville and crossing East Yeagua Street and continues south, passing east of Lake Limestone. The alignment crosses into Leon County west of Lynn Creek and crosses FM 1512 and 1469 before crossing U.S. 79. It continues south crossing FM 391 as it travels towards Concord and crosses Hwy 7 and veers south to parallel the utility easement. It crosses into Madison County northeast of Normangee and continues south crossing FM 2289, 978 and 1452 before crossing SH 190 west of Cottonwood. The alignment crosses FM 1372 and crosses into Grimes County just north of FM 1696.

Segment 4 includes two MOW facilities, two siding off tracks and four TPSSs. The locations of these facilities are outlined in **Table 2-11**.

Table 2-11: Facility Locations on Segment 4	
Type of Facility	**Proposed Location(s)**
MOW	CR 995 and SH 27
MOW	US 79 and CR 348
Siding Off Tracks	SH 39 and SH 164
Siding Off Tracks	Dawkins Road and Matzier Lane
TPSS	US 84 and FM 2777
TPSS	FM 1512 and Little Flock Road
TPSS	SH 7 and SH 39
TPSS	FM 978 and Poteet Road

Source: TCRR, 2017

2.6.2.8 Segment 5 (84.2 miles)

Segment 5 is located in Grimes, Waller and Harris counties (**Appendix D, Project Footprint Mapbook, Sheets 422-541**). Segment 5 continues south along the utility easement, crossing FM roads 155 and 39, before crossing SH 30 just west of Roans Prairie. It crosses several additional FM roads before crossing SH 105 as it reaches Waller County. The alignment veers southwest away from the utility easement and crosses Joseph Road west of Kickapoo Road and then parallels Kickapoo Road as it continues south. It crosses SH 6 and US 290/Hempstead Road and then curves southeast skirting south of Hockley. It crosses Warren Ranch Road and travels east to cross Grand Parkway/SH 99. It joins Hempstead road near Cypress and parallels US 290/Hempstead Road into Houston. It continues along Hempstead Road to the Northwest Mall area just south of IH-610 and US 290 where the alignment terminates.

Segment 5 includes one TMF, two MOW facilities, one siding off track and six TPSSs. The locations of these facilities are outlined in **Table 2-12**.

Table 2-12: Facility Locations on Segment 5	
Type of Facility	**Proposed Location(s)**
MOW	TX 90 and CR 126
TPSS	TX 90 and SH 39/CR 155
Siding Off Tracks	FM 1774 and CR 215
TPSS	High Oaks Drive and CR 311
MOW	Joseph Road and Hegar Road
TPSS	Betka Road and Kickapoo Road
TMF	Katy Hockley Road and US 290
TPSS	Hempstead Hwy and SH 6
MOW	Near West Road and US 290

Source: TCRR, 2017

Table 2-13 illustrates which segments create each Build Alternative. Each of the Build Alternatives, A through F, would be designed for the proposed HSR infrastructure and operations outlined above in **Section 2.2** and are illustrated in **Figures 2-27** through **2-32**.

2.6.3 Summary of Build Alternatives

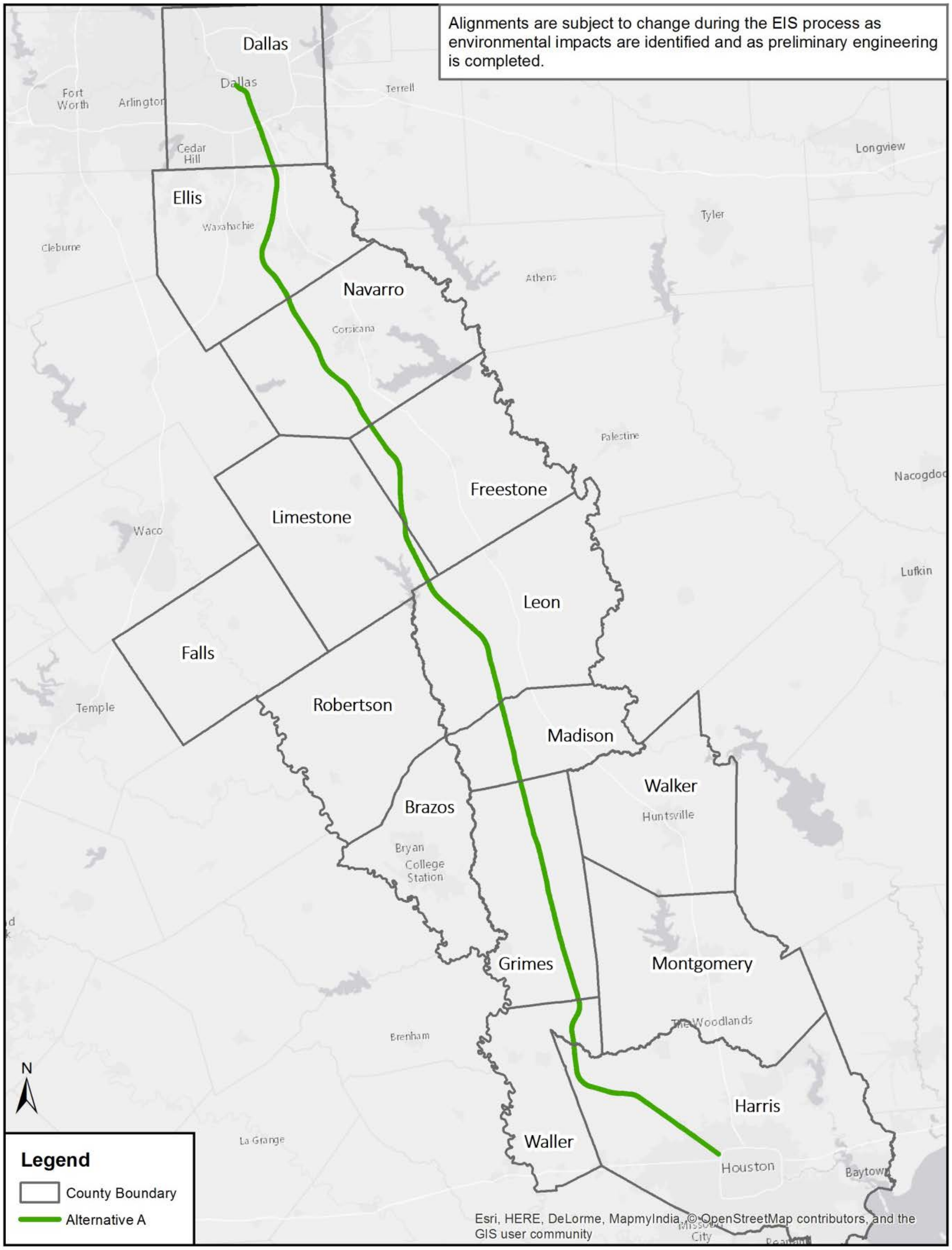
Table 2-13 identifies the segments that create each Build Alternative and **Figures 2-27 through 2-32** illustrate the six end-to-end Build Alternatives. Detailed maps can be found in **Appendix D, Project Footprint Mapbook.**

Table 2-13: Build Alternatives A-F

Alternative A	1, 2A, 3A, 4, 5
Alternative B	1, 2A, 3B, 4, 5
Alternative C	1, 2A, 3C, 5
Alternative D	1, 2B, 3A, 4, 5
Alternative E	1, 2B, 3B, 4, 5
Alternative F	1, 2B, 3C, 5

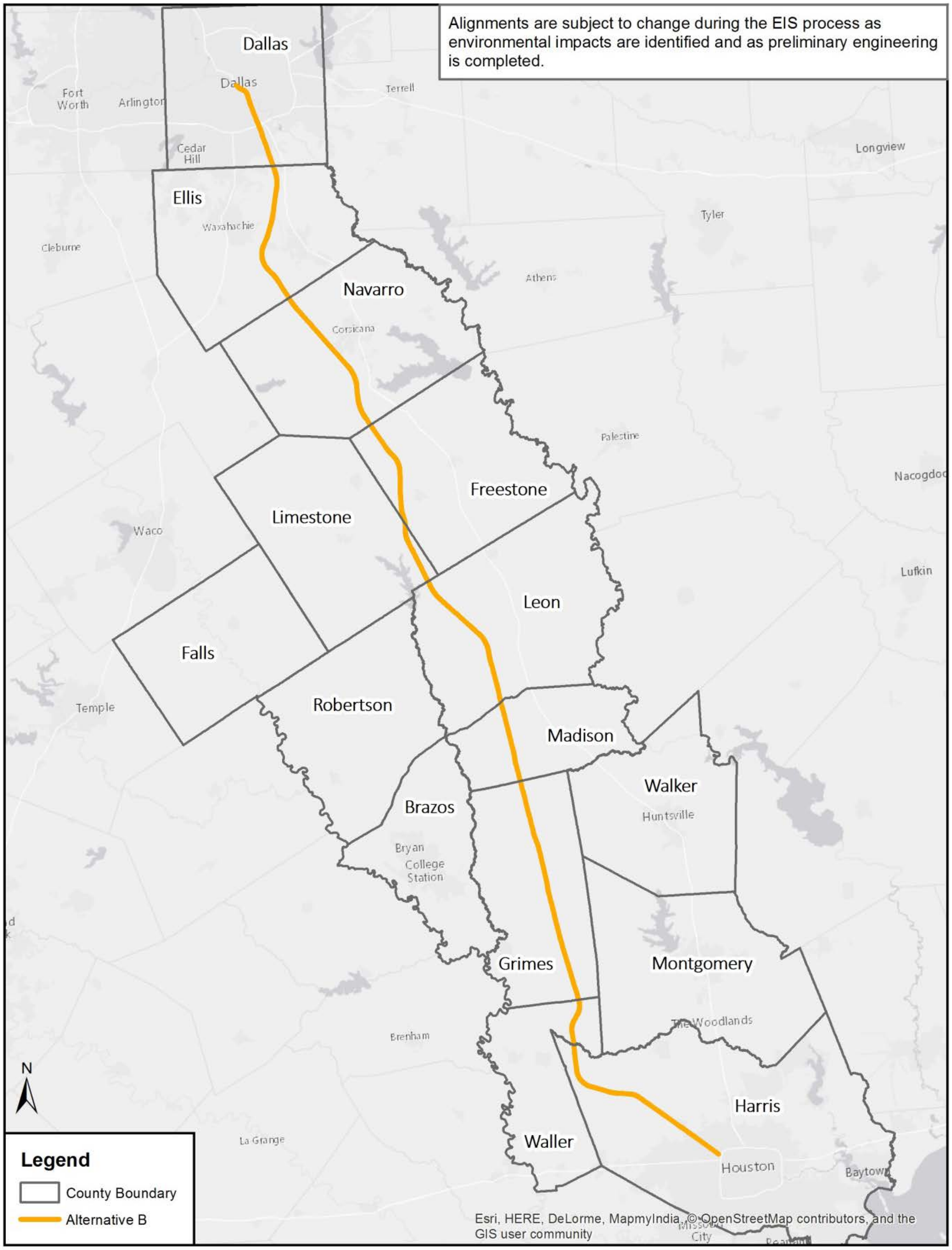
Source: AECOM, 2016

Figure 2-27: EIS End-to-End Alignment Alternative A



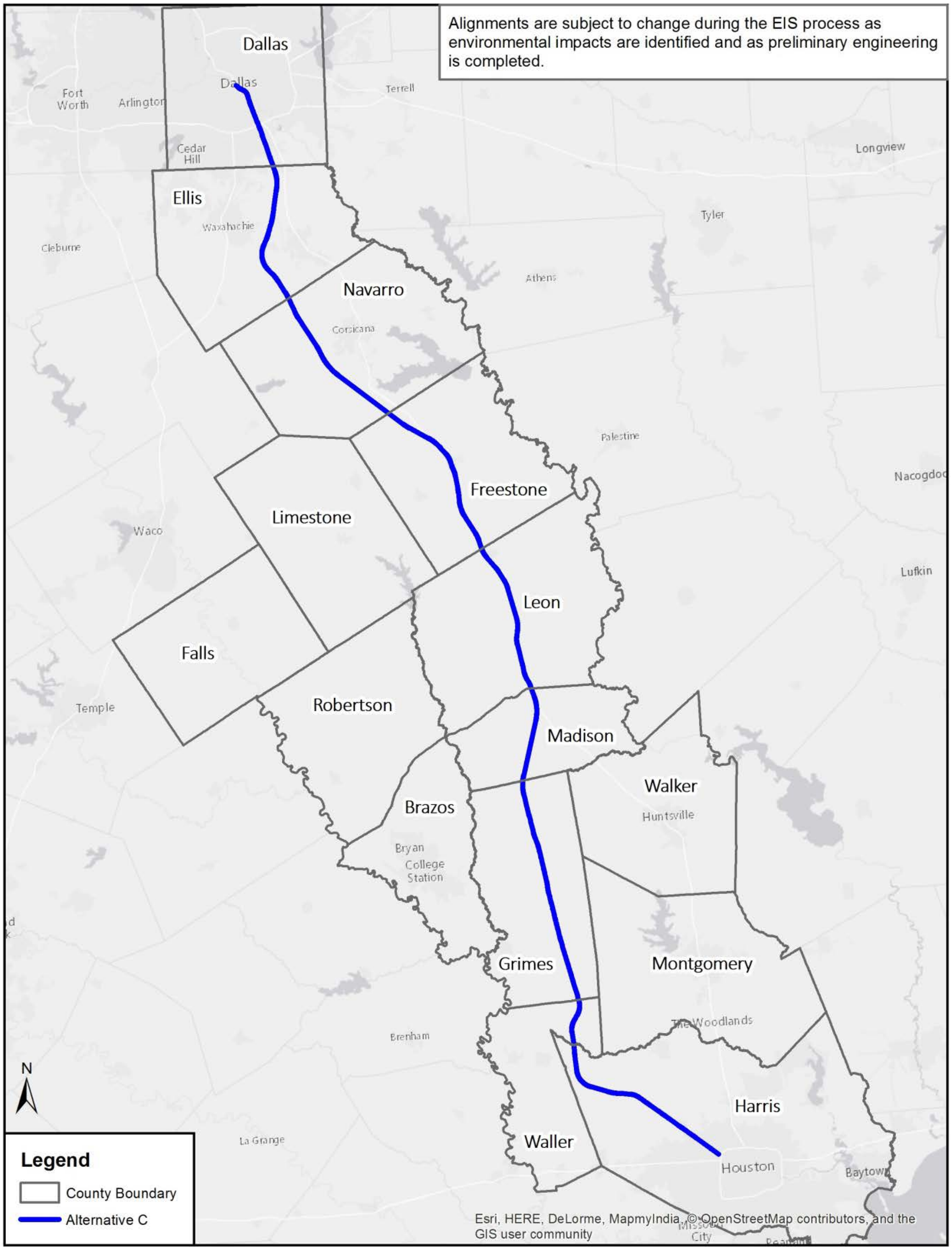
Source: AECOM, 2016

Figure 2-28: EIS End-to-End Alignment Alternative B



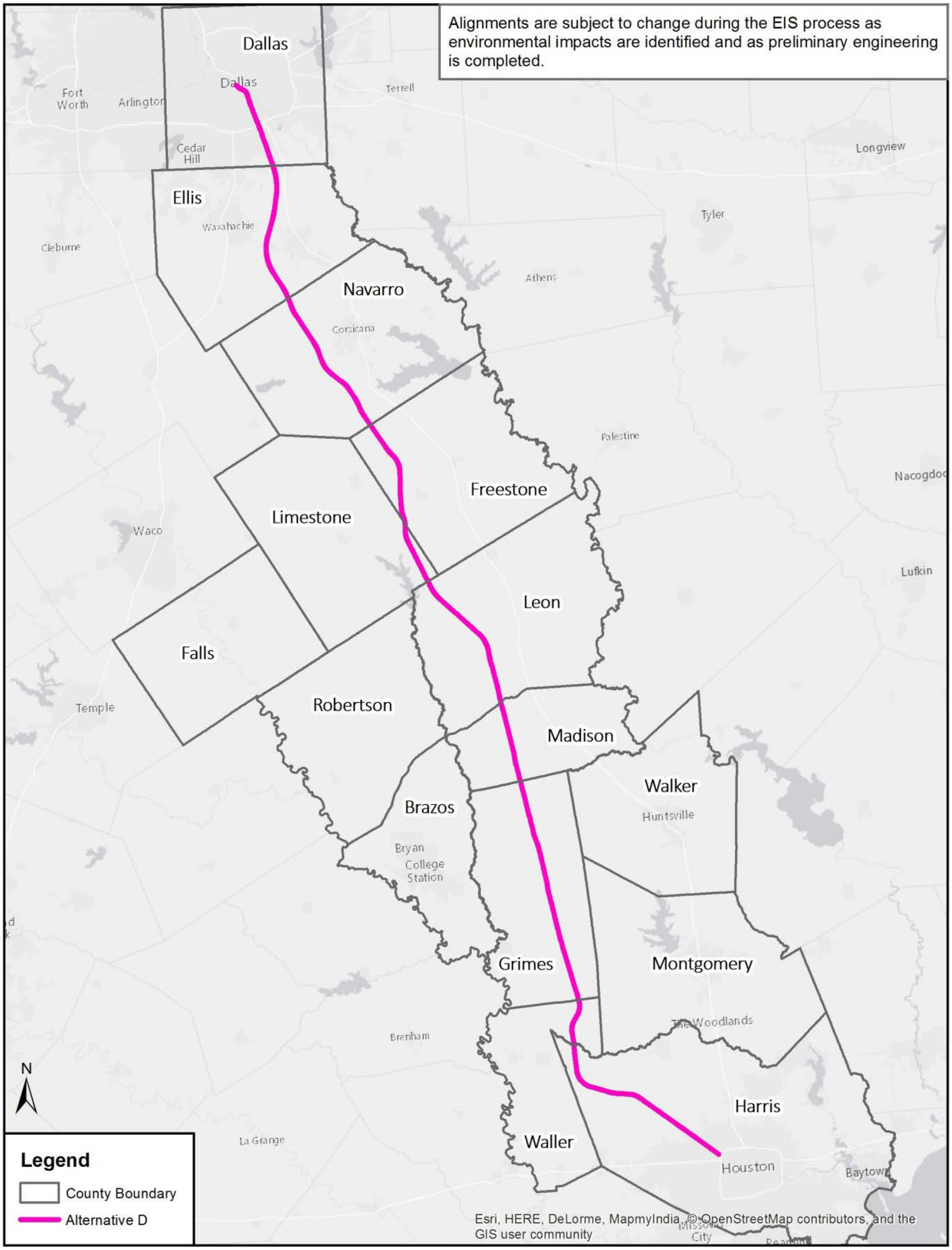
Source: AECOM, 2016

Figure 2-29: EIS End-to-End Alignment Alternative C



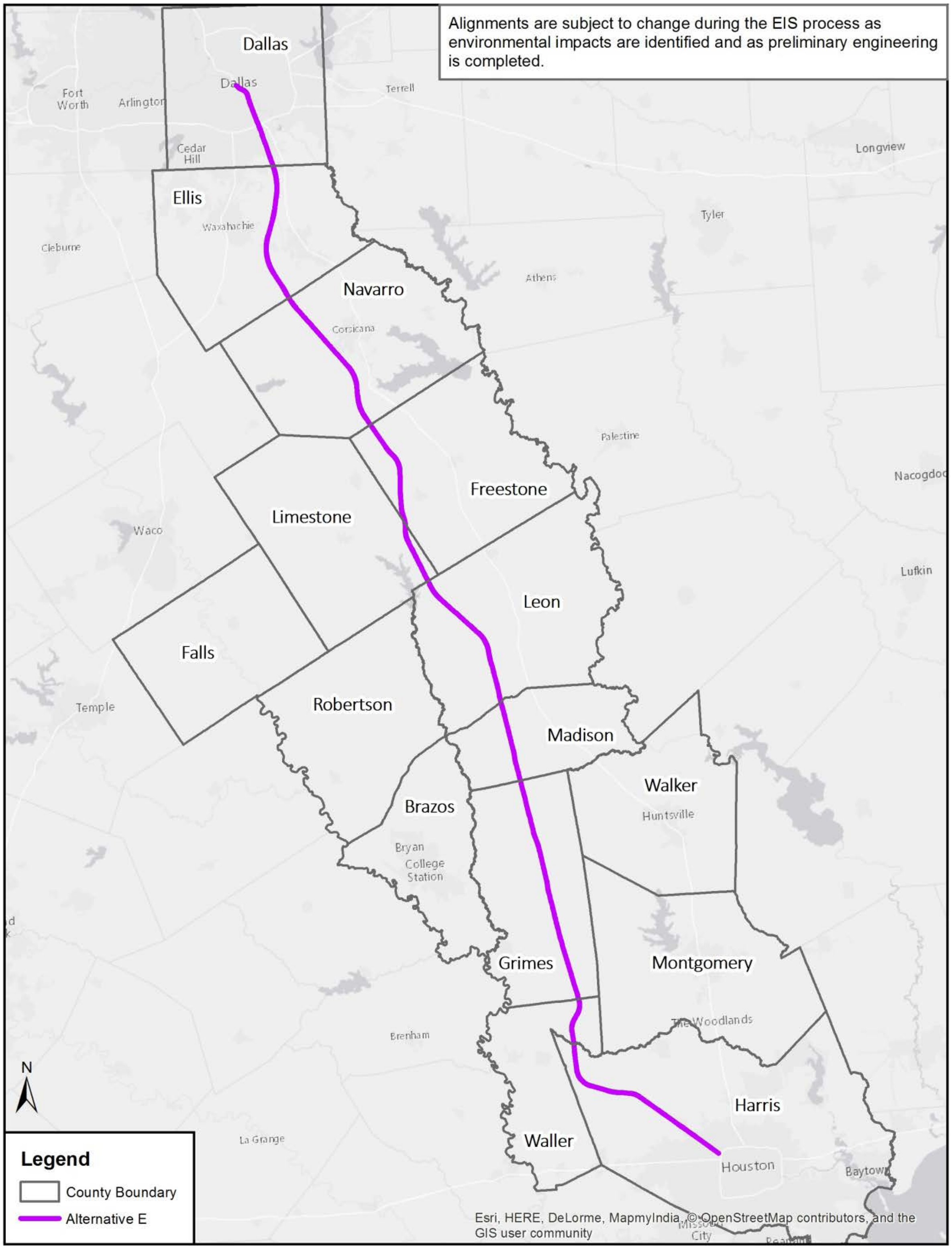
Source: AECOM, 2016

Figure 2-30: EIS End-to-End Alignment Alternative D



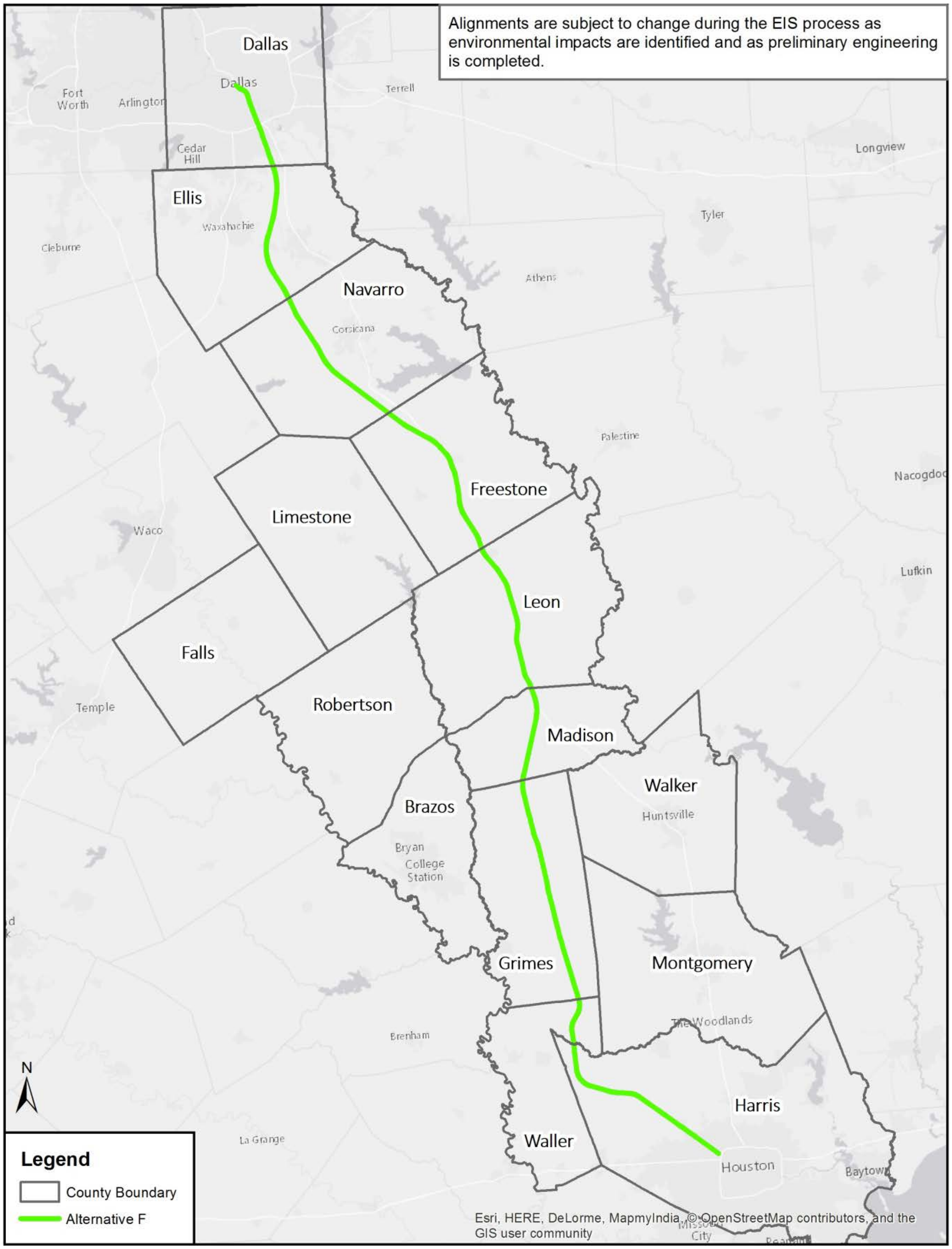
Source: AECOM, 2016

Figure 2-31: EIS End-to-End Alignment Alternative E



Source: AECOM, 2016

Figure 2-32: EIS End-to-End Alignment Alternative F



Source: AECOM, 2016

2.7 Preferred Alternative

FRA, as the lead federal agency, after considering the comparative analysis of the No Build Alternative and the Build Alternatives presented in this Draft EIS and the potential impacts of the Build Alternatives, identifies Build Alternative A as the preferred alternative. In identifying the preferred alternative, FRA has considered environmental, technical, and other factors, including the alternative that would best meet the cooperating agencies' defined plans, policies and regulations.

Build Alternative A (see **Figure 2-27**) is comprised of Segments 1, 2A, 3A, 4 and 5. It begins on the south side of downtown Dallas near IH-30 and Lamar Street at the Dallas Terminal station and parallels the existing UPRR freight line towards IH-45. It parallels the west side of IH-45 as it crosses the Trinity River, running between the existing BNSF freight line and the highway as it crosses E. Illinois Avenue (MOW facility), Loop 12 and Simpson Stuart Road. South of Simpson Stuart Road, the alignment separates from IH-45 and generally follows the BNSF freight line, crossing IH-20, N. Lancaster/Hutchins Road (TMF facility), E. Pleasant Run Road and W. Beltline Road. South of West Beltline Road, the alignment extends west of Lancaster Airport before turning towards the southwest to enter Ellis County and cross Farm to Market (FM) road 664. Near the City of Palmer, the alignment parallels the west side of the utility easement and crosses West Jefferson Street, FM 879 and SH 287 and FM 34. It crosses FM 984 (MOW facility) north of Rankin and continues south towards Barry, passes to the east of Barry and crosses FM 22. The alignment continues southeast, crossing FM 744 and SH 31 east of Corbet. As it continues, it crosses Bonner Avenue and FM 1394 as it enters Freestone County. The alignment travels southeast crossing over FM 246, 27 (MOW facility) and 1366. As it runs parallel to FM 80, it crosses FM 930 and SH 84. It travels through an oil and gas field and crosses FM 1365 west of Teague. It crosses into Limestone County just east of Browns Lake and travels south, tracking east of Personville and crossing East Yeagua Street and continues south, passing east of Lake Limestone. The alignment crosses into Leon County west of Lynn Creek and crosses FM 1512 and 1469 before crossing U.S. 79 (MOW facility). It continues south crossing FM 391 as it travels towards Concord and crosses Hwy 7 and veers south to parallel the utility easement. It crosses into Madison County northeast of Normangee and continues south crossing FM 2289, 978 and 1452 before crossing SH 190 west of Cottonwood. The alignment crosses FM 1372 and crosses into Grimes County just north of FM 1696. Build Alternatives A continues south along the utility easement, crossing FM 155 and 39, before crossing SH 30 just west of Roans Prairie (Brazos Valley Station). It crosses several additional FM roads before crossing SH 105 as it reaches Waller County. The alignment veers southwest away from the utility easement and crosses Joseph Road (MOW facility) west of Kickapoo Road and then parallels Kickapoo Road as it continues south. It crosses SH 6 and US 290/Hempstead Road and then curves southeast skirting south of Hockley. It crosses Warren Ranch Road and travels east to cross Grand Parkway. It joins Hempstead road near Cypress and parallels US 290/Hempstead Road into Houston. It continues along Hempstead Road to the Northwest Mall area just south of IH-610 and US 290 where the alignment terminates.

The preferred alignment does not contain a preferred station location in Harris County. There are three station options in Harris County – Houston Industrial Site, Houston Northwest Mall Site and the Houston Transit Center Site. All three of these station options are evaluated in this EIS.

While FRA is identifying a preferred alternative in this Draft EIS, FRA will continue to analyze all Build Alternatives and Houston station options through the Final EIS. Focused analysis on the preferred alternative and Houston station options will be completed in coordination with federal agencies to support permit applications, biological opinions and Section 106 consultation. The preferred alternative will be vetted during the public and agency review period of the Draft EIS. These comments will inform FRA's preparation of the Final EIS and its selection of a preferred alternative in the Record of Decision.

2.7.1 Statutory Considerations

Two important regulatory requirements that must be addressed in the selection of a preferred alternative are Section 404 of the Clean Water Act (33 USC 1344) (Section 404) and Section 14 of the Rivers and Harbors Act (33 USC 408) (Section 408). Under these requirements, the USACE, in consultation with EPA, is authorized to make permit decisions regarding the discharge of dredged or fill material into waters of the U.S. and alterations or modifications to existing USACE projects. All Build Alternatives would impact USACE-owned property and require Section 408 authorization from the USACE. Segment 1 would cross the Trinity River and the associated USACE levee system. Segment 2A would cross a Lake Bardwell flowage easement. Segment 2B would cross both the Lake Bardwell flowage easement and USACE-owned lands associated with Lake Bardwell, requiring a Section 408 authorization from the USACE.

Segment 1 is common to all Build Alternatives—proceeding south from the Dallas Terminal Station option all Build Alternatives must cross the Trinity River. Either Segment 2A or 2B, located in Ellis County, would be selected for all Build Alternatives. While both would cross the Lake Bardwell flowage easement, Segment 2B would cross fee land and would require Section 408 authorization. Further coordination with USACE determined that per the USACE National Non-Recreation Outgrant Policy, the segment proposed to cross fee land would be denied and not carried forward in the USACE evaluation criteria as there is a viable alternative not on federal property. This would result in the removal of Build Alternatives D, E and F, which include Segment 2B, from further consideration.

2.7.2 Comparison of Build Alternatives A, B and C

Chapter 3.0, Affected Environment and Environmental Consequences, describes the socioeconomic, natural, physical and cultural resources evaluation criteria used to compare all Build Alternatives. For most resource areas, there are no distinguishable differences among the Build Alternatives. For example, the difference in estimated emissions from both the construction and operation for each of the Build Alternatives would be negligible due to similar length and location. Likewise, the benefits of reduced emissions from automobiles would be the same across all Build Alternatives because ridership would not vary under each Build Alternative.

Environmental resources that have a negligible difference in the identification of a preferred alternative include:

- Air Quality
- Water Quality
- Hazardous Materials
- Utilities and Energy
- Aesthetic and Scenic Resources
- Elderly and Handicapped
- Electromagnetic Fields
- Public Safety and Security
- Recreational Facilities
- Environmental Justice
- Soils and Geology
- Greenhouse Gas Emissions and Climate Change

Environmental resources that differentiate Build Alternatives A, B, and C are presented in **Table 2-14**. These resources are not weighted, meaning that no one criterion is more meaningful than another.

Table 2-14: Comparison of Build Alternatives A, B and C

Evaluation Criteria	Measure	Alt A	Alt B	Alt C
Noise				
Severe Noise Impacts to Residences	Count	17	19	15
Natural Resources				
Protected Species Habitat - Temporary	Acres	341	341	337
Protected Species Habitat - Permanent	Acres	1,334	1,334	1,669
Waters of the U.S.				
Stream Crossings – Temporary	Feet	14,719	15,375	15,842
Stream Crossings – Permanent	Feet	48,710	51,909	46,110
Wetlands – Temporary	Acres	19.3	10.8	13.2
Wetlands – Permanent	Acres	102	104	106
Waterbodies – Temporary	Acres	7.4	7.3	6.7
Waterbodies – Permanent	Acres	38.0	34.3	26.6
Total Acres of Intersected Floodplain	Acres	653	612	648
Transportation				
Length added to Public Roads	Miles	18.0	20.0	47.9
Length removed from Public Roads	Miles	11.0	11.1	26.9
Land Use				
LU Conversion – Temporary	Acres	2,176.6	2,185.6	2,035.6
LU Conversion – Permanent	Acres	7,957.4	8,042.1	8,217.3
Special Status Farmland – Temporary	Acres	1,563.8	1,561.6	1,546.1
Special Status Farmland – Permanent	Acres	4,268.2	4,380.4	4,003.9
Special Status Farmland – Indirect	Acres	896.5	924.9	825.8
Displacement – Commercial	Count	49	49	68
Displacement – Residence	Count	283	293	272
Estimated Permanent Parcel Acquisitions	Count	1,970	2,025	1,982
Estimated Temporary Parcel Acquisitions	Count	191	200	169
Estimated Structure Acquisitions – Agriculture	Count	133	139	117
Estimated Structure Acquisitions – Commercial	Count	8	8	12
Estimated Structure Acquisitions – Community Facilities	Count	2	2	2
Estimated Structure Acquisitions – Cultural/Civic Resources	Count	1	1	0
Estimated Structure Acquisitions – Oil and Gas	Count	0	0	4
Estimated Structure Acquisitions – Residence	Count	65	69	56
Estimated Structure Acquisitions – Transportation and Utilities	Count	1	1	0
Cultural Resources				
Adverse Impacts to Historic Properties	Count	10	10	9

Source: AECOM, 2017

All three Build Alternatives would result in severe noise and vibration impacts to several residences. Alternative B would have the most severe noise impacts at 19.

All three Build Alternatives would have a temporary impact on approximately the same amount of protected species habitat. Build Alternative C has the potential to permanently impact 335 additional acres of protected species habitat compared to Build Alternatives A and B.

Determinations related to Waters of the U.S require USACE and EPA consideration. Temporary impacts to streams, wetlands and waterbodies would be comparable across Build Alternatives A, B and C. Permanent stream impacts under Build Alternative B would be approximately 3,200 feet greater compared to Build Alternative A and approximately 5,800 feet greater compared to Build Alternative C. Permanent impacts to wetlands across all three Build Alternative would range from 102-106 acres; Build Alternative A has the potential to permanently impact the fewest acres of wetlands. Permanent impacts to waterbodies would range from 26.6 acres to 38.0 acres; Build Alternative A has the potential to impact the most waterbodies. FRA has taken a conservative approach regarding jurisdictional determinations. The waterbodies data has not been revised to note USACE jurisdiction, which means that all waterbodies are assumed jurisdictional at this time. USACE site assessments are ongoing and the identification of non-jurisdictional features by the USACE will refine the evaluation of impacts to waterbodies during the Section 404 permitting process, potentially resulting in the identification of fewer impacts to waterbodies than those described in **Table 2-14**. Additionally, ongoing engineering design could further minimize these impacts by increasing the percent of track on viaduct or structure.

Build Alternatives A, B and C would impact 612 to 653 acres of floodplains. Build Alternative B intersects 27 acres less than Build Alternative C and 41 acres less than Build Alternative A.

Transportation impacts would be mitigated through reroutes and regrading roadways. Build Alternative C would result in the greatest length of roadways removed (26.9 miles), as well as miles added (47.9 miles). Build Alternative A would result in the least length of roadway removed (11 miles) and least length added (18 miles). Additionally, Build Alternative C would require the realignment of the frontage road along IH-45 for a length of approximately 45 miles. Throughout this length, the HSR system would operate between the frontage road and IH-45 main lanes, which would require some additional safety barriers to protect the vehicles and the system.

Build Alternative A has the potential to permanently convert 84.7 acres less of land use compared to Alternative B and 259.9 acres less compared to Build Alternative C. For special status farmland, Build Alternative C would impact 264.3 acres less than Build Alternative A and 304.5 acres less than Build Alternative B.

Build Alternatives A, B, and C would require the acquisition and/or displacement of several types of structures – homes, businesses, barns/sheds, community facilities, oil and gas facilities and cultural resources – in addition to parcels of property. Build Alternative A and B would result in fewer displacements of business compared to Build Alternative C, but would result in the displacement of several more homes. Build Alternative A would require the fewest number of land parcels, while Build Alternative B would require the most (55 more than Build Alternative A). Build Alternative A and B would require the acquisition of fewer commercial structures (34 less) and community facilities (3 less) compared to Build Alternative C. Build Alternative A would also result in the acquisition of fewer agricultural structures (barns/sheds) compared to Build Alternative B (34 more) and Build Alternative C

(50 more). Build Alternative C would result in the least number of homes acquired by the Project compared to Build Alternative A (29 more homes) and Build Alternative B (49 more homes).

Build Alternatives A and B would impact one additional cultural resource (Ten Mile Cemetery) in Madison County compared to Build Alternative C. This site will require additional surveys in consultation with THC. All other impacted cultural resources are common to Build Alternatives A, B and C.

Build Alternatives A, B and C would impact eight 4(f) resources along common segments in Dallas and Harris counties. Additionally, Build Alternative C would also impact Fort Boggy State Park. FRA's preliminary determination is that the use of Fort Boggy State Park will have a *de minimis* impact on the property. The evaluation of the Houston Industrial Site identified a use of a Section 4(f) protected resource, which is detailed in **Chapter 7.0, Section 4(f) and 6(f) Evaluation**, and would preclude the selection of this site as the Houston Northwest Mall and Houston Northwest Transit Center sites are feasible and prudent avoidance alternatives.

FRA's federal action related to the Project, the Rule of Particular Applicability, focuses on the evaluation of the safety of the system. The introduction of 45 miles of adjacent rail and highway frontage roads would require a safety barrier to prohibit vehicular drivers from impacting the track infrastructure. Due to this added safety component, FRA does not recommend Build Alternative C as the preferred alternative.

Build Alternatives A and B do not require the added safety barriers. When the environmental impacts of each Build Alternatives are compared, Build Alternative A would have fewer permanent impacts to the socioeconomic, natural, physical and cultural resources environment as noted in **Table 2-14** and described in the text above. Therefore, FRA identified Build Alternative A as the preferred alternative.

This page intentionally left blank.

3.0 AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

3.1 Introduction

Chapter 3.0 describes the existing human, social and natural environment analyzed for the No Build and Build Alternatives. These resources were evaluated and are documented in separate sections within this chapter. The order of the resources is as follows:

- 3.1 Introduction
- 3.2 Air Quality
- 3.3 Water Quality
- 3.4 Noise and Vibration
- 3.5 Hazardous Material and Solid Waste
- 3.6 Natural Ecological Systems and Protected Species
- 3.7 Wetlands and Waters of the U.S.
- 3.8 Floodplain Hazards and Floodplain Management
- 3.9 Utilities and Energy
- 3.10 Aesthetics and Scenic Resources
- 3.11 Transportation
- 3.12 Elderly and Handicapped
- 3.13 Land Use
- 3.14 Socioeconomics and Community Facilities
- 3.15 Electromagnetic Fields
- 3.16 Public Safety and Security
- 3.17 Recreational Facilities
- 3.18 Environmental Justice
- 3.29 Cultural Resources
- 3.20 Soils and Geology
- 3.21 Greenhouse Gas Emissions/Climate Change

Each section of Chapter 3.0 follows this organization:

- Introduction–describes the resource being analyzed and specific terminology and references related to the particular section of the EIS. If for any reason, the format of a resource section deviates from this outline, the change is noted and explained.
- Regulatory Context–outlines federal and state laws and regulations applicable to the Project.
- Methodology– defines the Study Area for the resource and describes the methodology and data sources used to analyze impacts.
- Affected Environment–describes the existing condition in the context of the study area for each Build Alternative. The study area varies depending on the resource being discussed. Generally, this discussion is organized by county, then segment, from north (Dallas County) to south (Harris County).
- Environmental Consequences–describes the direct and indirect impacts for each Build Alternative. It also explains short-term construction and long-term Project operation impacts that may result from the implementation of the Project. Generally, this discussion is also organized by county, then segment, from north (Dallas County) to south (Harris County).

- Avoidance, Minimization, and Mitigation–where impacts cannot be avoided or minimized through design, mitigation strategies that would deter adverse impacts are described. Additionally, any compliance measures required by local, state or federal regulation are described.

In conclusion, a matrix provides a comparison of the Build Alternatives, combining the findings from the resource areas studied. The following sections describe each resource that is analyzed in the EIS.

3.1.1 General Methodology

The Alignment Alternatives Analysis detailed in **Chapter 2.0, Alternatives Considered**, identified the No Build and six Build Alternatives. Chapter 3.0 details FRA's independent evaluation using data from readily available state and federal databases, fieldwork, modeling and detailed technical analyses. The six Build Alternatives are compared to the No Build Alternative.

To support these analyses, FRA incorporated Project assumptions to address the overall operations of the Project. As previously described in **Chapter 2.0, Alternatives Considered**, there are three operational scenarios considered by TCRR. The initial service level represents the initial or "opening day" scenario (two trains during peak hours and two trains during off-peak hours), the future service level (increases peak service by one train), and the peak service level represents the ultimate configuration of the Project in the 2040 horizon year (six trains during peak hours and four trains during off-peak). As part of the Project development process, the horizon year is used to forecast the impact of growth on the travel network and support the decision-making process.

TCRR's Final Draft Conceptual Engineering Report (see **Appendix F, TCRR Conceptual Engineering Design Report**) documents the key requirements, considerations, design criteria and approaches that form the basis of the Project Conceptual Design. This report is a companion document to TCRR's Final Draft Conceptual Engineering Design Documentation (see **Appendix G, TCRR Conceptual Engineering Plans and Details**), which define the physical limit of disturbance (LOD) and conceptual details for infrastructure configuration, systems and facilities for the Project construction and operation.

The LOD is comprised of the permanent construction and operation footprint of the six Build Alternatives and includes the rail infrastructure, access roads, drainage swales and ancillary facilities (e.g., stations, TMF and MOW facilities, TPSSs, maintenance roads and signal houses). For planning purposes, the proposed footprints for all stations, maintenance and ancillary facilities were estimated to the maximum size to ensure the system would not be capacity constrained under the ultimate buildout of the system. These areas comprise the proposed permanent HSR ROW.

The LOD also includes other Project-specific locations designated by TCRR that would be temporary or short-term in use and only required during the construction period of the Project (e.g., construction laydown areas, workspace areas and modifications to existing utility easements). It is anticipated that, in most cases, these areas would require temporary construction easements.

For evaluation purposes, this Draft EIS assesses the proposed LOD and, as necessary, a resource specific Study Area. The LOD includes both the permanent and temporary Project footprint, as described above. It should be noted that potential land acquisition and easements are subject to ROW negotiation with the property owner. Depending on these negotiations, TCRR may choose to acquire property beyond the Project footprint. These areas are unknown and not included in this analysis.

FRA anticipates that TCRR’s conceptual design, as presented in this Draft EIS, will continue to be refined based on the results of ongoing environmental and engineering surveys, stakeholder engagement, design development and the findings of the environmental analyses. Any changes to the conceptual design will be assessed by FRA in the Final EIS.

This page intentionally left blank.

3.2 Air Quality

3.2.1 Introduction

This section describes the air quality impacts of the alternatives through an analysis of emissions from various sources during the construction and operation of the Project. The purpose of this assessment is to identify potential air quality impacts for the Build Alternatives, as compared to the No Build Alternative, and identify any mitigation measures that would be implemented to reduce adverse impacts.

The following sections identify the current National Ambient Air Quality Standards (NAAQS), which include ozone (O_3), nitrogen oxide (NO_x) and sulfur dioxide (SO_2), and other regulatory requirements applicable to the Project, describe the methodology used to calculate pollutant emissions, provide a description of airborne pollutants of interest and their impact on health, provide a summary of existing regional and local air quality conditions, discuss regional attainment and transportation and general conformity requirements, reference the State Implementation Plan (SIP) and explains its relevance, quantify construction period and long-term operational pollutant emissions, discuss potential mobile source air toxics impacts, provide a general conformity analysis within applicable nonattainment areas, recommend mitigation measures, and provide a comparative analysis of potential air quality impacts amongst the Build Alternatives.

The Build Alternatives would be partially located within nonattainment areas for ozone and SO_2; therefore, a determination of applicability to demonstrate general conformity is necessary. The air quality impact analysis aggregates NO_x and volatile organic compounds (VOC) emissions (ozone precursor pollutants) that occur within the separate ozone nonattainment areas and SO_2 emissions within Freestone County. NO_x and VOC emissions are included from Dallas and Ellis counties in the Dallas-Fort Worth (DFW) ozone nonattainment area, and Waller and Harris counties in the Houston-Galveston-Brazoria (HGB) ozone nonattainment area, as explained in detail in **Section 3.2.3, Methodology**. The Build Alternatives do not pass through Montgomery County or any of the other HGB or DFW nonattainment area counties. SO_2 emissions are included from Freestone County in the Freestone and Anderson Counties nonattainment area (FRE). For this reason, the air quality analysis format differs from other resource sections that analyze impacts at the county level along the Build Alternatives. Instead, the air quality analysis analyzes impacts within the respective nonattainment counties as described above. The DFW and HGB nonattainment areas were designated based on the 2008 NAAQS for ozone. The NAAQS was revised in 2015, with nonattainment designations to occur on October 1, 2017. This is discussed in more detail under **Air Quality Trends and Monitoring** in **Section 3.2.4**.

3.2.2 Regulatory Context

Federal

The Clean Air Act of 1970 and Clean Air Act Amendments of 1990

The Clean Air Act of 1970 (as amended) establishes federal policy to protect and enhance the quality of the nation's air resources to protect human health and the environment.[1] The Clean Air Act requires that adequate steps be taken to control the release of air pollutants and prevent significant deterioration in air quality. The 1990 amendments to the Clean Air Act require federal agencies to determine the conformity of proposed actions with respect to SIPs for attainment of air quality goals.

Regulations implementing the Clean Air Act established primary and secondary NAAQS as a basis for assessing air quality. Primary standards set limits to protect public health, including the health of children, the elderly and asthmatics. Secondary standards set limits to protect public welfare, which includes damages to animals, crops, vegetation and buildings. The EPA regulates air quality in accordance with the primary and secondary NAAQS. The NAAQS currently regulate six criteria pollutants under the primary standards. These are carbon monoxide (CO), nitrogen dioxide (NO_2), O_3, lead (Pb), particulate matter (PM) and SO_2. PM standards are further defined into a standard for PM_{10}, regulating particulate matter smaller than 10 microns in diameter and $PM_{2.5}$ regulating particulate matter smaller than 2.5 microns in diameter. Of these pollutants, vehicular sources contribute significantly to emissions of CO and PM, along with NO_x, hydrocarbons, air toxics, and carbon dioxide (CO_2).

The State of Texas has adopted the federal NAAQS.[2] Therefore, the state standards are the same as the federal NAAQS. The Clean Air Act requires that all states attain compliance by adhering to the NAAQS, as demonstrated by the comparison of measured pollutant concentrations with the NAAQS. The NAAQS represent the maximum levels of background pollution considered acceptable with an adequate margin of safety to protect public health and welfare. These pollutants are typically quantified in units of milligrams per cubic meter (mg/m^3), parts per million (ppm), parts per billion (ppb) or micrograms per cubic meter ($\mu g/m^3$). **Table 3.2-1** shows the NAAQS for the six criteria pollutants.[3]

[1] Clean Air Act, 42 U.S.C. §7401 et seq. (1970).
[2] Texas Administrative Code [TAC], Title 30, Part 1, Chapter 101, Subchapter A, Rule §101.21.
[3] National Ambient Air Quality Standards Table: https://www.epa.gov/criteria-air-pollutants/naaqs-table (accessed May 8, 2016).

Table 3.2-1: National Ambient Air Quality Standards for Criteria Pollutants			
Pollutant	Primary Standards	Averaging Times[1]	Secondary Standards
CO	9 ppm (10 mg/m^3)	8-hour[2]	None
	35 ppm (40 mg/m^3)	1-hour[2]	None
Pb	0.15 µg/m^3	Rolling 3-Month Average	Same as Primary
NO_2	100 ppb (0.100 ppm)	1-hour[3]	None
	53 ppb (0.053 ppm)	Annual (Arithmetic Mean)	Same as Primary
PM_{10}	150 µg/m^3	24-hour[4]	Same as Primary
$PM_{2.5}$	12 µg/m^3	Annual[5]	15 µg/m^3
	35 µg/m^3	24-hour[3]	Same as Primary
O_3	0.070 ppm (2015 std)	8-hour[6]	Same as Primary
	0.075 ppm (2008 std)	8-hour[6]	Same as Primary
SO_2	75 ppb (0.075 ppm)	1-hour[7]	None
	None	3-hour[2]	0.5 ppm (1300 µg/m^3)

Source: EPA National Ambient Air Quality Standards Table, 2016
Notes: [1] – The time period for which compliance with the standard is measured.
[2] – Not to exceed more than once a year.
[3] – 98th percentile, averaged over three years.
[4] – Not to be exceeded more than once per year on average over three years.
[5] – Annual mean, averaged over three years.
[6] – To attain this standard, the three-year average of the fourth-highest daily maximum 8-hour average ozone concentrations measured at each monitor within an area over each year must not exceed 0.070 ppm (2015 standard) or 0.075 ppm (2008 standard).
[7] – 99th percentile of 1-hour daily maximum concentrations, averaged over three years.

Ground-level ozone is created by chemical reactions between NO_x and VOCs in the presence of sunlight.[4] Ground-level ozone is a harmful pollutant that can contribute to a variety of health problems including asthma. Areas of the country where pollutant levels persistently exceed the NAAQS are designated as nonattainment areas. In Texas, the Texas Commission on Environmental Quality (TCEQ) is tasked with how best to achieve air quality compliance and with developing a SIP for achieving health-based air quality standards. Once a nonattainment area meets the standards in the Clean Air Act, the area will be designated as a maintenance area with a plan developed to keep the former nonattainment area in compliance with the NAAQS.

The Clean Air Act has two major sets of rules regarding assurance that federal actions will conform to states' SIPs and not hamper their ability to achieve attainment of the NAAQS: Transportation Conformity and General Conformity. Transportation Conformity requires that federal funding and approval are only given to highway and transit projects that conform to air quality goals established by a state's SIP. The Transportation Conformity regulations in 40 CFR 93(A) specify that Transportation Conformity applies to projects that are part of transportation plans, or transportation improvement plans developed by MPO or state departments of transportation, or involving the approval, funding or implementation of FHWA/FTA projects. The Project is not an FHWA or FTA project; therefore, currently Transportation Conformity does not apply. However, planning and engineering for high speed rail between Dallas and Fort Worth is currently a project in the North Central Texas Council of Governments' (NCTCOG) transportation improvement program. If the Project becomes a listed project of either the NCTCOG (the Dallas-area MPO) or the Houston-Galveston Area Council [HGAC] (the Houston-area MPO), then Transportation Conformity would apply. The General Conformity regulations apply to all other federal actions. Therefore, under the General Conformity regulations in 40 CFR 93(B), FRA must make a determination that a federal action conforms to the State SIP pertaining to the Project.

[4] Ozone: The Facts. January 8, 2016. https://www.tceq.texas.gov/airquality/monops/ozonefacts.html (accessed January 25, 2016).

In addition to the NAAQS, the EPA regulates mobile source air toxics(s). MSATs are compounds, such as benzene and other hydrocarbons, emitted from highway vehicles and non-road mobile source engines (e.g., heavy construction equipment, trains or ships) that are known or suspected to cause cancer and other serious health and environmental effects. The Clean Air Act identified 188 air toxics labeled hazardous air pollutants, of which the EPA identified a group of 21 MSATs and further identified a subset of nine priority MSATs. These are acrolein, benzene, 1, 3-butadiene, acetaldehyde, ethylbenzene, diesel particulate matter plus diesel exhaust organic gases (diesel PM), formaldehyde, naphthalene and polycyclic organic matter. No federal ambient standards currently exist for MSATs.[5]

3.2.3 Methodology

The No Build Alternative does not include construction of the Project, while the Build Alternatives include construction of the Project. Operational emissions for the No Build Alternative and Build Alternatives were estimated using the same methods described in **Section 3.2.3.2** to calculate the difference in emissions from future passenger vehicle miles traveled (VMT) that would have occurred in the absence of HSR use and the emissions from power consumption required for HSR system operation. The No-Build emissions are the net change between vehicle emissions that are not avoided due to train travel minus the train power consumption emissions that are not produced since the Project is not built. In this case, the change is a net increase (except for SO_2) as discussed in **Section 3.2.5.1** and is the same magnitude, but opposite in sign, as the Build Alternative emissions. The Build Alternative emissions are the net change in emissions between the emissions due to train power consumption required minus the vehicle emissions that are avoided due to train travel. In this case, the change is a net decrease (except for SO_2) as discussed in **Section 3.2.5.2.4.**

To estimate air quality impacts of the Build Alternatives, quantitative estimates were made of emissions from construction and operational sources for the Build Alternatives using standard modeling platforms, emissions data and spreadsheet calculations. The following subsections summarize the methods and procedures used to calculate emissions to estimate impacts for determining environmental consequences and applicability of general conformity from the construction and operation of the Build Alternatives.

The air quality Study Area includes the counties of Dallas, Ellis, Navarro, Freestone, Limestone, Leon, Madison, Grimes, Waller and Harris. The DFW and HGB ozone nonattainment areas are located at the terminating ends of the Study Area with primarily rural areas located between.

3.2.3.1 Construction Emissions Methodology

Construction emissions were estimated using emissions factors, load factors, transient adjustment factors and other necessary inputs primarily using the NONROAD08 model. The construction emissions estimate was conducted using Project features (e.g., track, bridges and station construction) and quantities developed by the engineering analysis to define the construction equipment and usage necessary to implement the Build Alternatives. Construction emissions were estimated for Alternative C as a proxy for all Build Alternatives because this alternative is comprised of the longest track distance;

[5] Federal Highways Administration, *Updated Interim Guidance on Mobile Source Air Toxic Analysis in NEPA Documents. October 2016*. http://www.fhwa.dot.gov/environment/air_quality/air_toxics/policy_and_guidance/msat (accessed September 27, 2017).

therefore, it would have the greatest construction emissions and provide the most conservative estimate of the Build Alternatives.

3.2.3.1.1 Schedule

The construction schedule used to determine construction phase emissions was provided by TCRR. The equipment and workforce schedules were then used with either NONROAD08 or MOVES2014a emission factors to calculate construction period emissions, as discussed in **Sections 3.2.3.1.3** and **3.2.3.1.4**, respectively.

For the purposes of this analysis, Project mobilization was assumed to occur from January 2018 to March 2018. Regional building demolition and land grubbing for the embankment, elevated (viaduct), and retained-fill segments was anticipated to begin in March 2018 and conclude in December 2019. The major construction activities were anticipated to occur between 2018 and 2021, with construction of the TMFs, MOWs and stations completed during 2020 and 2021. Project demobilization would occur from September 2021 to December 2021. The years shown can be considered representative years for the purpose of the construction emissions analysis. Calculated construction emissions would be valid over any four-year construction timeframe.

3.2.3.1.2 Construction Activities

Construction period emissions within the DFW and HGB ozone nonattainment areas and SO_2 nonattainment area were quantitatively estimated for the following major construction activities associated with the Build Alternatives:

- Mobilization: would occur at 47 staging areas or precast yards throughout the Study Area
- Site preparation, including demolition, land clearing and grubbing
- Earthwork
- Hauling emissions, including truck and rail
- Track laying: elevated or viaduct, embankment and retained fill
- Elevated (bridge) structures
- Substations
- TMFs, including building and track construction
- MOW facilities
- Stations
- Roadway and railway crossings
- Staging areas and rail connections
- Demobilization

The regional emissions from these activities would account for the majority of the emissions that would be generated by the construction of the Build Alternatives. The estimated construction emissions from these activities were then used to estimate the regional air quality impacts within the DFW and HGB ozone nonattainment areas and SO_2 nonattainment area that would occur during the construction period.

3.2.3.1.3 Non-Road Equipment Construction Emissions

In general, mobile source emissions can be divided into on-road (e.g., cars, trucks and motorcycles) and non-road emission categories. The non-road emissions result from the use of fuel in a diverse collection of vehicles and equipment, including the following categories:

- Recreational vehicles, such as all-terrain vehicles
- Agricultural equipment, such as tractors
- Construction equipment, such as graders and back hoes
- Industrial equipment, such as fork lifts and sweepers
- Locomotive equipment, such as train engines
- Aircraft, such as jets and prop airplanes

For the Build Alternatives, two categories of non-road equipment were used: construction equipment and diesel locomotives.

NO_x, VOC, SO_2 and Green House Gas (GHG) emissions from regional building demolition and construction of the embankment, elevated (viaduct), and retained-fill rail segments, TPSSs, industrial buildings at the TMFs, MOWs and stations, including parking garages and platform facilities, were calculated using emission factors from the NONROAD2008 emissions model (see also **Section 3.21, Greenhouse Gas Emissions and Climate Change**). The NONROAD model provides the latest emission factors for construction off-road equipment. The use of emission rates from the NONROAD model accounts for new exhaust emission standards and reflects the recommendation of EPA to capture the latest off-road construction assumptions.

The NONROAD model estimates emissions for each specific type of non-road equipment by multiplying the following input data estimates:

- Equipment population for base year distributed by age, power, fuel type and application
- Average load factor expressed as average fraction of available power
- Available power in horsepower
- Activity in hours of use per year
- Emission factor (in g/hp-hr) with deterioration and/or new standards

In order to use the NONROAD model to estimate emissions for the Build Alternatives, a spreadsheet was developed for each major construction activity that listed the equipment population (by power category) and the activity factor (in hours per year) for each equipment type/power category. Equipment types, power category and utilization hour estimates for each piece of equipment were obtained from the construction quantities and equipment estimates developed by TCRR for the Build Alternatives. NONROAD default load factors (the ratio of average equipment horsepower utilized to maximum equipment horsepower) and useful life parameters were used to estimate emissions.
Non-road emissions were quantified for the construction of the track (including demolition and road crossings), stations, TMFs and MOWs. Emissions were determined using Tier 3 emissions standards consistent with the specific equipment construction standard classification code. For track construction, total emissions within the DFW and HGB ozone nonattainment areas and SO_2 nonattainment area were obtained by multiplying the total construction emissions by the fraction of the Build Alternatives occurring within each nonattainment area. The analysis assumes that the non-road track construction equipment (mobile, portable and stationary fuel-burning equipment) would be spread out evenly along

the Build Alternatives and that all equipment would be used based on a 58-hour work week over a 48-month construction period.

Station construction emissions were determined assuming one terminal station located at each end of the Build Alternatives, a TMF located at each end of the Build Alternatives, and one MOW facility each located in Dallas, Ellis, Waller and Harris counties. All stations and the TMF and MOW facilities would be constructed in 2020 and 2021. The Brazos Valley Station would be located within an attainment area for all NAAQS pollutants and is not required to be included in the general conformity air quality analysis.

3.2.3.1.4 <u>On-Road Vehicle and Material Hauling Emissions</u>

In addition to the non-road construction equipment, on-road vehicles would be used during all aspects of the construction and would result in emissions of NO_X, VOCs, SO_2 and GHGs. Calculation of emissions from these vehicles during the construction phase were quantified using VMT estimates for on-road vehicles and MOVES2014a emission factors for each nonattainment area county. The on-road vehicles that would be used for the Build Alternatives include passenger trucks, light commercial trucks and single-unit short-haul and long-haul diesel trucks.

Emissions from the exhaust of trucks that would be used to haul material (including concrete slabs) to the construction site or that would otherwise be used on the construction site were calculated using light-duty and heavy-duty truck emission factors from MOVES2014a model output and anticipated travel distances of trucks operating within the DFW and HGB ozone nonattainment areas and SO_2 nonattainment area. The analysis assumed that 50 percent of the sand, gravel and cement used for concrete would be transported to the railroad connection precast yards by truck, with the remaining quantities transported by rail as described in **Section 3.2.3.1.5**. The analysis also assumed that all construction materials, including ballast and sub-ballast materials, concrete, concrete rail ties, rail and steel would be transported by diesel truck from the Dallas, Ellis County, and Houston railroad connection precast yards to the construction site. Excavation and fill material would be transported by heavy trucks along the Build Alternatives. Finally, the analysis assumed that the number of trucks expected to be used during construction would be spread out evenly along the alignment and during the construction period.

For truck emissions, NO_x and VOC emission factors were based on available DFW and HGB fleet age distribution data composed of the last 30 model years 1987-2040. Separate emission factors were generated for each construction period truck vehicle category estimated to be used. Light-duty and heavy-duty vehicle emission factors were derived for the DFW and HGB nonattainment area counties. A composite SO_2 emission factor was developed for Freestone County based on TxDOT emission rate lookup tables for the area using a rural restricted roadway category and average truck speed of 40 mph. Annual emissions were calculated using year 2017 emission factors. Year 2017 would be the first year that on-road construction vehicles could potentially be used for mobilization, and emission factors for that year would be the most conservative within the construction schedule because future emissions would be expected to decrease each year as vehicle technologies improve. **Table 3.2-2** provides the emission factors used in the analysis. The specific equipment, utilization hours, total mileage and emissions calculations are shown in **Appendix E, Air Quality Technical Memorandum.**

Table 3.2-2: On-Road Construction Period Vehicle Emissions Factors

	NO_x Emission Factor (g/mi)		VOC Emission Factor (g/mi)		CO_2e Emission Factor (g/mi)		SO_2 Emission Factor (g/mi)
2017 DFW[a] Emission Factors							
Truck Category	Dallas Co.	Ellis Co.	Dallas Co.	Ellis Co.	Dallas Co.	Ellis Co.	--
Passenger Truck	0.646	0.664	0.343	0.364	618	617	--
Light Commercial Truck	0.793	0.811	0.377	0.398	625	625	--
Single Unit Short-Haul Truck	2.883	2.886	0.501	0.508	1,504	1,504	--
Single Unit Long-Haul Truck	3.225	3.225	0.424	0.426	1,447	1,447	--
2017 HGB[b] Emission Factors							
Truck Category	Harris Co.	Waller Co.	Harris Co.	Waller Co.	Harris Co.	Waller Co.	--
Passenger Truck	0.517	0.823	0.274	0.422	605	611	--
Light Commercial Truck	0.651	0.946	0.306	0.448	613	618	--
Single Unit Short-Haul Truck	2.669	2.671	0.467	0.467	1,488	1,486	--
Single Unit Long-Haul Truck	3.166	3.168	0.424	0.424	1,432	1,430	--
2017 Freestone Co. Composite SO_2 Emission Factor							
	--	--	--	--	--	--	Freestone Co.
All Vehicles	--	--	--	--	--	--	0.0034

Source: AECOM, 2016
Notes:
[a] The applicable DFW nonattainment area counties are Dallas and Ellis counties.
[b] The applicable HGB nonattainment area counties are Harris and Waller counties.

Truck hauling emissions were calculated using a standard truck capacity of 20 cubic yards or 30 tons per truck, and by multiplying the emission factor by the anticipated distance traveled and the amount of material hauled per trip for each hauling method. Emissions from the remaining on-road construction vehicles consisting of light duty commercial trucks, fuel and water trucks and passenger vehicles including worker vehicles were determined by multiplying the vehicle class emission factor by the anticipated distance traveled.

3.2.3.1.5 Freight Rail Material Hauling Emissions

In an effort to minimize on-road vehicle emissions and construction period traffic impacts, TCRR is proposing to transport sub-ballast, ballast, rail, and structural steel used for the construction of the Build Alternatives using freight rail. A majority of the aggregates used for ballast, sub-ballast and aggregates for concrete would come from quarries from within Texas. These aggregates would be transported to construction sites using existing railroad infrastructure as much as possible. It was assumed that one-half of the sand, gravel and cement used for concrete would be transported to the construction site by rail, with the remaining quantities transported by truck as described in **Section 3.2.3.1.4**. Rail, reinforcement steel and structural steel would also be transported to the site via rail.

Diesel locomotives are subject to air quality regulations under 40 CFR 92 and 94. These rules include standards for emissions of PM, NO_x, hydrocarbons and CO from diesel locomotives. The standards rely on engine-based technologies to reduce emissions. In March 2008, the EPA adopted more stringent standards to reduce diesel locomotive emissions. The new rule tightened emissions standards for existing locomotives, set near-term engine performance standards for newly built locomotives (known as Tier 3 standards), and set long-term standards, referred to as Tier 4 standards, for newly built locomotives that reflect the application of high-efficiency, after-treatment technology.[6] Engine manufacturers will produce new diesel engines with advanced emission-control technologies similar to those already expected for other transportation sources. The EPA estimates 90 percent PM reductions and 80 percent NO_x reductions from Tier 4 engines meeting these standards, compared to engines meeting the current Tier 2 standards.[7] According to TCRR engineers, the emissions analysis assumes that existing diesel locomotive engine technology would continue to be used for the HSR project. Therefore, for this analysis, it was assumed that diesel locomotives used for material hauling would continue to comply with the current Tier 2 emission standards.

Total NO_x and VOC emissions within the DFW and HGB nonattainment areas were determined using Tier 2 emissions factors applicable for line-haul diesel locomotives, as well as EPA conversion factors. Total annual material quantities were determined and allocated to each rail connection precast and storage yard with one rail connection yard proposed for Dallas, Ellis and Harris counties within the nonattainment areas. Rail distances to the rail connection precast and storage yards within the respective nonattainment areas were then determined. No freight rail transportation activity would occur within the Freestone County SO_2 nonattainment area. Detailed input data and locomotive emissions calculations are provided in **Appendix E, Air Quality Technical Memorandum**.

3.2.3.2 Operational Emissions Methodology

Operational emissions of the Build Alternatives would occur from power plants supplying electricity to operate the HSR system ("train operation emissions"), which would represent an increase in emissions, and from reduction in vehicle travel ("vehicle emissions reduction") due to use of the HSR system, which would represent a decrease in emissions. It should be noted that although power generation emissions were estimated and discussed in the following sections, they are technically exempt from general conformity analysis since power generation facilities would already be permitted for those emissions, as explained in detail **Section 3.2.5.6** below. The following subsections describe the methods to estimate train and vehicle operation emissions.

3.2.3.2.1 Train Operation Emissions

Power Consumption

Emissions due to the power consumption, trains and stations were calculated using power consumption estimates supplied by TCRR. Daily power consumption information was provided for initial service level at an initial level of ridership, assumed to occur in 2024, and FLS at the full assumed level of ridership, which is projected to occur by 2040 for the purposes of this analysis. Emissions scenarios were calculated for both initial service level and future service level. Fewer train trips are projected per day (68) under the initial service level than the future service level (80). Though the initial operations scenario would result in lower power consumption than full-service operations scenario, the power generation emissions factors could be higher in the earlier initial service level year because power plant regulation and emissions controls continue to improve into the future, according to trend data used to project future emissions rates, discussed in the subsection **Future Year Train Emissions Adjustment** below. Therefore, the initial service level scenario emissions were estimated to investigate if the higher emissions rate would overcome the effect of lower power consumption to result in higher emissions. The full service level scenario emissions were estimated, since it represents the maximum level of train

[6] U.S. EPA. 2009. Emission Factors for Locomotives. https://www3.epa.gov/nonroad/locomotv/420f09025.pdf
[7] U.S. EPA. Office of Transportation and Air Quality. 2016. Nonroad Engines, Equipment, and Vehicles: Locomotives. https://www3.epa.gov/otaq/locomotives.htm

activity and associated emissions. Train power consumption included the power used for traction (i.e., locomotion) and onboard services (e.g., lights, controls, public address). Electricity generated due to regenerative braking would be returned to the train's power demand and accounted for in the power consumption provided. Emissions were calculated using the train traction power calculated under operating at the maximum design speed of 205 mph (330 kilometers per hour [km/h]). However, initial operations will be limited to 186 mph (300 km/h) under the initial operating scenario per TCRR, which consumes approximately 14 percent less power and would produce fewer emissions initially. Train traction power was estimated accordingly with the slower initial operating speed in Year 2024 and the maximum design speed in Year 2040. Station and facility consumption includes power required for stations, signaling, power substations and maintenance facilities. **Table 3.2-3** summarizes the power consumption. **Appendix E, Air Quality Technical Memorandum** (**Tables E3.2-1** through **E3.2-3)** provide the full details of the consumption, based on operational assumptions provided by TCRR, and the calculated total daily demand. Service is assumed to be provided 365 days a year, and yearly power consumption was calculated accordingly. With regard to HSR electric power consumption, differences in estimates provided by TCRR would not vary among Build Alternatives because of track length, but because of variations in station, TMF, and signaling configuration. For conservative purposes, Build Alternative A power consumption was used, as it is estimated to have the highest power consumption amongst the Build Alternatives, although the difference with the alternative estimated to consume the least power (Alternative E) is negligible at less than one percent.

The power grid in Texas is interconnected throughout the state to meet demand. The ERCOT power sub-region is the entity that manages and regulates the power grid for most of Texas, including the air quality Study Area. Data from the Energy Information Agency (EIA) on power lost through transmission and transformers was obtained for ERCOT. Power is lost in transmission as heat generated by the resistance of power line conductors, and in transformers mainly as heat also due to conductor resistance and due to other electrical effect losses. Annual loss data for Texas from 1996 to 2013 (latest available) was reviewed and used to calculate an average rate of loss of five percent.[8]

[8] Energy Information Agency. 2015. Table 10. Supply and disposition of electricity, 1990 through 2014. *Texas Electricity Profile*. Online date available at https://www.eia.gov/electricity/state/Texas/ (accessed January 25, 2016).

Table 3.2-3: Total Train Operations Power Consumption

Power Demand	Year 2024 (Initial Service Level)	Year 2040 (Future Service Level)
Total daily train power demand (MWh)	448.87	680.0
Total Daily Station & Facility Consumption (MWh)	538.90	538.90
Total Daily Operating Power Consumption (MWh)	988	1,219
Transmission & Transformer Losses		
Percentage lost	5%	5%
Power lost (MWh)	49	61
Total Daily Power + Losses (MWh)	1,037	1,280
Operating days/year	365	365
Total Electric Power Consumed per Year (MWH)	**378,562**	**467,143**

Source: TCRR, 2016 for all power demand, consumption and operating days assumptions. EIA, 2015 for percentage of power lost.
Notes: ISL: Initial Service Level; FSL: Future Service Level

Emissions Factors

As there is no certain set of power plants designated or dedicated to providing electricity to the Build Alternatives, and power generation and distribution are interconnected statewide and primarily controlled by ERCOT. Therefore, emissions from power supplied to the Build Alternatives were determined using ERCOT data. The EPA's eGRID was used to determine power generation and associated emissions and emission rate data by plant, power sub-region and state. Emissions factors for the ERCOT sub-region were used. Power in any sub-region is supplied by various sources such as natural gas, coal, nuclear, and to a smaller degree, renewable sources (e.g., wind or solar). The emissions factors for ERCOT reflect the blend of power generation of this sub-region. Factors were available for NO_x, SO_2 and GHGs.

The eGRID data did not include VOC, CO or PM_{10} emissions factors. These emissions factors were derived from a National Renewable Energy Laboratory study that included emissions rates from power by power sub-region.[9] For VOC, the National Renewable Energy Laboratory study provided an emission factor for total non-methane organic compounds. Total non-methane organic compounds is a more inclusive group of airborne organic compounds conservatively assumed to represent VOCs in air emissions inventories.[10, 11] Therefore, the total non-methane organic compounds emission factor was assumed to represent VOC. The ERCOT emissions factors for VOC, CO and PM_{10} were used and reflect the Year 2004 data. No later comparable data was available. However, the use of earlier year factors is conservative, because emissions factors have been decreasing as time progresses, as discussed in the next section. These factors only reflected combustion generation and not the portion of power generated by non-combustion (e.g., wind or nuclear) that does not contribute pollutants. This was adjusted using the percent of non-combustion power from 2004 (for consistency) eGRID data. More detail on combustion and non-combustion power and emissions factors, and their calculation is discussed below.

[9] Deru, M. and P. Torcellini. Source Energy and Emission Factors for Energy Use in Buildings Technical Report NREL/TP-550-38617 Revised June 2007.

[10] Maris, Christophe, Myeong Chung, Udo Krischke, Richard Meller and Suzanne Paulson. An Investigation of the Relationship Between Total Non-Methane Organic Carbon and the Sum of Speciated Hydrocarbons and Carbonyls Measured by Standard GC/FID: Measurements in the South Coast Air Basin. Presentation given at the Air Resources Board (ARB) Research Seminar, June 17, 2002, California EPA Headquarters, 1001 "I" Street, Sacramento, CA. Department of Atmospheric Sciences, University of California at Los Angeles. Available at http://www.arb.ca.gov/research/seminars/paulson/paulson.htm (accessed 5/10/2016).

[11] U.S. Department of the Interior (USDOI) Bureau of Ocean Energy Management (BOEM). 2015. Gulf of Mexico Air Emissions Calculations Instructions and PRA Statement. Office of Management and Budget (OMB) Form OMB Control No. 1010-0151, BOEM Instructions for Form 0138.

Future Year Train Emissions Adjustment

Because the available power generation and emissions factor data used to calculate train operation emissions only reflect current and historical data and practices, it does not incorporate improvements to emissions controls that vehicle emissions models account for in future years and it does not reflect the increasing percentage of power from renewable or non-fossil fuel energy. Electric power generation in Texas comes not only from combustion sources (e.g., natural gas and coal), but also from non-combustion generation (e.g., wind or nuclear) that do not produce criteria pollutants. The State of Texas also set renewable energy generating capacity goals in Texas Administrative Code Title 16, Part 2, Chapter 25, Subchapter H, Division 1 Rule §25.173 that ranged from 2,280 MW in 2007 to 5,880 MW in 2015 with an end target of 10,000 MW by 2025. The latest Texas renewable energy profile from EIA documented a total net summer renewable capacity of 10,985 MW achieved in 2010, which more than doubled the 2011 target of 4,264 and exceeds the 2025 target.[12] EIA state-level data for the non-combustion portion of power was examined and indicated an increasing trend between 1990 and 2013 from 6 percent to 17 percent.[13] **Appendix E, Air Quality Technical Memorandum** (**Figure E3.2-1)** shows this trend in black markers and plot line. This trend indicates that eGRID data for overall emission rates per power generated dropped; for example, NO_x emissions decreased 70 percent between 2000 and 2012.

The increasing percentage of non-combustion power reflects the significant increase in renewable energy, most notably, wind power in Texas. Two methods were used to project this trend to 2040 using 1990-2013 data shown in **Appendix E, Air Quality Technical Memorandum** (**Figure E3.2-1)**, with the more conservative linear-fit trend line (thin black line) chosen that resulted in 21 percent non-combustion power in 2024, and 27 percent non-combustion power in 2040. These rates were used with available combustion emissions factors to calculate the future year overall emissions factors using Equation 5 in **Appendix E, Air Quality Technical Memorandum**, derived from general equations found in eGRID and the National Renewable Energy Laboratory technical documentation.[14,15] Historical combustion emission rates data also indicated that combustion emission factors (EF) also had decreasing trends (e.g., -7 percent per year for NO_x).[16] Available eGRID information was used to project the change in combustion emission rates of NO_x, SO_2 and the GHGs (CO_2, CH_4, N_2O) using the average percent change, shown in **Appendix E, Air Quality Technical Memorandum** (**Figure E3.2-2** through **Figure E3.2-6).**[17] The projected $EF_{combust}$ was then used in Equation 5 to calculate the overall EF_{total} for power generation in ERCOT in the Years 2024 and 2040 for NO_x, SO_2 and the GHGs. The resultant EF_{total} are shown in **Appendix E, Air Quality Technical Memorandum** (**Table E3.2-4)**.

For VOC, PM_{10} or CO, Texas data from the EPA's National Emissions Inventory show gradual downward trends.[18] These state-level emissions rates were not used directly for EF calculations and projections, but

[12] Energy Information Agency. " Summary Renewable Electric Power Industry Statistics (2010)" State Renewable Electricity Profiles. 2010. https://www.eia.gov/renewable/state/Texas/ (accessed October 7, 2016).
[13] Energy Information Agency. "Table 5. Electric power industry generation by primary energy source, 1990 through 2013" Texas Electricity Profile. 2015. https://www.eia.gov/electricity/state/Texas/ (accessed January 25, 2016).
[14] Deru, M. and P. Torcellini. Source Energy and Emission Factors for Energy Use in Buildings Technical Report NREL/TP-550-38617 Revised June 2007.
[15] Abt Associates. 2015. The Emissions and Generation Resource Integrated Database Technical Support Document for eGRID with Year 2012 Data. Technical report prepared for Clean Air Markets Division, Office of Atmospheric Programs, U.S. Environmental Protection Agency Washington, DC. Abt Associates, Bethesda, MD.
[16] U.S. Environmental Protection Agency (EPA). 2016. eGRID. Online database available at https://www.epa.gov/energy/egrid
[17] Ibid.
[18] EPA. 2016. Air Pollutant Emissions Trends Data. Online data available at https://www.epa.gov/air-emissions-inventories/air-pollutant-emissions-trends-data (accessed May 30, 2016).

to estimate rates of improvement in emissions rates of these pollutants in Texas and ERCOT. The most current year ERCOT EFs for VOC, PM_{10} and CO sourced from the National Renewable Energy Laboratory were used because they were more consistent with eGRID estimation methods used for the other pollutants, along with the calculated rates of improvement. **Appendix E, Air Quality Technical Memorandum (Figures E3.2-7** through **E3.2-9**) shows the gradual downward trends in National Emissions Inventory based emissions rates for VOC, PM_{10} and CO. The average percent change from this data was then used to project changes in the National Renewable Energy Laboratory based $EF_{combust}$ factors for VOC, PM_{10} and CO to forecast these factors for the Years 2024 and 2040. The projection was conducted in the same manner as NO_x, SO_2 and the GHGs. **Appendix E, Air Quality Technical Memorandum (Table E3.2-5)** summarizes the percent change calculated and projected 2024 and 2040 $EF_{combust}$ factors. The projected $EF_{combust}$ was used in Equation 5 to calculate the overall EF_{total} for power generation in ERCOT in the Years 2024 and 2040 for VOC, PM_{10} and CO. The resultant EF_{total} is shown in **Appendix E, Air Quality Technical Memorandum (Table E3.2-5)**. The 2024 and 2040 EF_{total} for all pollutants were then multiplied by the train operations annual power consumption to calculate the train operations emissions in tons per year.

3.2.3.2.2 Vehicle Emissions Reductions

The shift in travel mode during operations from passenger vehicles to HSR use that would occur with the operation of the Build Alternative would result in some passenger vehicles no longer making the round trip from Dallas to Houston and vice versa. This would eliminate the indirect emissions from those vehicles. Differences in the Build Alternatives do not affect the assumption of reducing vehicle travel along IH-45 or the assumed trip length along IH-45 described in the ensuing subsections. Therefore, the estimate of vehicle emissions reduction is equally applicable to all the Build Alternatives. This sub-section presents the estimate of indirect emissions from these vehicles.

Reduction in Vehicle Miles Traveled

Ridership information provided by TCRR (see **Appendix F, TCRR Conceptual Engineering Design Report**) was used to derive the expected numbers of cars no longer making the trip between Dallas and Houston. The long term forecast for annual ridership in 2040 would be 7.2 million passengers per year. TCRR estimates that 89 percent of the existing travel for the Dallas-Houston corridor currently occurs by car (private vehicle), while the remaining 11 percent occurs by air or bus. Based on this majority share, it was assumed for this EIS analysis that potential HSR passengers would primarily shift from private vehicle to rail. For the air quality emissions estimation at the full-service level (2040) scenario, the annual ridership of 7.2 million passengers, existing 89 percent share of people using passenger cars to travel between Dallas and Houston and average passenger occupancy of 1.2 passengers per car were then used to calculate the number of annual car trips of 5,340,000 cars per year. It should be noted that this number of vehicles that would no longer travel IH-45 between Houston and Dallas would equate to 14,630 vehicles per day, or about 14 percent of the 2035 annual average daily traffic of 106,475 vehicles per day projected in transportation planning documents for this corridor.[19] Therefore, the mode shift would not be assumed to constitute the majority of travel along IH-45. Because station planning focuses on accommodating the long term and peak capacity facility needs, annual passenger ridership was not projected by TCRR for the initial service (2024) level. However, the number of trains was projected, which was used along with the train passenger capacity, and the average occupancy rate derived from the future service level ridership, to estimate an initial service level passenger ridership. With 68 trains

[19] Texas Department of Transportation. 2011. Section 5: Planning Documentation, TxDOT Narrative Application Form for the High-Speed Intercity Passenger Rail (HSIPR) Program March 2011 Notice of Funding Availability (NOFA).

per day, at a 62 percent occupancy rate of each 400 passenger-capacity train for 365 days per year, an annual ridership of 6,155,360 passengers was estimated.

Projected rates of ground transportation activity into the Dallas and Houston stations were used to determine the distribution of trips originating in Dallas versus Houston assuming it reflects the proportion between these ground activity rates. A 47 percent/53 percent split between Dallas and Houston, respectively, was calculated. Because IH-45 is the principle and practical route used for Dallas-Houston travel, a city center-to-city center distance of 239 miles was assumed for the trip distance. Consistent with the average length of stay assumption of two days (see **Appendix F, TCRR Conceptual Engineering Design Report**), temporary stays with round trips back to the origin was assumed. The round trip distance and calculated cars/year were used to calculate the VMT that would have been traveled in the absence of the Build Alternatives, as shown in **Table 3.2-4**.

Round trip distance X cars/year = VMT

Table 3.2-4: Calculated VMT

Metro Share of VMT	2024 VMT	2040 VMT
Dallas VMT	1,021,310,065	1,194,638,721
Houston VMT	1,160,867,963	1,357,881,279
Total VMT avoided	**2,182,178,028**	**2,552,520,000**

Source: AECOM, 2016

The full derivation of VMT and cars per year from the ridership memo is provided in **Appendix E, Air Quality Technical Memorandum (Tables E3.2-7** through **E3.2-11).**

Emissions Factors

The MOVES2014a model was used to derive emissions factors.[20] Because the stations that would generate the majority of the HSR travel are located in Houston and Dallas, vehicles that would have otherwise used IH-45 to travel between Houston and Dallas would overwhelmingly be expected to originate in the counties of these two metropolitan areas. For consistency with the construction emissions estimated, the nonattainment area counties in the air quality Study Area were used in MOVES 2014a to define vehicle characteristics. MOVES input data used by the two relevant MPOs to conduct transportation conformity regional vehicle emissions air modeling was applied to provide regional and county model inputs for meteorological, inspection and monitoring program, age and vehicle class distributions. The H-GAC MPO website for the 2040 Regional Transportation Plan (RTP) conformity demonstration and the NCTCOG website for conformity demonstration of the Metropolitan Transportation Plan (MTP) [named Mobility 2040], and the 2015-2018 Transportation Improvement Plan (TIP) were used.[21, 22]

Key assumptions and model inputs used to generate emissions factors are listed in **Appendix E, Air Quality Technical Memorandum (Table E3.2-12)**. Year 2040 was chosen because it is the year that full service and usage of the HSR system is projected by TCRR. Therefore, it would represent future

[20] U.S. EPA. 2016. MOVES (Motor Vehicle Emission Simulator). Air quality emissions modeling system available at https://www3.epa.gov/otaq/models/moves/ (accessed February 2016).
[21] Houston-Galveston Area Council (H-GAC). 2016. 2040 RTP Conformity. Available at http://www.h-gac.com/taq/airquality_model/conformity/2040-RTP-Conformity.aspx (accessed May 2016).
[22] North Central Texas Council of Governments (NCTCOG). 2016. 2016 Transportation Conformity. Available at http://nctcog.org/trans/air/conformity/2016TransportationConformity.asp (accessed May 2016).

conditions under which the full effect of train and vehicle emissions would be expected. The time of year chosen to generate emissions factors was January and July, to represent the range of weather and seasonal conditions that affect fuel and meteorological parameters. The modeling assumed a rural restricted road type, which is defined for rural highways that can only be accessed by an on-ramp. Most of the length of IH-45 through the air quality Study Area is a rural highway with on-ramp or frontage road access. The assumed average vehicle speed was 40 mph, which was the average speed (39 mph rounded up) projected by TxDOT in 2035 for IH-45 travel between DFW and Houston, contained in the Project Planning Documentation for the state's funding application for the High-Speed Intercity Passenger Rail (HSIPR) Program.[23] This speed reflects the increasing traffic volume trend observed in traffic data, and the exceedance of the highway's design capacity in future years.

Because the large majority of passengers that would use the HSR system for Dallas-Houston travel would be those using passenger vehicles (and not commercial light or heavy duty trucks), emissions factors for passenger cars and trucks were calculated. Travel by bus and aircraft constitute minor portions of the existing travel mode at 2 percent and 9 percent respectively, based on ridership and travel mode projections (see **Appendix F, TCRR Conceptual Engineering Design Report**). On a relative basis, shifting to HSR from bus or aircraft travel would result in minor reductions of criteria pollutants. Therefore, omitting reductions of criteria pollutants from aircraft and bus travel from the net estimate of emissions due to travel shift to HSR is a conservative assumption since fewer emissions reductions would result by only considering passenger vehicle travel. Accordingly, emissions reductions were not calculated for bus and aircraft travel modes.

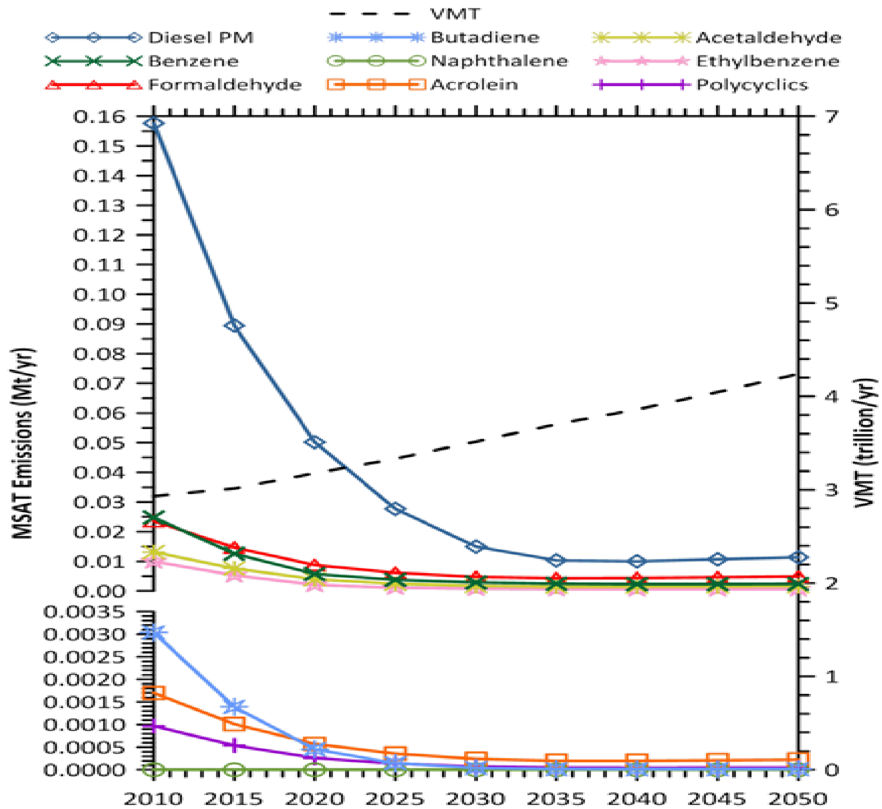
3.2.3.2.3 Additional National Ambient Air Quality Standards and Mobile Source Air Toxics Analysis Methodology

Because the Study Area is in attainment of both the CO and PM (PM_{10}/$PM_{2.5}$), meaning national ambient air quality standards and monitoring data indicate CO and PM criteria pollutant levels are below respective standards, hot-spot CO or PM analyses are not required.

The EPA MSAT rule requires controls to dramatically decrease MSAT emissions through cleaner fuels and cleaner engines. According to an FHWA analysis using EPA's MOVES2014a model, future emissions likely would be lower than present levels as a result of the EPA's national control programs, which are projected to reduce priority MSAT emissions by 91 percent from 2010 to 2050, even if VMT increases by 45 percent, as shown in **Figure 3.2-1**.[24]

[23] Texas Department of Transportation. 2011. Section 5: Planning Documentation, TxDOT Narrative Application Form for the High-Speed Intercity Passenger Rail (HSIPR) Program March 2011 Notice of Funding Availability (NOFA).
[24] Federal Highway Administration, *Updated Interim Guidance on Mobile Source Air Toxic Analysis in NEPA Documents. October 18*, 2016. http://www.fhwa.dot.gov/environment/air_quality/air_toxics/policy_and_guidance/msat (accessed September 27, 2017).

Figure 3.2-1: Projected National MSAT Emission Trends 2010 – 2050 for Vehicles Operating on Roadways Using EPA's MOVES2014a Model



Source: EPA MOVES2014a model runs conducted during September 2016 by FHWA.
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.

On February 3, 2006, the FHWA released *Interim Guidance on Air Toxic Analysis in NEPA Documents*. This guidance was updated on October 18, 2016 by FHWA's *Updated Interim Guidance on Mobile Source Air Toxic Analysis in NEPA Documents*.[25] The purpose of FHWA's guidance is to advise on when and how to analyze MSATs in the NEPA environmental review process for highways and other transportation-related projects. FRA does not have any specific MSAT guidance. Instead, FRA relies on the FHWA 2016 Updated Interim MSAT Guidance for the analysis of potential MSAT impacts. This guidance will be followed to define the MSAT analysis for the HSR project. This guidance is considered interim since MSAT science continues to evolve. As the science progresses, FHWA will update the guidance as needed.

The FHWA's Interim Guidance groups projects into the following tier categories:

- No analysis for projects that have no potential for meaningful MSAT impacts.
- Qualitative analysis for projects with a low potential for MSAT impacts.
- Quantitative analysis to differentiate alternatives for projects with a higher potential for MSAT impacts.

[25] Ibid.

According to the FHWA guidance, projects should be quantitatively analyzed if the project contains a significant number of diesel vehicles, concentrates high levels of diesel PM in a single location or creates new capacity where average daily traffic is projected to be 140,000 vehicles per day or greater and is located in proximity to populated areas. None of these conditions apply to the HSR project. The Build Alternatives would not be a significant source of MSATs; therefore, the MSAT analysis includes a qualitative assessment of emissions from applicable construction equipment and on-road vehicles accessing stations within the air quality Study Area. The qualitative assessment is derived in part from an FHWA study, *A Methodology for Evaluating Mobile Source Air Toxic Emissions Among Transportation Project Alternatives*.[26]

3.2.3.2.4 General Conformity Emissions Methodology

Because the Dallas and Houston Terminal Station options would be in nonattainment areas for ozone, and a small section of the Build Alternatives would be located within the SO_2 nonattainment area in Freestone County, a determination of applicability to demonstrate general conformity is necessary. The general conformity rules in 40 CFR 93(B) prescribe *de minimis* emissions thresholds dependent on the nonattainment classification of the nonattainment area, below which conformity analysis is not required. The applicable *de minimis* thresholds are those for moderate ozone and SO_2 nonattainment areas. For VOC or NO_x (the precursor pollutants for ozone), the general conformity *de minimis* level for either pollutant in a moderate ozone nonattainment area in Texas is 100 tons/year. The general conformity *de minimis* level for SO_2 is also 100 tons/year. [27] The estimate of emissions used to determine if a formal general conformity determination is required has been conducted as part of this emissions estimate, except that the analysis focuses on the portion of emissions that occurs in the ozone nonattainment area counties (Dallas, Ellis, Waller and Harris) and SO_2 nonattainment area county (Freestone), as listed in **Table 3.2-5** in **Section 3.2.4** below.

3.2.4 Affected Environment

3.2.4.1 Regional Air Quality

The existing general air quality of the counties in the air quality Study Area was reviewed to identify their location in nonattainment areas for criteria pollutants. **Table 3.2-5** lists their current status with respect to attainment and location in nonattainment areas designated by the TCEQ.[28] As shown, only those counties associated with the DFW and HGB nonattainment areas at the terminating ends of the Build Alternatives are in nonattainment for the 2008 8-hour O_3 standard. The nonattainment designation for SO_2 involves a portion of Freestone and Anderson counties. Freestone County is within the air quality Study Area. On August 22, 2017, the EPA responded to Round 3 designation recommendations from Texas, and listed Navarro County as one of nine remaining undesignated areas to be designated by December 31, 2020.[29] This county has not received the unclassifiable/attainment designation that all other Study Area counties other than Freestone have. Therefore, it is neither in

[26] *A Methodology for Evaluating Mobile Source Air Toxic Emissions Among Transportation Project Alternatives.* July 6, 2011. https://www.fhwa.dot.gov/environment/air_quality/air_toxics/research_and_analysis/mobile_source_air_toxics/msatemissions.cfm (accessed February 4, 2016).
[27] *General Conformity De Minimis Levels.* September 10, 2015b. http://www3.epa.gov/airquality/genconform/deminimis (accessed February 4, 2016).
[28] *Air Quality Successes - Criteria Pollutants.* October 21, 2015. http://www.tceq.state.tx.us/airquality/airsuccess/airSuccessCriteria (accessed January 29, 2016).
[29] Letter. Samuel Coleman, Acting Regional Administrator, Environmental Protection Agency, to the Honorable Greg Abbott, Governor of Texas. August 22, 2017, 1445 Ross Avenue, Suite 1200, Dallas, Texas.

attainment or nonattainment at this time, and was not included in the general conformity applicability analysis. The nonattainment and maintenance designations for lead in the DFW nonattainment area only involve a portion of Collin County, which is not in the air quality Study Area.

Though the HGB nonattainment area is currently in attainment for $PM_{2.5}$, it is vulnerable to being designated as non-attainment in the near term, considering recent air monitoring data trends. Because of this, the HGAC has applied to and been accepted by EPA into the PM Advance program, which is a collaborative effort between EPA, states and local governments to enact expeditious emission reductions to help near non-attainment areas remain in attainment of the NAAQS.

Table 3.2-5: Current Attainment Status by County

County	NAA	Status	Criteria Pollutant[1]
Dallas	DFW	Moderate Nonattainment	Ozone
		Attainment	All other pollutants
Ellis	DFW	Moderate Nonattainment	Ozone
		Attainment	All other pollutants
Navarro		No designation until 2020	Sulfur Dioxide
	-	Attainment	All Pollutants
Freestone	Freestone-Anderson	Nonattainment (partial county)	Sulfur Dioxide
		Attainment	All other pollutants
Limestone	-	Attainment	All Pollutants
Leon	-	Attainment	All Pollutants
Madison	-	Attainment	All Pollutants
Grimes	-	Attainment	All Pollutants
Waller	HGB	Moderate Nonattainment	Ozone
		Attainment	All other pollutants
Harris	HGB	Moderate Nonattainment	Ozone
		Attainment	All other pollutants

Source: TCEQ, 2015
Notes: [1] Regulated pollutants: Ozone, Lead, Carbon Monoxide, Nitrogen Dioxide, Particulate Matter (10 microns), Particulate Matter (2.5 microns), Sulfur Dioxide

3.2.4.2 Meteorological Conditions Affecting Local Air Quality

Air quality is affected by the rate and location of pollutant emissions and meteorological conditions that influence the movement and dispersal of pollutants in the atmosphere. These conditions include wind speed and direction, air temperature gradients, and local topography. The air quality Study Area is located in generally flat topography that does not hinder or trap air movement like hills and mountains would. The DFW and Houston climates are humid subtropical with hot summers and generally mild winters. Average temperatures in Dallas vary from 30F in January to 96F in August, with annual average precipitation of approximately 41 inches. Prevailing winds for the DFW area are out of the south.[30] Average temperatures in Houston vary from 44F in January to 93F in August, with annual average precipitation of approximately 45 inches. Prevailing winds are from the southeast near Houston.[31] The air quality Study Area weather conditions include extended hot summers and occasional stagnant, foggy

[30] *Dallas Texas Climate.* http://www.usclimatedata.com/climate/dallas/texas/united-states/ustx1575 (accessed May 3, 2016).
[31] *Houston Texas Climate.* http://www.usclimatedata.com/climate/houston/texas/united-states/ustx0617 (accessed May 3, 2016).

conditions during winter with temperature inversions,[32] all of which are conducive to either forming or retaining air pollutants within the lower atmosphere.[33]

With respect to ozone, winter inversions and fog conditions are not as frequent during the year or do not impact ozone exceedances as much as hot summer conditions do. The highest concentrations of ozone form on sunny days with low wind speeds, as high pressure systems dominate the regional weather and tend to produce clear skies that increase photochemical reaction and stagnate winds.[34] The ozone season in Texas is roughly March through November and TCEQ forecasts ozone action days during this period for several regions including the DFW and HGB metropolitan areas.[35]

3.2.4.3 Air Quality Trends and Monitoring

The TCEQ regulates air quality in the state and, along with other local organizations, performs air quality monitoring of criteria pollutants to determine compliance with the NAAQS. The TCEQ and local agencies maintain ambient air monitoring stations for criteria pollutants throughout Texas. A total of 8 monitoring stations located within and closest to the air quality Study Area were selected using a 5-mile buffer around the Build Alternatives and are shown in **Table 3.2-6** and **Table 3.2-7**. These stations monitor one or more of the criteria pollutants and are predominantly located around Dallas and Houston, with the Corsicana Airport station approximately one quarter of the total route length away from Dallas. **Table 3.2-6** summarizes ambient monitoring results at four DFW area stations from the latest 4 years of available data. **Table 3.2-7** summarizes ambient monitoring results at four Houston area stations from the same time period. The land uses within the air quality Study Area range from highly urbanized (predominantly residential and commercial) at the terminal stations, suburban at the outskirts of Dallas and Houston and rural/agricultural in the middle.

As shown in **Table 3.2-6** and **Table 3.2-7**, only ozone has exceeded the NAAQS, with recorded exceedances of the 2008 and 2015 8-hour ozone standard in the DFW and HGB metropolitan areas. Nonattainment areas are required to comply with the 2015 8-hour ozone standard within 3 to 20 years of being designated as nonattainment areas under the 2015 standard, depending on the severity of nonattainment.[36] The EPA will designate nonattainment areas by October 1, 2017.[37] Attainment schedules for the 2015 standard vary from 3 years for marginal nonattainment to 20 years for extreme nonattainment.[38] The air quality Study Area is located in areas currently designated as moderate for the 2008 8-hour ozone standard and a small section of the Build Alternatives would be located within Freestone County that is part of the Freestone and Anderson Counties SO_2 nonattainment area. Besides ozone, monitored data for all other NAAQS are below the respective standard. SO_2 monitoring in Freestone County began in November 2016 and validated data does not yet exist within the county. Except for PM_{10}, most of the long-term measures (e.g., 8-hour or 24-hour) for most NAAQS show a general decreasing trend. Data for PM_{10} have reached almost 90 percent of the 24-hour average standard at the Earhart site in Dallas, while data from $PM_{2.5}$ have reached almost 90 percent of the

[32] A temperature inversion is a thin layer of the atmosphere where the normal decrease in temperature with height switches to the temperature increasing with height. An inversion acts like a lid, keeping normal overturning of the atmosphere from penetrating through the inversion.
[33] Ozone: The Facts. January 8, 2016. https://www.tceq.texas.gov/airquality/monops/ozonefacts.html (accessed January 25, 2016).
[34] Ibid.
[35] Ibid.
[36] "Final Updates to National Ambient Air Quality Standards for Ozone." *USEPA Web Site.* October 21, 2015d. https://www.epa.gov/sites/production/files/2016-02/documents/20151021webinar.pdf (accessed February 9, 2016).
[37] Ibid.
[38] Ibid.

annual mean primary standard at the Convention Center site in Dallas. Both air quality monitoring stations are near the terminus, with the Convention Center Station within one-half mile of the Build Alternatives. Statewide, the average 24-hour $PM_{2.5}$ value fluctuates, but has slightly improved by 3 percent from 2002 to 2014, while the longer-term average annual value has decreased 18 percent, signaling a steady decline.[39] As a long-term trend, Texas air quality has improved markedly, especially in Dallas and Houston. In the DFW area, 8-hour ozone levels improved by 21 percent during the last 15 years, at the same time as the population grew by more than 29 percent. The Houston-area 8-hour ozone levels improved 29 percent between 2000 and 2014, at the same time as the population increased over 34 percent.[40] This statewide trend may be attributable to several improvements resulting from better compliance with air quality regulations, including industry cutting production of NO_x (an ozone precursor) over 80 percent in the last 10 years in Houston, tougher rules on compressor emissions in north and east Texas, tougher emissions rules on power plants, newer passenger cars and improved heavy-duty truck and gasoline standards.[41]

[39] *Air Quality Successes - Criteria Pollutants*. October 21, 2015. http://www.tceq.state.tx.us/airquality/airsuccess/airSuccessCriteria (accessed January 29, 2016).
[40] Texas Air Quality Continues to Improve. April 1, 2015. http://www.tceq.state.tx.us/publications/pd/020/2015/texas-air-quality-continues-to-improve (accessed January 28, 2016).
[41] Ibid.

Table 3.2-6: DFW Area Ambient Monitoring Results

Criteria Pollutant	Site: Concentration/ Exceedance	Convention Center 2013	Convention Center 2014	Convention Center 2015	Convention Center 2016	Earhart 2013	Earhart 2014	Earhart 2015	Earhart 2016	Dallas Hinton 2013	Dallas Hinton 2014	Dallas Hinton 2015	Dallas Hinton 2016	Corsicana Airport 2013	Corsicana Airport 2014	Corsicana Airport 2015	Corsicana Airport 2016
Carbon Monoxide (CO)	Maximum 1-Hr (ppm)	-	-	-	-	-	-	-	-	2.0	1.6	1.8	1.4	-	-	-	-
	Maximum 8-hr (ppm)	-	-	-	-	-	-	-	-	1.7	1.5	1.1	1.2	-	-	-	-
	Days>35 ppm 1-hr NAAQS	-	-	-	-	-	-	-	-	0	0	0	0	-	-	-	-
	Days>9 ppm 8-hr NAAQS	-	-	-	-	-	-	-	-	0	0	0	0	-	-	-	-
Lead (Pb)	Maximum 24-Hr (μg/m^3)	-	-	-	-	-	-	-	-	0.01	0.01	0.02	0.04	-	-	-	-
	Days>0.15 μg/m^3 3-month rolling avg. NAAQS	-	-	-	-	-	-	-	-	0	0	0	0	-	-	-	-
Nitrogen Dioxide (NO_2)	Maximum 1-Hr (ppb)	-	-	-	-	-	-	-	-	63	57	58	76	46	35	35	36
	Annual Mean (ppb)	-	-	-	-	-	-	-	-	12	11	10	9	4	2	2	2
	Days>100 ppb 1-hr NAAQS	-	-	-	-	-	-	-	-	0	0	0	0	0	0	0	0
	Days>53 ppb Annual Mean NAAQS	-	-	-	-	-	-	-	-	0	0	0	0	0	0	0	0
Ozone (O_3)*	Maximum 8-Hr (ppb)	-	-	-	-	-	-	-	-	87	70	84	82	78	68	72	64
	Annual fourth-highest concentration (ppb)	-	-	-	-	-	-	-	-	81	66	80	69	74	60	64	60
Particulate Matter, 10 microns (PM_{10})	Max. 24-hour Concentration (μg/m^3)	102	91	99	93	96	132	52	83	-	-	-	-	-	-	-	-
	Days>150 μg/m^3 24-hr avg. NAAQS	0	0	0	0	0	0	0	0	-	-	-	-	-	-	-	-
Particulate Matter, 2.5 microns ($PM_{2.5}$)	Max. 24-hour Concentration (μg/m^3)	30	26	16	22	-	-	-	-	31	27	20	28	-	-	-	-
	Annual Mean (μg/m$_3$)	10.6	10.7	8.3	8.5	-	-	-	-	9.6	10.0	8.7	8.3	-	-	-	-
	Days>35 μg/m^3 24-hr avg.	0	0	0	0	-	-	-	-	0	0	0	0	-	-	-	-
	Days>12.0 μg/m^3 annual mean	0	0	0	0	-	-	-	-	0	0	0	0	-	-	-	-
Sulfur Dioxide (SO_2)	Maximum 1-Hr (ppb)	-	-	-	-	-	-	-	-	7	6	6	4	56	56	85	38
	99th percentile of 1-hour daily max (ppb)	-	-	-	-	-	-	-	-	5	5	4	4	30	41	46	20
	Days>75 ppb 1-hr daily max 99th percentile NAAQS	-	-	-	-	-	-	-	-	0	0	0	0	0	0	0	0

Source: TCEQ, 2016 and EPA, 2015
(-) = Data not monitored
*The current standard is the 2008 8-hour standard of 75 ppb until designations are made in 2017 with the earliest deadline to comply in 2020.

Table 3.2-7: Houston Area Ambient Monitoring Results

Criteria Pollutant	Site:	NW Harris County				Lang				Bunker Hill Village				Houston SW Freeway			
	Concentration/ Exceedance	**2013**	**2014**	**2015**	**2016**	**2013**	**2014**	**2015**	**2016**	**2013**	**2014**	**2015**	**2016**	**2013**	**2014**	**2015**	**2016**
Carbon Monoxide (CO)	Maximum 1-Hr (ppm)	-	-	-	-	3.2	2.8	1.7	1.7	-	-	-	-	-	-	-	-
	Maximum 8-hr (ppm)	-	-	-	-	2.1	2.5	1.5	1.3	-	-	-	-	-	-	-	-
	Days>35 ppm 1-hr NAAQS	-	-	-	-	0	0	0	0	-	-	-	-	-	-	-	-
	Days>9 ppm 8-hr NAAQS	-	-	-	-	0	0	0	0	-	-	-	-	-	-	-	-
Lead (Pb)	Maximum 24-Hr (μg/m^3)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Days>0.15 μg/m^3 3-month rolling avg. NAAQS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nitrogen Dioxide (NO_2)	Maximum 1-Hr (ppb)	43	98	43	95	61	66	65	52	-	-	-	-	-	55	61	59
	Annual Mean (ppb)	5	5	5	4	12	11	11	11	-	-	-	-	-	13	13	11
	Days>100 ppb 1-hr NAAQS	0	0	0	0	0	0	0	0	-	-	-	-	-	-	-	-
	Days>53 ppb Annual Mean NAAQS	0	0	0	0	0	0	0	0	-	-	-	-	-	-	-	-
Ozone (O_3)*	Maximum 8-Hr (ppb)	83	71	91	79	88	70	95	80	82	72	85	-	-	-	-	-
	Annual fourth-highest concentration (ppb)	80	63	78	67	79	64	91	69	73	65	74	-	-	-	-	-
Particulate Matter, 10 microns (PM_{10})	Max. 24-hour Concentration (μg/m^3)	-	-	-	-	88	94	78	87	-	-	-	-	-	-	-	-
	Days>150 μg/m^3 24-hr avg. NAAQS	-	-	-	-	0	0	0	0	-	-	-	-	-	-	-	-
Particulate Matter, 2.5 microns ($PM_{2.5}$)	Max. 24-hour Concentration (μg/m^3)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Annual Mean (μg/m$_3$)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Days>35 μg/m^3 24-hr avg.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Days>12.0 μg/m^3 annual mean	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sulfur Dioxide (SO_2)	Maximum 1-Hr (ppb)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	99th percentile of 1-hour daily max (ppb)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Days>75 ppb 1-hr daily max 99th percentile NAAQS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Source: TCEQ, 2016 and EPA, 2015
(-) = Data not monitored
*The current standard is the 2008 8-hour standard until designations are made in 2017 with the earliest deadline to comply in 2020.

3.2.5 Environmental Consequences

3.2.5.1 No Build Alternative

The No Build Alternative does not include construction of the Project. The No Build Alternative assumes that existing transportation improvements already planned within the air quality Study Area would be implemented. The No Build Alternative would result in gradually increasing VMT within the air quality Study Area as traffic volumes increase and traffic congestion worsens within the existing roadway system over time. In accordance with the trend of improving air quality discussed in the previous section, no new exceedances of criteria pollutant standards would occur under the No Build Alternative; however, no emissions would be reduced as a result of implementation of an intercity high speed rail project. Based on the information on the operational emissions estimated, which is discussed in the next section, the potential emissions reduction from implementation of the Build Alternatives would be significantly greater than generation of new emissions. Therefore, the net effect of not taking the opportunity to reduce emissions through travel mode shift due to implementation of the Project would be expected to result in higher emissions under the No Build Alternative. The higher emissions would be the inverse of the net operational emissions for the Build Alternative presented in **Table 3.2-14**. These higher emissions would represent an annual net increase in emissions**.**

Future MSAT emissions under the No Build Alternative would likely be lower than existing conditions as a result of EPA's national control programs that would reduce annual MSAT emissions by 91 percent from 2010 to 2050.[42] 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 air quality Study Area would likely be lower in the future when compared to existing conditions.

3.2.5.2 Build Alternatives Comparison

Construction of the Build Alternatives has the potential to cause localized, short-term air quality impacts including the exceedance of applicable general conformity *de minimis* thresholds for specific criteria pollutants. The construction emissions analysis quantifies NO_x and VOC air emissions within the relevant DFW and HGB ozone nonattainment counties for use in the general conformity analysis. Construction-period SO_2 emissions were quantified for the small section of the Build Alternatives that would be located within the SO_2 nonattainment area surrounding the Big Brown power plant located on Fairfield Lake in Freestone County. Construction emissions generated would be largely a function of alternative length. Build Alternative C would have the longest end-to-end length of approximately 241 miles. Of this length, approximately 45.7 miles would occur within the DFW ozone nonattainment counties, and approximately 48.8 miles would occur within the HGB ozone nonattainment counties. In addition, approximately 1.95 miles of Build Alternative C would occur within the SO_2 nonattainment area in Freestone County. The lengths of the Build Alternatives that deviate from Build Alternative C would be comparable to the length of Build Alternative C for the equivalent section for embankment and viaduct or elevated track and station/MOW structures. Therefore, construction emissions of Build Alternative C within the respective nonattainment counties are analyzed and presented. These emissions would be representative of the construction emissions from all the Build Alternatives. Therefore, separate analysis

[42] *Updated Interim Guidance on Mobile Source Air Toxic Analysis in NEPA Documents.* October 18, 2016. http://www.fhwa.dot.gov/environment/air_quality/air_toxics/policy_and_guidance/msat (accessed September 27, 2017).

for each Build Alternative is not provided in Section 3.2.5, Environmental Consequences.

Operation of the Build Alternatives would provide a net regional air quality benefit. Operation of the Build Alternatives would generally reduce regional criteria and GHG pollutants (see also **Section 3.21, Greenhouse Gas Emissions and Climate Change**). The exception would be emissions of SO_2, which would increase due to the nature of power plant emissions that partially rely on coal for fuel, compared to cars, which use gasolines with much lower sulfur content. However, these emissions are permitted under rules for the electrical generation facilities and would be exempt from general conformity applicability as discussed in detail in **Section 3.2.5.6** below.

3.2.5.2.1 Construction Emissions

Construction emissions were estimated for Build Alternative C as a proxy for all Build Alternatives because this alternative is comprised of the longest track distance; therefore, it is expected it would have the greatest construction emissions and provide a conservative estimate.

The methods described in **Section 3.2.3.1** were used to estimate construction period emissions for the Build Alternatives. Annual NO_x, VOC and SO_2 emissions from the exhaust of equipment used to construct the Build Alternatives are shown in **Table 3.2-8**. GHG emissions are reported separately in **Section 3.21, Greenhouse Gas Emissions and Climate Change**.

Total emissions shown on **Table 3.2-8** would be the maximum emissions during any given year during the construction period. The specific construction equipment, including the rated horsepower, average load factor, utilization and total number of equipment for each major construction activity, are provided in **Appendix E, Air Quality Technical Memorandum**.

Table 3.2-8: Annual Non-Road Construction Period Emissions (tons/year)a

Construction Activity	DFW NAA[b]		HGB NAA[c]		Freestone Co. NAA
	NO_x (tons)	VOC (tons)	NO_x (tons)	VOC (tons)	SO_2 (tons)
Track[d]	15.08	1.24	16.10	1.32	0.0011
Stations[e]	15.14	1.26	15.14	1.26	0
TMFs[f]	15.14	1.26	15.14	1.26	0
MOWs[g]	17.36	1.44	17.36	1.44	0
Total	**62.72**	**5.20**	**63.74**	**5.28**	**0.0011**

Source: AECOM, 2016
Notes:
[a] These construction emissions were estimated for the Build Alternative C, which is used as a proxy to estimate construction emissions for all other alternatives. Total construction emissions of NO_x, VOC and SO_2 from all other alternatives would be lower and are estimated to differ from Alternative C by less than 2.2 percent.
[b] The applicable DFW NAA counties are Dallas and Ellis counties.
[c] The applicable HGB NAA counties are Harris and Waller counties.
[d] Total includes demolition activities and construction of track (elevated, at-grade, retained fill) and roadway crossings.
[e] Assumes construction of one terminal station in Dallas and one terminal station in Houston. No station would be constructed in Freestone County.
[f] Assumes construction of one TMF in Dallas and one TMF in Houston. No TMF would be constructed in Freestone County.
[g] Assumes construction of one MOW each in Dallas, Ellis, Waller and Harris counties. No MOW would be constructed in Freestone County.

3.2.5.2.2 On-Road Vehicle and Material Hauling Emissions

In addition to the non-road construction equipment, on-road vehicles would be used during all aspects of construction and would result in emissions of NO_X, VOCs, SO_2 and GHGs. Truck hauling emissions were calculated following the methodology provided in **Section 3.2.3.1**. The following pollutants were calculated: NO_x, VOC and SO_2. GHG emissions are reported separately in **Section 3.21, Greenhouse Gas Emissions and Climate Change**. Emissions were calculated separately for each nonattainment area in which the construction period on-road vehicles would be used or materials would be hauled. Total annual NO_x, VOC and SO_2 emissions resulting from all on-road construction period vehicle operations within the DFW and HGB ozone nonattainment areas and SO_2 nonattainment area are shown in **Table 3.2-9**.

Table 3.2-9: Annual On-Road Construction Period Vehicle Emissions (tons/year)[a]

Construction Activity	DFW NAA[b]		HGB NAA[c]		Freestone Co. NAA
	NO_x (tons)	VOC (tons)	NO_x (tons)	VOC (tons)	SO_2 (tons)
Truck Hauling	14.99	1.97	10.85	1.45	0.0023
On-Road Vehicles - Track	11.97	6.29	10.76	5.48	0.0025
On-Road Vehicles - Station	2.40	1.24	1.94	1.00	0
On-Road Vehicles - TMF	1.29	0.65	1.05	0.53	0
On-Road Vehicles - MOW	2.49	1.29	2.53	1.27	0
Total	**33.14**	**11.44**	**27.13**	**9.73**	**0.0048**

Source: AECOM, 2016
Notes:
[a] These construction emissions were estimated for Alternative C, which is used as a proxy to estimate construction emissions for all other alternatives. Total construction emissions of NOx, VOC and SO_2 from all other alternatives would be lower and are estimated to differ from Alternative C by less than 2.2 percent.
[b] The applicable DFW NAA counties are Dallas and Ellis counties.
[c] The applicable HGB NAA counties are Harris and Waller counties.

3.2.5.2.3 Freight Rail Material Hauling Emissions

Table 3.2-10 shows the annual locomotive line-haul emissions of NO_x and VOC within the DFW and HGB ozone nonattainment areas and SO_2 nonattainment area. GHG emissions are reported separately in **Section 3.21, Greenhouse Gas Emissions and Climate Change.** Emissions were calculated for the maximum amount of material hauled during any given year and using year 2018 emission factors. Year 2018 would be the first year that ballast and aggregate materials would be required for construction, and emission factors for that year would be the most conservative within the construction schedule because future emissions would be expected to decrease each year as rail vehicle technology improves. The detailed results from the locomotive emission calculations are provided in **Appendix E, Air Quality Technical Memorandum**.

Table 3.2-10: Annual Locomotive Line-Haul Emissions from Construction Activities During Period 2018–2021a (tons/year)

Construction Activity	DFW NAA[b]		HGB NAA[c]		Freestone Co. NAA[d]
	NO_x (tons)	VOC (tons)	NO_x (tons)	VOC (tons)	SO_2 (tons)
Material Hauling	3.27	0.17	4.89	0.26	0

Source: AECOM, 2016
Notes:
[a] These construction emissions were estimated for Alternative C, which is used as a proxy to estimate construction emissions for all other alternatives. Total construction emissions of NO_x, VOC and SO_2 from all other alternatives would be lower and are estimated to differ from Alternative C by less than 2.2 percent.
[b] The applicable DFW nonattainment area counties for rail line-haul emissions are Dallas and Ellis counties.
[c] The applicable HGB nonattainment area counties for rail line-haul emissions are Harris and Waller counties.
[d] Locomotives are not expected to operate within the SO_2 nonattainment area of Freestone County.

Table 3.2-11 shows a summary of NO_x, VOC and SO_2 emissions within the nonattainment areas. Maximum annual emissions from off-road construction equipment, on-road construction vehicles and locomotive hauling within the respective nonattainment area are included. Detailed analysis of the construction emissions can be found in **Appendix E, Air Quality Technical Memorandum.**

Table 3.2-11: Maximum Annual Construction Period Emissions for Years 2018–2021a (tons/year)

Construction Activity	DFW NAA[b]		HGB NAA[c]		Freestone Co NAA
	NO_x (tons)	VOC (tons)	NO_x (tons)	VOC (tons)	SO_2 (tons)
Off-Road Construction Equipment	62.72	5.20	63.74	5.28	0.0011
On-Road Construction Vehicles	33.14	11.44	27.13	9.73	0.0048
Locomotive Hauling	3.27	0.17	4.89	0.26	0
Total	**99.13**	**16.81**	**95.76**	**15.27**	**0.0059**

Source: AECOM, 2016
Notes:
[a] These construction emissions were estimated for Alternative C, which is used as a proxy to estimate construction emissions for all other alternatives. Total construction emissions of NO_x, VOC, and SO_2 from all other alternatives would be lower and are estimated to differ from Alternative C by less than 2.2 percent.
[b] The applicable DFW nonattainment area counties are Dallas and Ellis counties.
[c] The applicable HGB nonattainment area counties are Harris and Waller counties.

As shown in **Table 3.2-11**, there would be an increase in NO_x, VOC and SO_2 emissions during the construction period in the DFW and HGB nonattainment areas as a result of the Build Alternatives. Therefore, an adverse short-term (48 month) impact would occur.

3.2.5.2.4 Operational Emissions

For future train operation emissions, Build Alternative A power consumption was used, as TCRR estimated it to have the highest power consumption amongst the Build Alternatives. This alternative had the combination of facility numbers and size that resulted in the highest estimated power consumption. Therefore, it was used as a proxy to estimate operation emissions for all Build Alternatives.

The methods described in **Section 3.2.3.2** were used to estimate operational emissions. The results for train operation emissions are shown in **Table 3.2-12** below.

Table 3.2-12: Train Operations Emissions								
Emissions (tons per year)								
NO_x	**VOC**	**PM_{10}**	**SO_2**	**CO**	**CO_2**	**CH_4**	**N_2O**	**CO_{2eq}**
Year 2024 (Initial Service Level)								
43.6	5.3	6.0	113.6	38.9	131,819	2.5	1.5	132,316
Year 2040 (Future Service Level)								
16.9	4.4	3.0	34.0	30.0	96,354	2.6	1.1	96,747

Source: AECOM, 2016

For vehicle emissions reductions, the resultant emissions factors generated for the DFW and HGB nonattainment area counties in the air quality Study Area, for January and July, were averaged to provide emission factors for each of the NAA areas for the criteria pollutants, expressed as grams per mile (g/mile) and converted to pounds per mile (lbs/mile), and are shown in **Appendix E, Air Quality Technical Memorandum (Table E3.2-13** and **Table E3.2-14)**. The total annual VMT avoided and emission factors were used to calculate the emissions that would have occurred in the absence of the Build Alternatives, as shown in **Table 3.2-13**.

Table 3.2-13: 2040 Passenger Vehicle Emissions Reduction							
Emissions (tons per year)							
VMT	**CO**	**NO_x**	**VOC**	**PM_{10}**	**$PM_{2.5}$**	**SO_2**	**CO_{2eq}**
Year 2024 (Initial Service Level)							
Houston Trip Emissions							
829,816,507	1,883.8	110.3	99.6	31.9	7.2	1.8	274,762
Dallas Trip Emissions							
730,057,145	1,618.9	93.6	84.1	28.0	6.4	1.6	233,362
TOTAL	3,502.7	203.9	183.7	59.9	13.5	3.4	508,124
Year 2040 (Future Service Level)							
Houston Trip Emissions							
1,357,881,279	937.3	26.3	81.7	49.4	8.8	2.0	291,898
Dallas Trip Emissions							
1,194,638,721	1,153.1	44.4	84.2	43.4	8.3	1.8	264,249
TOTAL	**2,090.4**	**70.7**	**165.8**	**92.8**	**17.1**	**3.8**	**556,147**

Source: AECOM, 2016

The train operation emissions represent increases in emissions due to the Build Alternatives. The vehicle emissions reduction represents emissions reduced by the Build Alternatives. Vehicle VMT reduction emissions were subtracted from the train operation emissions to calculate net emissions due to implementation of the Build Alternatives. **Table 3.2-14** shows the results using the 2024 and 2040 train operations emissions and 2024 and 2040 passenger vehicles emissions reductions calculated above.

Table 3.2-14: 2040 Net Operational Emissions (tons per year)					
NO_x	VOC	PM_{10}	SO_2	CO	CO_{2eq}
Year 2024 (Initial Service Level)					
(160.3)	(178.3)	(53.9)	110.2	(3,464)	(375,808)
Year 2040 (Future Service Level)					
(53.8)	(161.4)	(89.7)	30.3	(2,060)	(459,401)

Source: AECOM, 2016
Note: ( ) represents a net reduction in emissions

As shown in **Table 3.2-14**, there would be net reductions of all the estimated criteria pollutants except SO_2. This is consistent with other HSR projects proposed in California, comparing train power consumption emissions versus vehicle emissions.[43, 44] This net increase in SO_2 would occur because electric power generation from coal produces significantly more SO_2 than other forms of power generation, and passenger vehicles produce very little SO_2 due to the nature of the fuel, its refinement, and car emission controls. Even in places where coal constitutes a small percentage of power generation, power consumption for traction and station power would still produce more SO_2 than vehicles eliminated by travel mode shift.[45] The emissions would be relatively small. One county (Freestone) in the air quality Study Area is in nonattainment of the SO_2 standard and emissions would be below *de minimis* as discussed in **Section 3.2.5.2.6**, and the Build Alternatives would result in net reduction of all the other pollutants. For NO_x, VOC and CO, the net reductions in 2024 are greater than in 2040, despite ridership and VMT reduction being greater in 2040. This is because the vehicle emissions of cars improve more drastically in 2040 compared to 2024, making the potential emissions that would be reduced by taking cars off the road, smaller. For example, the NO_x emission factor drops by an order of magnitude from 2024 to 2040, countering the effects of greater ridership. By contrast, the train NO_x emissions factor only drops by roughly half. For the other pollutants, the relative drop in emissions rates from 2024 to 2040 would be smaller, and the increase in ridership helps make emissions smaller or have greater net reduction. Most criteria pollutant emissions would be reduced over the long-term under the Build Alternatives. Therefore, no adverse significant long-term impact would occur.

3.2.5.2.5 Mobile Source Air Toxics

The Build Alternatives have a low potential for MSAT impacts. Accordingly, a qualitative analysis was used to provide a basis for identifying and comparing the potential differences among MSAT emissions, if any, for the Build Alternatives.

The Build Alternatives would provide another option for intercity travel between Dallas and Houston that would emit air pollutants, including MSATs, into the atmosphere. However, the Build Alternatives would decrease overall VMT from passenger vehicles compared to the No Build Alternative, thereby decreasing regional MSAT emissions generated by passenger vehicles, and consequently have a beneficial impact on regional MSAT emissions.

[43] California High-Speed Rail Authority and USDOT Federal Railroad Administration. 2012. FINAL California High-Speed Train Project Environmental Impact Report/Environmental Impact Statement, Merced to Fresno Section Project EIR/EIS.
[44] USDOT Federal Railroad Administration. 2011. Final Environmental Impact Statement and Final Section 4(f) Evaluation for the Proposed DesertXpress High-Speed Passenger Train Victorville, California to Las Vegas, Nevada.
[45] California High-Speed Rail Authority and USDOT Federal Railroad Administration. 2012. FINAL California High-Speed Train Project Environmental Impact Report/Environmental Impact Statement, Merced to Fresno Section Project EIR/EIS.

During the construction period, increases in MSAT emissions would occur from construction activities. The primary construction period emissions of MSATs would be diesel PM from diesel powered construction equipment used to construct the track, bridges, stations and MOW facilities. The potential impacts of MSAT emissions would be minimized by using latest model construction equipment to the greatest extent possible and compliance with Texas low emission diesel fuel standards. In addition, the Texas Emissions Reduction Plan (TERP) provides financial incentives to reduce emissions from vehicles and equipment. TCEQ encourages construction contractors to use this and other local and federal incentive programs to the fullest extent possible to minimize diesel emissions. However, considering the temporary and transient nature of construction period emissions, the use of late model construction equipment, the encouragement of the use of TERP, compliance with applicable regulatory diesel fuel requirements and the small ratio of construction equipment MSAT emission sources to total on-road MSAT emission sources in a given area, it is anticipated that emissions from construction of the Build Alternatives would have no significant impact on total MSAT emissions in the air quality Study Area.

The operation of the train propulsion technology used by the Build Alternatives would not have combustion emissions, so no direct MSAT emissions would occur during operation. The potential MSAT emission sources during operation of the Build Alternatives would be from vehicles used at MOW facilities and passenger vehicles traveling to and from these facilities, and the passenger vehicles and buses travelling to and from the stations. Buses serving the stations would be fueled by a mixture of diesel and natural gas; however, the number of diesel buses serving each station would not generate a substantial amount of diesel PM emissions when compared to the total vehicle activity on nearby roadways.

This evaluation includes a basic analysis of the likely MSAT emission impacts of the Build Alternatives. The lack of a national consensus on an acceptable level of risk and other air quality criteria assumed to protect the public health and welfare, as well as the unreliability of available technical tools, does not allow predicting, with confidence, the project-specific health impacts of the emission changes associated with the Build Alternatives.[46] The outcome of such an assessment would be influenced more by the uncertainty introduced into the process by the assumptions made rather than from insight into the actual health impacts from MSAT exposure directly attributable to the Build Alternatives.[47] As reductions in regional MSAT emissions are predicted with the Build Alternatives, further MSAT analysis would not be suggested even if it were practicable to accomplish.

3.2.5.2.6 Compliance with General Conformity Rules

As discussed in **Section 3.2.2**, projects requiring approval or funding from federal agencies that would be in areas designated as nonattainment or maintenance for the NAAQS are subject to the EPA's Conformity Rule.

General conformity is concerned with two types of emissions, direct and indirect, which are evaluated on an annual, calendar-year basis. For the Project, direct emissions, resulting from construction of the track, stations, TMFs, MOWs, bridges and roadway crossings, would occur over a 48-month construction period from 2018 to 2021. Subsequent years would realize only indirect emissions resulting from the operation of the Build Alternatives and reduction of passenger vehicle emissions within the DFW and

[46] FHWA. 2016. Updated Interim Guidance on Mobile Source Air Toxic Analysis in NEPA Documents. Available at: http://www.fhwa.dot.gov/environment/air_quality/air_toxics/policy_and_guidance/msat
[47] Ibid.

HGB ozone nonattainment areas and SO_2 nonattainment area. General conformity guidance requires conformity determinations for (1) the year(s) during which the total of direct plus indirect emissions are estimated to be the greatest on an annual basis and (2) the attainment year specified in the applicable SIP. The total of direct emissions would be greatest during the 2018-2021 construction period. Total indirect emissions would be greatest once the Build Alternatives achieve the maximum service level with the greatest amount of ridership and train operations, which is assumed to occur by 2040. According to the TCEQ, the 2008 ozone standard attainment date as specified in the latest DFW SIP is July 20, 2018.[48] The 2008 ozone standard attainment date as specified in the latest HGB SIP is July 20, 2015.[49] Because the latest SIP attainment dates occur either prior to or during the construction period, only emissions generated during the construction phase and emissions associated with maximum operational conditions were compared to the threshold values to determine whether the General Conformity Rule would apply.

Direct (Construction) Emissions in the Nonattainment Areas

Table 3.2-15 presents the results of the maximum annual direct (construction-related) emissions from the Build Alternatives. As shown, maximum annual direct (construction-related) NO_x, VOC and SO_2 emissions within the DFW and HGB ozone nonattainment areas and the Freestone County SO_2 nonattainment area during the four year construction period would be less than the respective general conformity *de minimis* threshold level. The emissions shown are the maximum construction-related emissions occurring during any year of construction. Annual construction-related emission calculations are provided in **Appendix E, Air Quality Technical Memorandum.**

[48] Dallas-Fort Worth: Current Attainment Status. October 14, 2015. https://www.tceq.texas.gov/airquality/sip/dfw/dfw-status (accessed May 27, 2016).
[49] Houston-Galveston-Brazoria: Current Attainment Status. October 14, 2015. https://www.tceq.texas.gov/airquality/sip/hgb/hgb-status (accessed May 27, 2016).

Table 3.2-15: Maximum Annual Construction-Related Emissions for Years 2018 – 2021[a] by Nonattainment Area

Emission Source	NO_x (tons)	VOC (tons)	SO_2 (tons)
DFW NAA[b]			
Non-Road Vehicles & Activities	62.72	5.20	--
On-Road Vehicles	33.14	11.4416	--
Locomotive Hauling	3.27	0.17	--
Total	**99.13**	**16.81**	**--**
GC *de minimis* level	100	100	--
Exceeds GC threshold?	No	No	--
HGB NAA[c]			
Non-Road Vehicles & Activities	63.74	5.28	--
On-Road Vehicles	27.13	9.73	--
Locomotive Hauling	4.89	0.26	--
Total	**95.76**	**15.27**	**--**
GC *de minimis* level	100	100	--
Exceeds GC threshold?	No	No	--
Freestone County NAA			
Non-Road Vehicles & Activities	--	--	0.0011
On-Road Vehicles	--	--	0.0048
Locomotive Hauling	--	--	0
Total	--	--	0.0059
GC *de minimis* level	--	--	100
Exceeds GC threshold?	--	--	No

Source: AECOM, 2016
Notes: GC: General Conformity
[a] These construction emissions were estimated for the Build Alternative C, which is used as a proxy to estimate construction emissions for all other alternatives. Total construction emissions of NO_x, VOC and SO_2 from all other alternatives are lower and estimated to differ from Alternative C by less than 2.2 percent.
[b] The applicable DFW NAA counties are Dallas and Ellis counties.
[c] The applicable HGB NAA counties are Harris and Waller counties.

Indirect (Operational) Emissions in the Nonattainment Areas

Because not all of the Build Alternatives' length would be located in a nonattainment area, operational emissions attributable to the nonattainment areas in the air quality Study Area had to be estimated. Emissions due to train and station power consumption of electricity from the power grid are relatively indirect effects spatially since they would occur at distant power plants located away from the Build Alternatives. These emissions would occur at the power plants meeting the operational demand at any particular time that the trains and stations would be operating, which can be any number of regional power plants connected to the ERCOT grid. Therefore, it would be impractical to identify or directly attribute the Build Alternatives' power demand throughout the year to any particular set of power plants within ERCOT. However, two assumptions were analyzed for the fraction of power used by the Build Alternative being supplied by power plants in the nonattainment area counties using the most current plant-level eGRID data for ERCOT to calculate the fractions under two basic assumptions.[50]

The first assumption was that the Build Alternatives would draw power from the ERCOT grid uniformly from plants in the nonattainment areas as their percentages of total annual ERCOT power. This was calculated using the same methods described above using the projected 2024 and 2040 EFs for NO_x, VOC, and SO_2 and applying the resultant percentages for DFW (8 percent), HGB (21 percent) and

[50] U.S. Environmental Protection Agency (EPA). 2016. eGRID. Online database available at https://www.epa.gov/energy/egrid (accessed February 2016).

Freestone-Anderson (3 percent) to the total train power consumption. The second assumption was that traction, switching and signaling power for the trains would draw uniformly from plants along the Build Alternatives evenly, but station and TMFs were assumed to draw from plants in their respective locations. The emissions were calculated using the same methods described in above using the projected 2024 and 2040 EFs for NO_x, VOC and SO_2 and applying the train power consumptions equally to plants along the Build Alternatives, and the power consumption of stations and TMFs in their respective nonattainment areas. The second assumption resulted in higher emissions and is shown for conformity purposes in **Table 3.2-16** below. The full details of calculations for both assumptions are provided in **Appendix E, Air Quality Technical Memorandum (Table E3-18)**.

Vehicle emissions were calculated using the portion of emissions that would occur within the segment lengths of IH-45 within the nonattainment areas, and assuming the vehicle trip activity in each nonattainment area would be comprised of local cars leaving, then returning to the nonattainment area, and visiting cars arriving then departing the nonattainment area through the associated lengths of IH-45. In the case of the Freestone-Anderson nonattainment area, the vehicles originating from Dallas and Houston would pass through Freestone County on their departure and arrival trips for the portion of IH-45 through Freestone County. IH-45 does not pass through Anderson County. The segment lengths, arriving/leaving/passing assumptions and numbers of annual vehicles from each nonattainment area city used in the vehicle emissions analysis described above, were used to calculate the VMT. The same 2024 and 2040 EFs and methodology from above were then used to calculate the emissions. **Table 3.2-16** below provides the results of the estimated emissions. The full details of calculations for nonattainment area vehicle emissions reduction are provided in **Appendix E, Air Quality Technical Memorandum (Table E3-19)**.

The 2024 and 2040 train operation emissions and vehicle emissions reduction for each nonattainment area were then used to calculate the net operational emissions within each nonattainment area. The results are provided in **Table 3.2-16** below. Net reductions are shown for all pollutants except SO_2. The increase in SO_2 would be comparatively negligible and well below the current moderate nonattainment threshold of 100 TPY. Operational emissions of the regulated pollutants in nonattainment areas due to the Build Alternatives are below *de minimis* thresholds.

Table 3.2-16: Maximum Indirect (Operational) NAA Emissions									
NAA	Train Operation Emissions (TPY)			Vehicle Emissions (TPY)			Net Emissions (TPY)		
	NO_x	VOC	SO_2	NO_x	VOC	SO_2	NO_x	VOC	SO_2
de Minimis Thresholds									
GC *de minimis* level	100	100	100	100	100	100	100	100	100
Emissions for Year 2024 (Initial Service Level)									
DFW	16.6	2.0	--	-34.6	-31.1	--	-18.1	-29.1	--
HGB	12.0	1.5	--	-73.4	-66.3	--	-61.4	-64.8	--
FRE	--	--	11.9	--	--	-0.45	--	--	11.4
Exceeds GC threshold?	No	No	No	No	No	No	No	No	No
Emissions for Year 2040 (Future Service Level)									
DFW	6.3	1.6	--	-12.2	-28.7	--	-6.0	-27.1	--
HGB	4.3	1.1	--	-25.0	-58.7	--	-20.7	-57.6	--
FRE	--	--	4.0	--	--	-0.5			3.5
Exceeds GC threshold?	No	No	No	No	No	No	No	No	No

Source: AECOM, 2016

General Conformity Applicability Determination and Impact

As shown in **Table 3.2-15**, maximum annual construction period emissions within the DFW and HGB ozone nonattainment areas and SO_2 nonattainment area would be less than the respective general conformity pollutant threshold values for all years of construction. For operational emissions, 40 CFR 93.153(d)(1) states that the portion of an action that includes major or minor new or modified stationary sources that require a permit under the new source review program or the prevention of significant deterioration program of the CAA, is exempt from the general conformity rules. Power plants are permitted as stationary sources under these programs and emissions from them would therefore be exempt. As such, the remaining operational emissions would consist of vehicle emissions reductions, and could therefore not exceed *de minimis* thresholds. However, operational analysis included the power plant emissions for demonstration, even though they do not technically apply to determining general conformity applicability. **Table 3.2-16** shows that maximum annual operational indirect emissions within the DFW, HGB and FRE nonattainment areas would also be less than the respective general conformity threshold values for NO_x, VOC and SO_2. Therefore, a formal conformity determination would not be necessary for the Project and additional NO_x, VOC and SO_2 analyses would not be required. Since NO_x, VOC and SO_2 emissions would be less than *de minimis*, the Build Alternatives would not cause new violations or exacerbate an existing violation of any criteria pollutant. The impact would be not significant considering that the emissions are less than the NAA regional threshold requiring further evaluation and comparison to the NAA's budget of pollutant emissions needed to attain air quality standards. Therefore, these emissions would not be expected to be of sufficient magnitude or intensity to jeopardize achieving air quality standards in the region.

3.2.6 Avoidance, Minimization and Mitigation

In an effort to minimize on-road vehicle emissions and construction period traffic impacts to benefit local air quality, TCRR shall transport most of the Build Alternatives construction materials using freight rail.

Operation of the Build Alternatives would generally improve air quality compared to the No Build Alternative because of the reduction in regional emissions that would occur due to a shift from passenger vehicle traffic to the HSR system. However, construction of the Build Alternatives would increase local and regional emissions of particulate matter (fugitive dust) and pollutant emissions from fuel combustion (diesel PM, CO, CO_2, NO_x, VOCs, and sulfur compounds). TCRR shall implement best management practices (BMPs) as described in the following sections to reduce potential short-term air quality impacts associated with construction activities. In addition, TCRR shall conduct all construction and waste disposal activities in accordance with applicable local, state and federal statutes and regulations. As such, TCRR shall implement the following compliance and mitigation measures to minimize potential short-term air quality impacts during the construction phase of the Project.

3.2.6.1 Compliance Measures

The following compliance measures would be required for the Build Alternatives A through F.

AQ-CM#1: Texas Low Emission Diesel Fuel (TxLED) Program. The TxLED Program was implemented to reduce emissions of nitrogen oxides from diesel-powered motor vehicles and non-road equipment operating in 110 central and eastern Texas counties, including all counties in which the HSR project would operate. The TCEQ administers and has oversight of the TxLED Program. TCRR and its construction contractor shall adhere to the Texas Low Emission Diesel Fuel Program for all diesel fuel on-road motor vehicles and non-road construction equipment.

WQ-CM#1: Stormwater BMPs that would minimize fugitive dust are discussed in **Section 3.3.6.1, Water Quality**.

3.2.6.2 Mitigation Measures

The short-term emission increases during the construction period would be reduced through the implementation of the following mitigation measures for Build Alternatives A through F:

AQ-MM#1: Dust suppression techniques. During the construction period, TCRR and its construction contractor shall cover and/or treat disturbed areas with dust suppression techniques, including but not limited to: soil binders, sprinkling, watering and/or chemical stabilizer/suppressants. This shall also include effectively controlling fugitive dust emissions by the application of water, presoaking, or other dust suppression technique during all clearing, grubbing, scraping, excavation, grading, cut and fill, and demolition activities. If winds are greater than 25 mph, the construction contractor shall either soak the exposed work area or suspend dust-generating activities.

AQ-MM#2: Materials transport. During construction, TCRR and its construction contractor shall cover or effectively wet all materials transported offsite or within the construction site to limit visible dust emissions.

AQ-MM#3: Construction off-road vehicle speed limitations. During construction, TCRR and its construction contractor shall limit vehicle travel speeds on unpaved roads to 15 mph.

AQ-MM#4: Road surface maintenance. During construction within urban areas, TCRR and its construction contractor shall promptly remove trackout of soil on area roadways when it extends 50 or more feet from the construction site and at the end of each workday.

AQ-MM#5: Construction equipment. During construction, TCRR and its construction contractor shall limit idling of construction equipment during periods when the equipment is inactive, and properly maintain construction equipment in accordance with the manufacturer's specifications.

AQ-MM#6: Ground disturbing activities. During the construction period, TCRR and its construction contractor shall phase ground disturbing activities to the greatest extent possible to reduce the amount of disturbed surfaces at any one time.

Implementation of the above mitigation measures during construction period would reduce localized PM_{10} and $PM_{2.5}$ emissions by reducing fugitive dust and exhaust from construction and on-road vehicles. These mitigation measures could also reduce the quantity of other criteria pollutants (NO_x, VOC and CO) and GHG emissions by limiting idling or otherwise controlling exhaust emissions from construction and on-road vehicles.

No new air quality violations of the NAAQS would occur during operation of the Build Alternatives; therefore, no adverse significant long term operational impacts would occur and thus, no operational mitigation measures would be required.

3.2.7 Build Alternatives Comparison

The lengths of the Build Alternatives vary by no more than approximately 5.35 miles; therefore, the differences in criteria pollutant emissions produced from power consumption to propel trains those extra distances would not be substantial. In fact, the maximum power consuming Build Alternative and the least consuming Build Alternative vary by one percent in annual power consumption. The travel time differences at HSR speeds would be on the order of 1.5 to 2 minutes, which would be insignificant to an approximate 90-minute trip time. Given the negligible travel time differences and same station locations, ridership would be expected to be the same among Build Alternatives A through F. Therefore, criteria pollutant emissions reduction from travel mode shift would be expected to be similar between the Build Alternatives. The following discusses the minor difference expected among the Build Alternatives.

Build Alternatives A, B, D and E would be essentially the same length (varying by approximately 1 mile or less) and would have slightly shorter routes than Build Alternatives C and F. Emissions from train power consumption would be negligibly lower than emissions from the slightly longer Build Alternatives C and F. Therefore, emissions reduction due to shift in travel mode from vehicles to train would be expected to be the same as the other Build Alternatives. Overall, a net substantial reduction in emissions would occur with implementation of any of the Build Alternatives.

Construction emissions would also vary by Build Alternative. As described in **Section 3.2.3.1 Construction Emissions Methodology**, construction emissions were estimated for Build Alternative C because this alternative is comprised of the longest track distance and was therefore used as a proxy to estimate construction emissions for all Build Alternatives. Based on the Build Alternative C emissions analysis, maximum annual construction period emissions within the DFW and HGB nonattainment areas would be less than the respective general conformity threshold values for both NO_x and VOC for all years of construction. Construction-related emissions would be lower for all other Build Alternatives. All Build Alternatives would have a construction period impact for NO_x, VOCs, and MSATs; however, these impacts would be short-term and localized and would not be significant.

3.3 Water Quality

3.3.1 Introduction

This section evaluates surface water quality, groundwater quality and water supply. Surface water is defined as water on the surface of the ground, such as streams and ponds, whereas groundwater lies beneath the surface and is stored in geological formations called aquifers that transmit groundwater to sources, such as wells and springs.[1] Water quality is a measure of the suitability of a waterbody to be used for a particular purpose based on its chemical, physical and biological characteristics.[2] For the purpose of this analysis, waterbodies include rivers, streams, canals, lakes, drinking water reservoirs and retention and detention basins under the jurisdiction of the U.S. watersheds, including all waterbodies that drain to a certain point and the connected groundwater features. Poor water quality in a waterbody has the potential to influence the quality of other waterbodies throughout the watershed.

Surface water resources in this chapter are organized by watersheds from north to south rather than by county and Build Alternative segment to account for the influence of water quality on the watershed as a whole. Similarly, groundwater resources are organized by aquifers from north to south. Surface water in watersheds interacts with groundwater. Groundwater from aquifers can discharge to surface water in watersheds when groundwater levels are close to the surface, and surface water can drain or seep to groundwater through soils and man-made vessels, such as wells. An analysis by watershed and aquifer was selected because this best represented direct, indirect and cumulative effects to surface water and groundwater resources.

3.3.2 Regulatory Context

Federal

Clean Water Act of 1972

The Clean Water Act (33 U.S.C. §§1251-1387) is the primary federal law that protects the nation's waters. Section 303 and 501 of the Clean Water Act give the EPA and its delegates the responsibility to create programs to protect and restore water quality, including monitoring and assessing the nation's waters and reporting on their quality. TCEQ implements the Surface Water Quality Monitoring Program to fulfill the requirements of Clean Water Act Section 305(b). Through a data sharing process, TCEQ monitors data from total maximum daily load (TMDL)[3,4] and Nonpoint Source programs; EPA; U.S. Geologic Survey (USGS); and the Clean Rivers Program collected by river authorities and local partner agencies. The data is used to evaluate compliance with Texas Surface Water Quality Standards.[5]

[1] USGS. "Water Science Glossary of Terms." last updated November 06, 2015. http://water.usgs.gov/edu/dictionary.html.
[2] Ibid.
[3] U.S. Environmental Protection Agency, "Impaired Waters and TMDLs," last updated December 1, 2015, http://www.epa.gov/tmdl/impaired-waters-and-tmdls-program-overview-introduction.
[4] TMDL is a planning tool that includes a calculation of the maximum amount of a pollutant that can be present in a waterbody and still meet water quality standards.
[5] Texas Commision on Environmental Quality. "Texas Surface Water Quality Monitoring and Assessment Strategy FY 2012-2017, Rev. 1," Austin, TX: TCEQ Water Quality Planning Division, December 2013. https://www.tceq.texas.gov/assets/public/waterquality/swqm/monitor/swqm_strategy.pdf.

Sections 303(d) and 305(b) of the Clean Water Act require states to identify water bodies that do not meet federal water quality standards. States must develop TMDLs for pollutants that exceed water quality standards in those water bodies. The TCEQ routinely monitors surface water quality in the state and conducts biannual assessments to comply with Section 305(b) of the Clean Water Act. The status of the Texas' surface water quality is reported to EPA in *The State of Texas Surface Water Quality Inventory*, known as the 305(b) Report, published every two years. The biennial 305(b) assessment identifies those surface water resources not meeting their designated uses. According to the Clean Water Act, waters not meeting their intended use are listed as impaired water bodies in reference to Section 303(d) of the CWA.[6] The 2014 report was approved by the EPA on November 19, 2015.[7]

Section 404 of the Clean Water Act regulates the discharge of dredged or fill material into waters of the U.S.; therefore, site grading activities may require permit authorization from the USACE.[8] The Build Alternatives would be located within the jurisdictional areas of the USACE Fort Worth and Galveston districts. It is anticipated that Section 404 permits would be required from these districts prior to construction. As part of Section 404 compliance, Section 401 of the Clean Water Act regulates the discharge of pollutants into waters of the U.S. and is enforced by TCEQ. Tier I projects are those that affect less than 3 acres of waters in the state and/or less than 1,500 linear feet of streams, and Tier II projects are those that affect greater than 3 acres of waters in the state, and/or greater than 1,500 feet of streams. Tier I projects require the use of TCEQ approved best management practices and Tier II projects require the use of TCEQ approved best management practices and an individual certification review by TCEQ.[9]

The Texas Water Code[10] establishes provisions to maintain and control water quality in the State of Texas. The Texas Water Code makes it unlawful to discharge pollutants into or adjacent to any water in the state unless authorized by a rule, permit or order.[11] In accordance with Section 402 of the Clean Water Act, the State of Texas maintains permitting authority under the National Pollutant Discharge Elimination System (NPDES). TCEQ's Texas Pollutant Discharge Elimination System (TPDES) program has federal regulatory authority over discharges of pollutants to Texas surface waters, with the exception of discharges associated with oil, gas and geothermal exploration and development activities, which are regulated by the Railroad Commission of Texas.[12] Stormwater discharges are considered a point source of pollutants during construction and require permitting under TPDES. TPDES permits require that a project develop and implement a Stormwater Pollution Prevention Plan (SWPPP) prior to and during construction activities.[13] The TCEQ TPDES General Construction Permit (TXR150000) applies to small construction activities that disturb between 1 and 5 acres of land and large construction activities which disturb 5 or more acres.

[6] Texas Commision on Environmental Quality. "2014 Texas Integrated Report for the Clean Water Act Sections 305(b) and 303(d)," last updated December 4, 2015, Accessed December 7, 2015, https://www.tceq.texas.gov/waterquality/assessment/14twqi/14txir.
[7] Texas Commission on Environmental Quality, "2014 Texas Integrated Report Index of Water Quality Impairments," November 19, 2015, Accessed: December 7, 2015, https://www.tceq.texas.gov/assets/public/waterquality/swqm/assess/14txir/2014_imp_index.pdf.
[8] U.S.C. *Clean Water Act, Title 33, Part 1251 et seq*. U.S. Government Publishing Office, 1972.
[9] C.F.R. *Water Pollution Prevention and Control Title 33 C.F.R. Section 1341*. U.S. Government Publishing Office, 1994.
[10] Water Quality Control, *Texas Water Code*, Title II, Subtitle D, Chapter 26, http://www.statutes.legis.state.tx.us/Docs/WA/htm/WA.26.htm.
[11] Texas Commission on Environmental Quality, "Stormwater Discharges from Construction Activities - TXR150000." *Storm Water.* February 13, 2013, Accessed January 18, 2016, http://www.tceq.state.tx.us/assets/public/permitting/stormwater/TXR150000_Fact_13.pdf.
[12] Texas Commission on Environmental Quality, "What Is The "Texas Pollutant Discharge Elimination System (TPDES)"?," last updated October 7, 2015, http://www.tceq.state.tx.us/permitting/wastewater/pretreatment/tpdes_definition.html.
[13] Texas Commission on Environmental Quality, "TXR150000." *Storm Water.* February 13, 2013, Accessed January 18, 2016, http://www.tceq.state.tx.us/assets/public/permitting/stormwater/TXR150000_Fact_13.pdf.

Safe Drinking Water Act

The Safe Drinking Water Act of 1974, amended in 1986 and 1996, (42 U.S.C. §300f et seq.) is a federal law that sets drinking water quality standards for all public water systems in the U.S.[14] The EPA sets standards for drinking water quality and then oversees states' implementation of programs to protect water quality. The Safe Drinking Water Act protects drinking water sources including rivers, lakes, reservoirs, springs and groundwater wells; it does not regulate private wells serving less than 25 individuals. Construction or potential releases of water priority chemicals can alter source water quality and, in turn, affect public water supplies. The EPA adopts rules under the Safe Drinking Water Act and the State of Texas must adopt regulations of the same standard. The rules and regulations for public water systems are established by TCEQ in 30 TAC Chapter 290.[15]

TCEQ created the Source Water Assessment and Protection Program to fulfill the 1996 Amendments to the Safe Drinking Water Act requirements to assess public drinking water sources for susceptibility to certain chemical constituents.[16] A major component of the Source Water Assessment and Protection Program is the Wellhead Protection Program, which is designed to protect groundwater sources of drinking water. The program sets public health protection measures to ensure safe drinking water from groundwater public drinking water supplies.

State

Regional Water Supply Planning

In 1997, the State of Texas established a regional water planning approach through Senate Bill 1.[17] Following the approach outlined in the bill, the Texas Water Development Board (TWDB) divided Texas into 16 regional planning areas with designated regional water planning groups for each of these areas. The planning groups identify water demands and water management strategies through evaluating population projections, water demand projections and existing water supplies that would be available during times of drought. Each group compiles its findings into a regional water plan and submits the plan to the TWDB every five years. The TWDB adopts each regional plan and creates a comprehensive state water plan to address the projected demands resulting from population and infrastructure changes.[18]

Groundwater Conservation Districts

Texas Groundwater Conservation Districts (GCD*s*) were created by the Texas Legislature to preserve and protect groundwater and are granted authority in Chapter 36 of the Texas Water Code.[19] Texas has 100 established GCDs which are authorized with responsibilities to manage groundwater resources. In coordination with surface water management entities, each GCD is required to develop groundwater management plans to address management goals. The TWDB provides assistance to GCDs in the development of management plans and also provides final approval of plans. Other than coordinating with regional planning groups to develop groundwater management plans, the primary duties of each

[14] Texas Natural Resource Conservation Commission. "State of Texas Source Water Assessment and Protection Program Strategy," Austin, TX: Texas Natural Resource Conservation Commission Public Drinking Water Section, Water Utilities Division, February 1999.
[15] Texas Commission on Environmental Quality, "Rules and Regulations for Public Water Systems," last updated. February 23, 2015. Accessed January 22, 2016, https://www.tceq.texas.gov/drinkingwater/pdw_rules.html.
[16] Texas Commission on Environmental Quality, "Source Water Protection," August 06, 2015, Accessed January 22, 2016, https://www.tceq.texas.gov/drinkingwater/SWAP.
[17] Texas Water Development Board. "2017 State Water Plan." Austin, TX. May 2016.
[18] Ibid.
[19] Groundwater Conservation Districts, *Texas Water Code*, Title II, Subtitle E, Chapter 36, http://www.statutes.legis.state.tx.us/Docs/WA/htm/WA.36.htm.

GCD include permitting and registering groundwater wells and adopting and enforcing rules to implement the plan.[20]

Texas Department of Licensing and Regulation

The Texas Department of Licensing and Regulation regulates public water system wells. Requirements for water well drillers in Texas are established under 16 TAC Chapter 76.[21] This code was developed to ensure the quality of the state's groundwater for the safety and welfare of the public.

Local

The Municipal Separate Storm Sewer System (MS4) is a conveyance or system of conveyances, including ditches, curbs, gutters and storm sewers that do not connect with a wastewater collection system or treatment plant. MS4s are operated by public agencies such as cities, flood control districts, counties and federal agencies. Operators of MS4s and discharges within the MS4s are subject to the regulations outlined in 40 C.F.R. Part 122.[22]

3.3.3 Methodology

3.3.3.1 Water Quality Study Area

The LOD of each Build Alternative was the basis for identifying watersheds and groundwater aquifers that could be directly impacted by the Build Alternatives; therefore, the LOD serves as the water quality Study Area for analyzing direct impacts to surface water and groundwater quality. A watershed is an area of land that drains all the streams and rainfall to a common surface water outlet such as the outflow of a reservoir, mouth of a bay, or any point along a stream channel. Effects on water resources, including changes in hydrology and hydraulics, and the effects of pollutants on water quality resulting from development or natural processes can best be understood when considering the combined effects "above" the river-outflow point. Surface water in watersheds and groundwater in aquifers interact through seeps, springs and processes such as groundwater recharge and discharge. Because these resources are fluid through this connectivity and effects on one could impact the larger system, the combined subwatersheds and aquifers intersected by the LOD were evaluated with the Study Area for effects to these systems. The subwatershed was selected because this watershed scale best represented direct, indirect and cumulative effects.

The TCEQ uses a 1,000-foot buffer from waterbody shorelines that may extend upstream to include areas with a 2-hour or less travel time to public water supply intakes to complete source water assessments.[23] The same buffer was applied to the LOD to define the Study Area and identify public water supply intakes that may be directly or indirectly impacted by the Build Alternatives within 1,000 feet of the LOD. This water quality Study Area was also reviewed with reference to surface water quality, groundwater quality and water supply as discussed below.

[20] Texas Commission on Environmental Quality, "What is a Groundwater Conservation District (GCD)?" Groundwater Conservation Districts, January 2016. https://www.tceq.texas.gov/assets/public/permitting/watersupply/groundwater/maps/gcd_text.pdf.
[21] Water Well Drillers and Water Well Pump Installers. *Texas Administrative Code.* Title 16. Chapter 76.
[22] C.F.R. *Protection of the Environment. Title 40 C.F.R. Section 122*. U.S. Government Publishing Office, 2011.
[23] TCEQ, "How to Interpret SWSA Maps." Accessed June 8, 2016, https://www.tceq.texas.gov/drinkingwater/SWAP/swsa_maps.html.

3.3.3.2 Surface Water Quality

Surface water resources were evaluated based on the watersheds and subwatersheds that intersect the LOD of the Build Alternatives. A watershed is the area of land that catches precipitation, including rain and snow, before it drains or seeps into a marsh, stream, river, land or groundwater.[24] Hydrologic units are used to classify water systems. A Hydrologic Unit Code (HUC) identifies unique hydrologic unit drainage areas, ranging from larger, multi-state basis to small watersheds.[25] In Texas, water quality management is typically conducted at the watershed level with influence from local subwatershed management.[26] Watersheds are assigned 8-digit identifications (HUC8) and encompass multiple subwatersheds (HUC12). Subwatersheds are smaller drainage areas, such as a tributary of a creek, which drain into watersheds, larger streams or lakes.

To assess potential impacts to surface water quality, watershed information was obtained from the TCEQ, USGS, EPA and TWDB for all watersheds within the water quality Study Area (Section 3.3.3). In addition, the *2014 Texas Integrated Report Index of Water Quality Impairments* was reviewed to identify threatened or impaired water bodies in the Study Area. Potential direct impacts to water quality were identified by assessing HSR design elements (e.g., crossing methods and the location and placement of piers) of the Build Alternative with analysis of data obtained from the TCEQ, TWDB and EPA, such as locations of impaired waters and watershed boundaries.

3.3.3.3 Groundwater Quality

Surface water and groundwater interact in watersheds; however, groundwater is typically managed by the aquifer it comprises. Therefore, information on the aquifers that intersect the Study Area was reviewed. To assess potential impacts to groundwater quality, the TWDB's well data were reviewed within the Study Area. Potential direct impacts to aquifers were identified by comparing HSR design elements of the Build Alternatives (e.g., pier construction and location) with analysis of data obtained from the TCEQ, TWDB and EPA, such as locations of groundwater wells and aquifer boundaries.

3.3.3.4 Water Supply

GIS data was obtained from the TCEQ and queried to locate all public water supplies within the Study Area. In addition, the Texas Source Water Protection program participants list was reviewed and any public water systems located within the Study Area were identified based on mapped public water systems. Potential direct impacts to water supply, including reservoirs and public supply wells, were identified by comparing HSR design elements of the Build Alternatives (e.g., construction methodology and/or pier placement) with analysis of data obtained from the TCEQ, TWDB and EPA, such as locations of public water supplies and drinking water reservoirs.

[24] Purdue University, "What is a Watershed?" Know Your Watershed*,* 2016, Accessed January 18, 2016, http://www.ctic.purdue.edu/Know%20Your%20Watershed/What%20is%20a%20Watershed?/
[25] U.S. Geological Survey, "Hydrologic Units," Water Resources of the U.S.*,* September 2, 2015. Accessed January 18, 2016, http://water.usgs.gov/GIS/huc.html.
[26] Texas A&M University, "Watershed approach to water quality management" Texas Water, Accessed June 6, 2016, http://texaswater.tamu.edu/surface-water/watershed-water-quality-management.html.

3.3.4 Affected Environment

To assess the existing conditions of surface water quality, groundwater quality and water supply in the Study Area, the following section describes watersheds, subwatersheds and connected aquifers that encompass the Study Area and the associated features, including impaired waters, groundwater wells, reservoirs and public water systems.

3.3.4.1 Surface Water Quality

Water in the water quality Study Area generally drains to the southeast towards the Gulf of Mexico. Nine watersheds (8-digit HUCs) are intersected by the water quality Study Area and are described below. A figure showing the watersheds is provided in **Appendix D, Surface Water Resources Mapbook.**

3.3.4.1.1 Upper Trinity Watershed

The Upper Trinity Watershed (USGS number 12030105) is part of the Upper Trinity River Basin and located in nine counties, including Dallas and Ellis counties. Four smaller watersheds, Lower West Fork Trinity, Elm Fork Trinity, East Fork Trinity and Cedar, drain into the Upper Trinity Watershed. The Upper Trinity Watershed drains into one watershed, the Lower Trinity-Tehuacana Watershed. Eight waterbodies contribute to the Upper Trinity Watershed, including the Trinity River.[27] The Upper Trinity Watershed underlies three of the Build Alternative segments: Segment 1 in Dallas and Ellis counties and Segments 2A and 2B in Ellis County. The following are the subwatersheds contained within the Upper Trinity Watershed that underlie the water quality Study Area:

- Headwaters Turtle Creek (Segment 1 – Dallas County)
- Prairie Creek-Trinity River (Segment 1 – Dallas County)
- Turtle Creek-Trinity River (Segment 1 – Dallas County)
- Deep Branch-Tenmile Creek (Segment 1 – Dallas County)
- Five Mile Creek-Trinity River (Segment 1 – Dallas County)
- Lower Grove Creek (Segments 2A and 2B – Ellis County)
- Middle Red Oak Creek (Segments 1, 2A and 2B – Dallas/Ellis counties)
- Upper Grove Creek (Segments 2A and 2B – Ellis County)
- Upper Red Oak Creek (Segments 2A and 2B – Ellis County)

3.3.4.1.2 Chambers and Richland Watersheds

The Chambers (USGS number 12030109) and Richland (USGS number 12030108) watersheds are also part of the Upper Trinity River Basin. The northernmost portion of the Chambers Watershed begins in Dallas and Johnson counties and extends south and southeast through Hill, Navarro and Ellis counties.[28] The Chambers Watershed underlies portions of five of the Build Alternative segments: Segments 2A, 2B, 3A, 3B, and 3C in Ellis County, and Segments 3A, 3B and 3C in Navarro County. It eventually drains into the Richland Watershed in Hill and Navarro counties. The Richland Watershed extends across Navarro County and continues southeast through two additional counties before discharging into the Lower

[27] U.S. Environmental Protection Agency, "Upper Trinity Watershed -- 12030105, *" last updated* January 7, 2016. Accessed January 7, 2016, http://cfpub.epa.gov/surf/huc.cfm?huc_code=12030105.
[28] U.S. Environmental Protection Agency, "Richland Watershed -- 12030108," Accessed January 7, 2016. http://cfpub.epa.gov/surf/huc.cfm?huc_code=12030108.

Trinity-Tehuacana Watershed.[29] The Richland Watershed underlies portions of Segments 3A, 3B and 3C in Navarro County.

The following are the subwatersheds contained within the Chambers and Richland watersheds that underlie the water quality Study Area:

- Chambers Watershed
  - Lower Big Onion Creek (Segments 2A and 2B – Ellis County)
  - Middle Waxahachie Creek (Segments 2A and 2B – Ellis County)
  - Mustang Creek-Bardwell Lake (Segments 2A and 2B – Ellis County)
  - Cryer Creek-Chambers Creek (Segments 2A, 2B, 3A, 3B and 3C – Ellis/Navarro counties)
  - Briar Creek (Segments 3A, 3B and 3C – Navarro County)
- Richland Watershed
  - Melton Branch-Richland Creek (Segment 3A – Navarro County)
  - Mesquite Creek-Little Pin Oak Creek (Segments 3A, 3B and 3C – Navarro County)
  - Rush Creek (Segments 3A, 3B and 3C – Navarro County)
  - Board Creek-Pin Oak Creek (Segments 3A, 3B and 3C – Navarro County)
  - Little Pin Oak Creek-Richland Creek (Segments 3B and 3C – Navarro County)
  - Cedar Creek-Richland Creek (Segments 3A, 3B and 3C – Navarro County)
  - Grape Creek-Richland Creek (Segment 3C – Navarro County)

3.3.4.1.3 Navasota Watershed

The Navasota (USGS number 12070103) Watershed is the only watershed in the water quality Study Area that is part of the Brazos River Basin. No other watersheds upstream drain into the Navasota Watershed, but water from the Navasota Watershed drains downstream to the Lower Brazos-Little Brazos Watershed.[30] The Navasota Watershed underlies portions of Segment 4 in Freestone, Limestone, and Leon counties, Segments 3C and 4 in Leon County, and Segment 5 in Grimes County. The following are the subwatersheds contained within the Navasota Watershed that underlie the water quality Study Area:

- Pigeon Roast Creek-Clear Creek (Segment 3C – Leon County)
- Holman Creek (Segment 4 – Freestone and Limestone counties)
- Lambs Creek (Segment 4 – Leon and Limestone counties)
- Big Creek (Segment 4 – Limestone County)
- Running Branch-Navasota River (Segment 4 – Leon and Limestone counties)
- Sanders Creek (Segment 4 – Limestone County)
- Upper Brushy Creek (Segment 4 – Leon County)
- Birch Creek (Segment 4 – Leon County)
- Holland Creek (Segment 5 – Grimes County)
- Middle Gibbons Creek (Segment 5 – Grimes County)
- Rocky Creek (Segment 5 – Grimes County)
- Upper Gibbons Creek (Segment 5 – Grimes County)

[29] U.S. Environmental Protection Agency, *"Lower Trinity-Tehuacana Watershed -- 12030201,"* Accessed January 7, 2016. http://cfpub.epa.gov/surf/huc.cfm?huc_code=12030201 (accessed January 7, 2016).
[30] U.S. Environmental Protection Agency, "Navasota Watershed -- 12070103," Accessed January 7, 2016. http://cfpub.epa.gov/surf/huc.cfm?huc_code=12070103.

3.3.4.1.4 *Lower Trinity-Tehuacana and Lower Trinity-Kickapoo Watersheds*

The Lower Trinity-Tehuacana (USGS number 12030201) Watershed receives water from both the Richland Watershed and the Upper Trinity Watershed. The watershed flows through seven counties and is part of the Trinity River Basin. Water from this watershed drains to the Lower Trinity-Kickapoo (USGS number 12030202) Watershed, which is also part of the Trinity River Basin. The Lower Trinity-Tehuacana Watershed intersects Segments 3A and 3B in Navarro and Freestone counties; Segment 3C in Freestone, Leon, and Navarro counties; and Segment 4 in Freestone County. The Lower Trinity-Kickapoo Watershed spans three counties intersecting Segments 3C and 4 in Grimes, Leon and Madison counties and Segment 5 in Grimes County.[31] The following are the subwatersheds contained within the Lower Trinity-Tehuacana and Lower Trinity-Kickapoo watersheds that underlie the water quality Study Area:

- Lower Trinity-Tehuacana Watershed
  - Alligator Creek (Segment 3C – Freestone and Leon counties)
  - Cedar Creek (Segments 3A, 3B and 4 – Freestone and Navarro counties)
  - Linn Creek-Buffalo Creek (Segment 3C – Freestone County)
  - Lower Caney Creek (Segment 3C - Freestone County)
  - Mims Creek-Upper Keechi Creek (Segment 3C – Freestone County)
  - Pin Oak Creek-Cottonwood Creek (Segment 3C – Freestone County)
  - Sloan Creek-Tehuacana Creek (Segment 3C – Freestone County)
  - Bliss Creek-Buffalo Creek (Segment 3C – Leon County)
  - Browns Creek-Buffalo Creek (Segment 3C – Freestone and Leon counties)
  - Little Tehuacana Creek-Tehuacana Creek (Segments 3C and 4 – Freestone/Navarro counties)
- Lower Trinity-Kickapoo Watershed
  - Beaver Creek-Lower Keechi Creek (Segment 3C – Leon County)
  - Cedar Creek-Boggy Creek (Segment 3C – Leon County)
  - Kickapoo Creek (Segments 3C and 4 – Madison County)
  - Myrtle Creek-Larrison Creek (Segment 3C – Madison County)
  - North Bedias Creek-Bedias Creek (Segments 3C, 4 and 5 – Grimes and Madison counties)
  - Pine Creek-South Bedias Creek (Segment 5 – Grimes County)
  - Spring Creek-Boggy Creek (Segments 3C and 4 – Leon County)
  - Twomile Creek-Boggy Creek (Segment 3C – Leon and Madison counties)
  - Whites Branch-Lower Keechi Creek (Segment 3C – Leon County)
  - Brushy Creek-Caney Creek (Segments 3C and 4 – Madison County)
  - East Caney Creek-Caney Creek (Segment 4 – Leon and Madison counties)
  - Ferry Branch-Caney Creek (Segment 3C – Madison County)
  - Iron Creek (Segments 3C and 4 – Madison County)

3.3.4.1.5 *West Fork of the San Jacinto, Spring and Buffalo-San Jacinto Watersheds*

The three remaining watersheds in the surface water quality Study Area, West Fork of the San Jacinto (USGS number 12040101), Spring (USGS number 12040102) and Buffalo-San Jacinto (USGS number 12040104), are part of the San Jacinto River Basin and underlie the proposed Segment 5. The Spring Watershed begins in Grimes County and flows south-southeast through Waller, Montgomery and Harris counties. Water from this watershed drains into the West Fork of the San Jacinto River Watershed then

[31] U.S. Environmental Protection Agency, "Lower Trinity-Kickapoo Watershed -- 12030202," Accessed January 7, 2016. http://cfpub.epa.gov/surf/huc.cfm?huc_code=12030202.

continues on to the Buffalo-San Jacinto Watershed. The West of the Fork San Jacinto Watershed intersects the water quality Study Area in Grimes County and the Buffalo-San Jacinto Watershed intersects the water quality Study Area in Harris County. The Buffalo-San Jacinto underlies all three Houston terminal options in Harris County.[32] The following are the subwatersheds contained within the West Fork of the San Jacinto, Spring and Buffalo-San Jacinto watersheds that underlie the Study Area:

- West Fork of the San Jacinto Watershed
  - Garretts Creek (Segment 5 – Grimes County)
  - Haynie Creek-Little Caney Creek (Segment 5 – Grimes County)
  - Sand Creek-Caney Creek (Segment 5 – Grimes County)
- Spring Watershed
  - Birch Creek-Walnut Creek (Segment 5 – Grimes and Waller counties)
  - Dry Creek-Cypress Creek (Segment 5 – Harris County)
  - Hurricane Creek-Mill Creek (Segment 5 – Grimes County)
  - Kickapoo Creek-Spring Creek (Segment 5 – Harris and Waller counties)
  - Little Cypress Creek (Segment 5 – Harris County)
  - Mallard Lake-Cypress Creek (Segment 5 – Harris County)
  - Mound Creek-Cypress Creek (Segment 5 – Harris County)
  - Threemile Creek-Brushy Creek (Segment 5 – Waller County)
- Buffalo-San Jacinto Watershed
  - Langham Creek (Segment 5 – Harris County)
  - Jersey Lake-Whiteoak Bayou (Segment 5 – Harris County)
  - Cole Creek-Whiteoak Bayou (Segment 5 – Harris County)
  - Little Whiteoak Bayou-Whiteoak Bayou (Segment 5 and Terminal Options – Harris County)
  - City of Houston-Buffalo Bayou (Segment 5: Northwest Transit Center Terminal Option – Harris County)

A summary of the Build Alternative segments that occur within each watershed by county is provided in **Table 3.3-1** and depicted in **Appendix D, Surface Water Resources Mapbook**.

Table 3.3-1: Watersheds Within the Water Quality Study Area

Watershed	Build Alternative Segment	County	Watershed Area (Acres)*
Upper Trinity	Segment 1	Dallas	1,001.1
	Segment 1	Ellis	23.3
	Segment 2A	Ellis	475.8
	Segment 2B	Ellis	448.6
Chambers	Segment 2A	Ellis	499.6
	Segment 2B	Ellis	509.6
	Segment 3A	Ellis	118.7

[32] U.S. Environmental Protection Agency, "Spring Watershed -- 12040102," Accessed January 7, 2016. http://cfpub.epa.gov/surf/huc.cfm?huc_code=12040102; U.S. Environmental Protection Agency, "West Fork San Jacinto Watershed -- 12040101," Accessed January 7, 2016. http://cfpub.epa.gov/surf/huc.cfm?huc_code=12040101.

Table 3.3-1: Watersheds Within the Water Quality Study Area

Watershed	Build Alternative Segment	County	Watershed Area (Acres)*
	Segment 3B	Ellis	121.7
	Segment 3C	Ellis	118.7
	Segment 3A	Navarro	250.3
	Segment 3B	Navarro	197.2
	Segment 3C	Navarro	250.3
Richland	Segment 3A	Navarro	876.5
	Segment 3B	Navarro	1,020.8
	Segment 3C	Navarro	876.0
Navasota	Segment 4	Freestone	413.9
	Segment 4	Limestone	357.8
	Segment 3C	Leon	1.6
	Segment 4	Leon	603.1
	Segment 5	Grimes	684.1
Lower Trinity-Tehuacana	Segment 3A	Navarro	18.5
	Segment 3B	Navarro	18.1
	Segment 3C	Navarro	25.2
	Segment 3A	Freestone	0.4
	Segment 3B	Freestone	0.4
	Segment 3C	Freestone	1,365.2
	Segment 4	Freestone	578.0
	Segment 3C	Leon	241.4
Lower Trinity-Kickapoo	Segment 3C	Leon	1,128.0
	Segment 4	Leon	543.3
	Segment 3C	Madison	600.6
	Segment 4	Madison	727.8
	Segment 3C	Grimes	89.9
	Segment 4	Grimes	79.8
	Segment 5	Grimes	202.4
West Fork San Jacinto	Segment 5	Grimes	497.8
Spring	Segment 5	Grimes	476.8
	Segment 5	Waller	306.1
	Segment 5	Harris	1,146.4
Buffalo-San Jacinto	Segment 5	Harris	254.7
Buffalo-San Jacinto	Segment 5: Industrial Site Terminal Option	Harris	97.1
Buffalo-San Jacinto	Segment 5: Northwest Mall Terminal Option	Harris	80.2
Buffalo-San Jacinto	Segment 5: Northwest Transit Center Terminal	Harris	87.3

Source: TWDB, 2016
* Acreages reflect both temporary and permanent impacts

Water quality is evaluated on a local level for inclusion in overall watershed management and implementation plans and protection plans. Typically, water quality is influenced at a local level and local entities or stakeholders may provide input on subwatershed-specific plans. Water quality plans for the subwatersheds are incorporated into plans for the overall watersheds to account for site-specific conditions that influence a larger system. No watershed protection plans are currently in effect for any subwatersheds in the study area; therefore the Project would not be subject to local watershed protection plan requirements.[33]

3.3.4.1.6 Impaired Waterbodies

The TCEQ assesses specific surface waterbodies to assign designated uses (e.g., recreation). Each use has minimum water quality criteria, and TCEQ assesses these waterbodies to see if they meet the criteria and can support their designated uses. A waterbody too degraded or polluted to meet water quality standards for its designated use is considered impaired per Section 303(d) of the Clean Water Act. Impaired waters are identified in the *Texas Integrated Report Index of Water Quality Impairments.* The report classifies the assessed waterbodies by individual assessment units (AUs) and an associated assessment unit identification (AU ID) number describes the location of the specific area within a waterbody that is not in compliance. If a waterbody is in compliance with water quality standards, but data show declining water quality trends indicating the waterbody may be impaired in the future, the waterbody may be considered threatened.

Of the assessed freshwater streams in the water quality Study Area, six AUs were identified as threatened or impaired in the *2014 Texas Integrated Report Index of Water Quality Impairments* (**Table 3.3-2**). These waters do not meet their designated or intended uses under TCEQ's assessment. If an action should degrade the ability of a waterbody to meet its designated uses, it would not comply with the State's anti-degradation policy and would be subject to reviews by the TCEQ as outlined in Chapter 307 of the Texas Administrative Code. [34] The reviews would determine whether degradation is authorized by the state and may affect permit approval or result in TPDES permit requirements.

Table 3.3-2: Impaired Waterbodies Within the Study Area

Watershed/ Subwatershed	Waterbody Name	Waterbody ID/ AU_ID	Impaired Designation Use	Parameter/ Category	County	Segment
Upper Trinity/Five Mile Creek-Trinity River	Upper Trinity River	0805/ 0805_03	Fish Consumption	Dioxin in edible tissue/ 5a	Dallas	1
				PCBs in edible tissue/ 5a	Dallas	1
			Recreation	Bacteria/ 4a	Dallas	1
Spring/Kickapoo Creek-Spring Creek	Spring Creek	1008/ 1008_02	Recreation	Bacteria/ 4a	Waller, Harris	5
			Aquatic Life	Depressed Dissolved Oxygen/ 5c	Waller, Harris	5
Spring/Dry Creek-Cypress Creek	Cypress Creek	1009/ 1009_04	Recreation	Bacteria/ 4a	Harris	5

[33] Texas Commission on Environmental Quality. "Texas Watershed-Based Plans (May 2015)" Watershed Protection Plans for Nonpoint Source Water Pollution. May 2015, Accessed June 7, 2016, https://www.tceq.texas.gov/assets/public/waterquality/nps/watersheds/WBP_ListForWeb.pdf.

[34] Antidegradation, *Texas Administrative Code*, Title 30, Chapter 307, https://texreg.sos.state.tx.us/public/readtac$ext.TacPage?sl=T&app=9&p_dir=P&p_rloc=166380&p_tloc=14713&p_ploc=1&pg=3&p_tac=&ti=30&pt=1&ch=307&rl=7.

Table 3.3-2: Impaired Waterbodies Within the Study Area						
Watershed/ Subwatershed	Waterbody Name	Waterbody ID/ AU_ID	Impaired Designation Use	Parameter/ Category	County	Segment

Source: TCEQ, 2015
Notes: AU_ID: Identifies the assessment unit and describes the location of the specific area within a classified or unclassified waterbody for which one or more water quality standards are not met.
SegID: The unique identifier given to a waterbody.
Category 4: Impairments that are not suitable for a TMDL or for which a TMDL has already been approved.
Category 4a –TMDLs have been completed and approved by EPA for the surface water parameter bacteria only.
Category 5: Impairments which may be suitable for development of a TMDL (303[d] List)
Category 5a - TMDLs are underway, scheduled or will be scheduled for one or more parameters.
Category 5b – A review of the standards will be conducted before a management strategy is selected.
Category 5c - Additional data or information will be collected and/or evaluated for one or more parameters before a management strategy is selected.

As identified in **Table 3.3-2,** Impaired Waterbodies within the water quality Study Area, bacteria is the only surface water parameter that has TMDLs completed and approved by the EPA (Category 4a) in Dallas County (AU 0805_03), Waller and Harris counties (AU 1008_02) and Harris County (AU 1009_04). These AUs correspond to four waterbodies within the water quality Study Area: Five Mile Creek-Trinity River, Kickapoo Creek-Spring Creek, Dry Creek-Cypress Creek and Cole Creek-Whiteoak Bayou subwatersheds, respectively.

Table 3.3-2 also identifies impairments which may be suitable for development of a TMDL (Category 5) that do not have regulated TMDLs at this time (303[d] list). These include dioxins and PCBs in edible tissue for Dallas County (AU 0805_03) as well as depressed dissolved oxygen (DO) in Freestone County (Segment 3C) and Waller and Harris counties (AU 1008_02).

Dioxins refer to a group of organic compounds that are structurally related to benzene that have no particular use, often containing chlorine. They are not manufactured intentionally but are often formed as by-products of other chemical procedures.[35] Dioxins originated in the manufacture of certain herbicides and hexachlorophene (an antibacterial agent used in soaps and other cleaning products); both are now banned in the U.S. Dioxins are also formed as by-products of other industrial operations, such as the incineration of municipal wastes and the bleaching of wood pulp.

Polychlorinated biphenyls (PCBs) are synthetic chemicals which are no longer produced in the U.S. and were banned in 1979, but can still be found in the environment. PCBs were used as coolants and lubricants in transformers, capacitors and other electrical equipment because they do not easily burn and are good insulators.[36]

Waters with depressed DO do not have sufficient concentration of oxygen to support aquatic life. This is a nutrient-related impairment in a natural stream environment, caused by numerous factors including excessive algae growth caused by excess phosphorus and nitrogen. Sources of excess phosphorus and nitrogen include contaminated runoff from agricultural or industrial practices, such as fertilizer and waste in stormwater. As the algae die and decompose, the process consumes the available dissolved

[35] Science Clarified, "Dioxins," Accessed June 12, 2016. http://www.scienceclarified.com/Di-El/Dioxin.html#ixzz4BQsz5GZS.
[36] U.S. Environmental Protection Agency, "PCBs Questions and Answers," Accessed June 12, 2016, https://www3.epa.gov/region9/pcbs/faq.html.

oxygen, resulting in insufficient amounts of DO available for fish and other aquatic life. Die-off and decomposition of submerged plants also contributes to insufficient DO levels.[37]

The project will be assessed during both construction and operation with regard to water quality and the elements that can cause impairment as discussed in **Section 3.3.5.2**.

3.3.4.2 Groundwater Quality

Aquifers provide a source of groundwater used for purposes such as irrigation, public and private drinking water and livestock. The State of Texas contains nine major aquifers and 21 minor aquifers. Aquifers are defined by the amount of water they produce and the geographical area for which they produce water. Major aquifers produce large amounts of water over large areas, and minor aquifers produce limited water for a large area or a lot of water for a small area. Major and minor aquifers underlying the water quality Study Area are described below and depicted in **Appendix D, Groundwater Resources Mapbook**.[38]

3.3.4.2.1 Aquifers

Three major aquifers (Trinity, Carrizo-Wilcox and Gulf Coast) and five minor aquifers (Woodbine, Nacatoch, Queen City, Sparta and Yegua Jackson) underlie the water quality Study Area (**Table 3.3-3**). The EPA designates aquifers that supply at least 50 percent of the drinking water for a service area where no other drinking water sources are reasonably available as a sole source aquifer. Section 1424(e) of the Safe Drinking Water Act (42 U.S.C. §1424[e])[39] requires EPA to review any project receiving federal funds that is located over a sole source aquifer or its recharge zone.[40] None of the aquifers in the water quality Study Area are designated as sole source aquifers.

Table 3.3-3: Aquifers Within the Study Area by County

Counties	Major Aquifer	Minor Aquifers
Dallas	Trinity (subcrop)	Woodbine Aquifer (subcrop)
Ellis	Trinity (subcrop)	Woodbine Aquifer (subcrop)
Navarro	Trinity (subcrop)	Nacatoch (outcrop)
		Woodbine Aquifer (subcrop)
Limestone	Carrizo-Wilcox (outcrop)	None
Freestone	Carrizo-Wilcox (outcrop)	None
Leon	Carrizo-Wilcox (outcrop)	Sparta Aquifer (subcrop and outcrop)
		Queen City Aquifer (subcrop and outcrop)
Madison	Carrizo-Wilcox (Subcrop)	Yegua Jackson Aquifer (outcrop)
		Sparta Aquifer (subcrop)
		Queen City Aquifer (subcrop)
Grimes	Carrizo-Wilcox (Subcrop)	Sparta Aquifer (subcrop)
		Queen City Aquifer (subcrop)
	Gulf Coast	Yegua Jackson Aquifer (outcrop)
Waller	Gulf Coast	None

[37] Minnesota Pollution Control Agency, "Low Dissolved Oxygen in Water, Causes, Impact on Aquatic Life – An Overview," Water quality/Impaired Waters 3.24, St. Paul, MN, February 2009.
[38] George, Peter G., Robert E. Mace and Rima Petrossian. "Aquifers of Texas Report 380," Austin, Texas: Texas Water Development Board, 2011
[40] Safe Drinking Water Search for the State of Texas, 2015; *My WATERS Mapper: Drinking Water Information.* October 9, 2015. http://watersgeo.epa.gov/mwm/?layer=LEGACY_WBD&feature=12030102&extraLayers=null (accessed December 3, 2015)

Table 3.3-3: Aquifers Within the Study Area by County		
Counties	**Major Aquifer**	**Minor Aquifers**
Harris	Gulf Coast	None

Source: George, P., et al., 2011

Major Aquifers

The Trinity Aquifer extends across 61 counties in the central and northeastern part of Texas. The deeper (subcrop) portion underlies Dallas, Ellis, Navarro and Limestone counties in the water quality Study Area. Total dissolved solids (TDS) increase with aquifer depth and are typically between 1,000 and 5,000 milligrams per liter (mg/L), or slightly to moderately saline. Typically, groundwater cannot be used for public water supply when TDS are above 1,000 mg/L. Groundwater with TDS above 1,000 mg/L can potentially be treated by desalination or used for selective irrigation or livestock.[41] Saturated thickness of an aquifer is the vertical measurement of the space filled with water. The top of the saturated layer is known as the water table and is also the first depth that water is found from the ground surface. Freshwater saturated thickness of the Trinity Aquifer ranges from 600 to 1,900 feet.

The Carrizo-Wilcox Aquifer extends in a curved pattern from the Louisiana border to the border of Mexico, including Navarro, Limestone, Freestone, Leon, Madison and Grimes counties. It is primarily composed of sand locally interbedded with gravel, silt, clay and lignite. Freshwater saturated thickness typically averages 670 feet. The outcrop of the Carrizo-Wilcox Aquifer is typically freshwater, but some portions of the subcrop have TDS concentrations of greater than 1,000 mg/L. Portions of the subcrop have high levels of iron and manganese and require treatment prior to use as drinking water. Water levels within this aquifer have declined in the Study Area due to municipal pumping.[42]

The Gulf Coast Aquifer underlies the water quality Study Area in Grimes, Waller and Harris counties. The aquifer extends in a curved pattern that generally parallels the Gulf of Mexico coastline from the Louisiana border to the border of Mexico, and consists of interbedded clays, silts, sands and gravels that are hydraulically connected to form a leaky, confined aquifer system. Freshwater saturated thickness averages 1,000 feet. The majority of groundwater use from this aquifer is domestic, municipal, agricultural and industrial. In Harris County, high levels of radionuclides (atoms that have an unstable nucleus that emits radiation) are found in water collected from some wells. These areas are mostly located in the western and southwestern portions of Harris County.[43] The EPA has set a maximum acceptable limit of gross alpha radiation for drinking water of 15 picocuries per liter. If radionuclide levels in drinking water supplies exceed the maximum, communities and water providers must treat the groundwater, blend it with another source or find an alternative source of drinking water.

Water level declines have occurred in the Harris County area of the Gulf Coast Aquifer with some wells experiencing a water elevation drop of more than 350 feet.[44] Compaction of subsurface clay layers due to the loss of supporting pressure caused by water level declines have resulted in land subsidence in some parts of Harris County, notably in the area of Baytown near Galveston Bay, as well as in the northwestern part of Harris County in areas of over-pumping of groundwater for municipal, industrial

[41] Safe Drinking Water Search for the State of Texas, 2015; *My WATERS Mapper: Drinking Water Information.* October 9, 2015. http://watersgeo.epa.gov/mwm/?layer=LEGACY_WBD&feature=12030102&extraLayers=null (accessed December 3, 2015)
[42] Ibid.
[43] Campbell, M.D. and H.M. Wise. *Hydrogeologic Risks in the Groundwater Supply of Harris County, Texas: Radioactive Constituents, Natural Gas, & Growth Faults.* Prod. LLC I2M Associates. May 8, 2013.
[44] George, Peter G., Robert E. Mace and Rima Petrossian. "Aquifers of Texas Report 380," Austin, Texas: Texas Water Development Board, 2011.

and irrigation purposes. While land subsidence cannot be reversed in these areas, groundwater restrictions are currently in place to reduce pumping.

Minor Aquifers

The subcrop of the Woodbine Aquifer underlies portions of Dallas, Ellis and Navarro counties and overlies the Trinity Aquifer. It consists of sandstone interbedded with shale and clay that form three water-bearing zones. Generally, the lower zones of the aquifer yield the most water and the upper zone yields limited water that tends to be very high in iron. Freshwater saturated thickness averages 170 feet throughout the aquifer. Water to a depth of 1,500 feet is typically fresh and contains less than 1,000 mg/L of TDS. Deeper water is slightly to moderately saline, containing from 1,000 to 4,000 mg/L of TDS. The aquifer provides water for municipal, industrial, domestic, livestock and small irrigation supplies.[45]

The Nacatoch Aquifer consists of Nacatoch Sand layers and a layer of alluvium that is as much as 80 feet thick along major drainages, allowing water to move easily throughout the aquifer. Alluvium is a mixture of sand, silt, clay and gravel that was left by flowing water.[46] Freshwater saturated thickness averages about 50 feet in the Nacatoch Aquifer.[47] Groundwater in this aquifer is usually under artesian conditions, meaning the water is under pressure and rises to a certain height when there is relief, such as a drilling a well. These conditions do not exist in shallow wells where the water table is present because there is not enough pressure to push the water up. The groundwater in the aquifer is typically alkaline, high in sodium bicarbonate and soft. TDS in the subsurface increase and are significantly higher south of the Mexia-Talco Fault Zone, where the water contains between 1,000 and 3,000 mg/L of TDS. Water from the aquifer is extensively used for domestic and livestock purposes.[48]

The Queen City Aquifer is widespread and stretches across 42 counties in Texas, including Freestone, Leon, Madison and Grimes counties. Water in the Queen City Aquifer is stored in sand, loosely cemented sandstone and interbedded clay layers of the Queen City Formation that range from 0 to 600 feet in thickness in the counties within the groundwater quality Study Area. Freshwater saturated thickness averages 140 feet throughout the aquifer. TDS ranges from 100 to 1000 mg/L TDS in Leon and Madison counties and increases to the south towards Grimes County where the aquifer is deeper. Although salinity decreases from south to north, areas of excessive iron concentration and high acidity occur in the northeast. The aquifer is primarily used for livestock and domestic purposes, with significant municipal and industrial use in northeast Texas, and water levels have remained fairly stable over time in the northern part of the aquifer. Water level declines are more common in the central (10 to 70 feet) and southern (5 to 130 feet) parts of the aquifer.[49]

The Sparta Aquifer extends across east and south Texas, parallel to the Gulf of Mexico coastline and about 100 miles inland. It underlies Leon, Madison and Grimes counties in the Study Area. Water within the Sparta Aquifer is contained within a sand-rich unit interbedded with silt and clay layers and with massive sand beds in the bottom section. The thickness of the formation gradually decreases from east Texas to south Texas. Freshwater saturated thickness averages 120 feet throughout the aquifer. In outcrop areas and for a few miles in the subsurface, the water is usually fresh, with an average concentration of 300 mg/L of TDS; however, water quality deteriorates with depth (below about 2,000

[45] Ibid.
[46] U.S. Geological Survey. "Water Science Glossary of Terms," last updated November 06, 2015, Accessed December 21, 2015, http://water.usgs.gov/edu/dictionary.html.
[47] George, Peter G., Robert E. Mace and Rima Petrossian. "Aquifers of Texas Report 380," Austin: Texas Water Development Board, 2011.
[48] Ibid.
[49] George, Peter G., Robert E. Mace and Rima Petrossian. "Aquifers of Texas Report 380," Austin: Texas Water Development Board, 2011.

feet), where groundwater has an average concentration of 800 mg/L of TDS. Excess iron concentrations are common throughout the Sparta Aquifer. Water from the aquifer is predominantly used for domestic and livestock purposes, and its quality has not been significantly impacted by pumping. No significant water level declines have been detected throughout the aquifer in wells measured by the TWDB.[50]

The Yegua Jackson Aquifer spans 34 counties, including Madison and Grimes counties. The geologic units consist of interbedded sand, silt and clay layers originally deposited as fluvial and deltaic sediments. Freshwater saturated thickness averages about 170 feet. Groundwater quality varies greatly owing to sediment composition in the aquifer formations, and in all areas the aquifer becomes highly mineralized with depth. Most groundwater is produced from the sand units where the water is fresh and TDS range from less than 50 to 1,000 mg/L. Some slightly to moderately saline water, with concentrations of TDS ranging from 1,000 to 10,000 mg/L, also occurs in the aquifer. Significant water level declines have not occurred in wells measured by the TWDB. Groundwater for domestic and livestock purposes is typically extracted from shallow wells throughout the aquifer. Water is also used for some municipal, industrial and irrigation purposes.[51]

Each of these minor aquifers contains sediment. Gravel, sand and sandstone are sediment that is typically permeable (i.e., allow water to travel through its pores).[52] A more permeable composition typically allows pollutants in surface water runoff to contaminate groundwater sources.

Groundwater is accessed by pumping through wells completed in the aquifer. Uses for groundwater vary depending factors such as owner, water quality and depth. The review identified 12 total wells used for water withdrawal within the water quality Study Area, including registered private wells (**Table 3.3-4**).

Table 3.3-4: Wells Within the Study Area

County	Aquifer	Well ID	Well Owner	Well Depth (feet)	Segment
Dallas	Woodbine	3327402	Heads Lake Water System	1,169	1
Ellis	Other	3335502	N. L. Everett	24	2A
Navarro	Other	3905703	Unknown	24	3A, 3B
Navarro	Woodbine	3360202	Corsicana Water Department	2029	3B
Navarro	Nacatoch	3905103	A. L. Weeks	77	3B
Limestone	Carrizo-Wilcox	3938907	J. Carpenter	290	4
Grimes	Gulf Coast	6033502	Frank H. Nelson	462	5
Harris	Gulf Coast	6502202	Warren Ranch Well 1	550	5
Harris	Gulf Coast	6504702	Humble Pipe Line Co.	333	5
Harris	Gulf Coast	6504713	H and TC Railroad	56	5
Harris	Gulf Coast	6504802	Carl Williford	156	5
Harris	Gulf Coast	6513503	Phillip Carey	160	Houston Terminal Station Options (Industrial Site and Northwest Mall)

Source: TWDB, 2015

[50] Ibid.
[51] Ibid.
[52] Ibid.

3.3.4.2.2 Groundwater Conservation Districts

The Texas Alliance of Groundwater Districts (formerly the Texas Groundwater Conservation Districts Association) was created by the Texas Legislature to preserve and protect groundwater.[53] Three GCDs, Prairielands, Mid-east Texas and Bluebonnet are established in the Study Area, as is the Harris Galveston Subsidence District.[54] More information on the GCDs is provided in **Section 3.8, Floodplains** and the GCDs within the Study Area are depicted in **Appendix D, Groundwater Resources Mapbook**.

3.3.4.2.3 Municipal Setting Designations

Municipal Setting Designations (MSD) are official state designations given to property within a municipality or its extraterritorial jurisdiction where a municipal ordinance restricts the use of shallow groundwater for potable (human consumption) purposes inside a MSD boundary. MSDs use a municipal ordinance or restrictive covenant as a substitute for TCEQ cleanup regulations to protect against exposure to groundwater contamination. When a MSD is implemented, the groundwater contamination remains and public access is removed. MSDs ensure public health is protected by prohibiting the use of shallow groundwater as drinking water while not affecting zoning or development standards.

Portions of four MSDs are located within the Study Area (**Appendix D, Natural Resources Mapbook**). Three of the MSDs are located in the City of Dallas within the Trinity and Woodbine Aquifers. Combined, they cover approximately 86.5 acres of Segment 1 in Dallas County. The northernmost MSD covers the Dallas Terminal Station option and 0.02 miles of Segment 1 from 0-200 feet below ground surface. This MSD applies to groundwater beneath properties generally located at 318 Cadiz and the following physical addresses: 1000, 1006, 1008, 1010, 1018, 1120, 1200, 1208, 1212, 1500, 1827 and 1819 South Riverfront Boulevard in the City of Dallas. **Table 3.5-2** in **Section 3.5, Hazardous Materials and Solid Waste** identifies the northernmost MSD as moderate risk for environmental concern. The second MSD intersects Segment 1 in the small northeasternmost corner. The groundwater bearing unit in this location is from 9 to 25 feet below ground surface. The third MSD intersects Segment 1 where it extends southward along IH-45, covering multiple properties from 5-50 feet below ground surface. This MSD covers groundwater under multiple properties, including 1100, 1240 and 1020 Sargent Rd in the City of Dallas, described in **Section 3.5, Hazardous Materials and Solid Waste. Table 3.5-2** identifies this site as having a low risk for environmental concern. The fourth MSD within the Study Area covers a total of approximately 0.41 acre of Segment 5 in Harris County and is located at 1300 N Post Oak Road. The Industrial Site Terminal Station option accounts for 0.06 acre and the Northwest Transit Center Terminal Station option accounts for 0.35 acre of that total. **Table 3.5-2** in **Section 3.5, Hazardous Materials and Solid Waste** identifies this southernmost MSD as moderate risk for environmental concern.

3.3.4.3 Water Supply

3.3.4.3.1 Regional Water Supply Planning

Every five years the TWDB compiles a comprehensive state water plan from information collected from 16 regions throughout the state.[55] The water quality Study Area spans three of 16 regional planning areas: Region C, Brazos G Region and Region H. Region C overlaps a large portion of the Trinity River Basin and spans 16 counties. Four counties within the water supply Study Area are included in Region C:

---

[53] Texas Natural Resource Conservation Commission. State of Texas Source Water Assessment and Protection Program Strategy," Austin: Public Drinking Water Section, Water Utilities Division, 1999.
[54] Texas Commission on Environmental Quality," TCEQ Groundwater Conservation Districts," *TCEQ_GCD*, Austin, Texas, 2014.
[55] Texas Water Development Board. "2017 State Water Plan." Austin, TX. May 2016.

Dallas, Ellis, Freestone and Navarro counties.[56] The Brazos G Region is predominantly located in the Brazos River Basin. This region spans 37 counties in Texas including two counties, Limestone and Grimes, in the water supply Study Area.[57] Region H spans 15 counties and portions of five river basins. Four counties within the water supply Study Area are included in Region H: Leon, Madison, Waller and Harris counties.[58]

3.3.4.3.2 Reservoirs and Dams

The only major public water supply reservoir identified near the Study Area is Lake Limestone (**Appendix D, Natural Resources Mapbook**).[59] Lake Limestone is owned and operated by the Brazos River Authority and is primarily used for water supply and recreational purposes. The reservoir has a capacity of 203,780 acre feet with a water surface area of 12,486 acres.[60] It is located in portions of Limestone and Leon counties in the Navasota Watershed. Other reservoirs in the study area, like Lake Bardwell, are primarily used for flood control.

There are a total of 196 dams located within the subwatersheds that intersect the Study Area. Twenty-nine of these dams are located within one-half mile of the Study Area. The nearest dam, Everett GSS, is located 0.02 miles west of the Study Area in Ellis County.

3.3.4.3.3 Public Water Supply

The EPA Safe Drinking Water Information System identifies 1,160 public water systems located within the nine watersheds of the water quality Study Area.[61] Public water systems are classified as either a Community Water System, a Non-Transient Non-Community Water System or a Transient Non-Community Water System. On an annual basis, each community water system provides water to the same population. City water systems and utilities fall into the community water supply category. Water systems that provide service to the same population on a periodic, but not annual basis, such as a school or doctor's office with its own water system, is a non-transient, non-community water system. A water system that temporarily provides water to changing populations, such as a golf club or campground, is a transient non-community water system.[62] **Table 3.3-5** identifies the type of public water system within the water supply Study Area counties by watershed.

[56] Ibid.
[57] Ibid.
[58] Ibid.
[59] TCEQ, "Source Water Protection." Accessed June 7, 2016, https://www.tceq.texas.gov/drinkingwater/SWAP
[60] Ibid; Texas Water Development Board, "Lake Limestone (Brazos River Basin)," Accessed December 3, 2015, http://www.twdb.texas.gov/surfacewater/rivers/reservoirs/limestone/index.asp.
[61] Safe Drinking Water Search for the State of Texas, 2015; *My WATERS Mapper: Drinking Water Information.* October 9, 2015, http://watersgeo.epa.gov/mwm/?layer=LEGACY_WBD&feature=12030102&extraLayers=null (accessed December 3, 2015)
[62] Ibid.

Table 3.3-5: EPA Safe Drinking Water Information System

Watershed	Counties	PWS Source	PWS Type			Totals
			CWS	NTNCWS	TNCWS	
Upper Trinity	Dallas	GW	3	0	0	**3**
		SW	3	0	0	**3**
	Ellis	GW	2	0	0	**2**
		SW	5	0	0	**5**
Lower Trinity - Kickapoo	Leon	GW	7	0	0	**7**
	Madison	GW	5	0	0	**5**
	Grimes	GW	4	1	0	**5**
Lower Trinity-Tehuacana	Freestone	GW	17	3	3	**23**
	Limestone	SW	1	0	0	**1**
	Leon	GW	6	0	0	**6**
Chambers	Ellis	GW	14	0	0	**14**
		SW	5	0	0	**5**
	Navarro	SW	1	0	0	**1**
Richland	Navarro	GW	0	1	0	**1**
		SW	2	0	0	**2**
Navasota	Freestone	GW	2	0	0	**2**
	Limestone	GW	7	1	2	**10**
	Limestone	SW	3	0	0	**3**
	Leon	GW	6	2	0	**8**
	Grimes	GW	4	0	1	**5**
West Fork San Jacinto	Grimes	GW	2	1	1	**4**
	Harris	GW	16	1	4	**21**
		SW	4	0	0	**4**
Spring	Grimes	GW	3	0	0	**3**
	Waller	GW	13	1	0	**14**
	Harris	GW	176	43	58	**277**
		SW	2	0	0	**2**
Buffalo-San Jacinto	Waller	GW	0	5	1	**6**
Buffalo-San Jacinto	Harris	GW	267	174	106	**547**
	Harris	SW	66	4	1	**71**
TOTALS			**646**	**237**	**177**	**1,060**

Source: EPA, 2015
CWS – Community Water System
GW – Groundwater
SW – Surface Water
NTNCWS – Non-Transient Non-Community Water Systems
PWS – Public Water System
TNCWS – Transient Non-Community Water Systems

Any public water system is eligible to participate in the voluntary Texas State Water Plan. The only public water system identified on the *Participants in the Source Water Protection Program* list is the City of Houston.[63] Land subsidence resulting from increased groundwater drawdown has led to transitioning local water supplies in Harris County from the Gulf Coast Aquifer to surface water resources. As a result, the City of Houston is transitioning to surface water supply for their main water supply and previous City of Houston water supply wells within the Study Area are plugged. There are a total of five active public water system wells within the Study Area (**Table 3.3-6)**. A surface water intake is the point where water

[63] Texas Commission on Environmental Quality, "Texas Source Water Protection Program Participants," TCEQ: Participants in the Source Water Protection Program . May 27, 2008. https://www.tceq.texas.gov/drinkingwater/SWAP/participants.html/at_download/file.

is pumped from surface water for use as drinking water. The nearest surface water intake is approximately one mile from the water quality Study Area.[64]

Table 3.3-6: Public Water System Wells Within the Study Area

County	Aquifer	Source ID	PWS Name/ID	Well Depth (feet)	Segment	Status
Navarro	Nacatoch	G1750020E	City of Richland/1750020	120	3A	Plugged
Freestone	Carrizo-Wilcox	G0810015B	Pleasant Grove WSC/0810015	411	3C	Active
Waller	Gulf Coast	G2370093A	G&W WSC Saddle Creek Forest Subd./2370093	508	5	Active
Waller	Gulf Coast	G2370093B	G&W WSC Saddle Creek Forest Subd./2370093	865	5	Active
Harris	Gulf Coast	G1010013NK	City of Houston/1010013	862	5	Plugged

Source: TCEQ, 2012

3.3.5 Environmental Consequences

This section provides an analysis of the potential water quality impacts of the No Build Alternative and each Build Alternative. Stream and wetland impacts are discussed in **Section 3.7.5, Wetlands and Waters of the U.S.** and floodplains and bridge crossings are discussed in **Section 3.8.5, Floodplains**. Impacts from existing contamination and hazardous materials are discussed in **Section 3.5.5, Hazardous Materials and Solid Waste.** Since MSDs are ordinances to restrict contaminated groundwater usages, the consequences are the same as those discussed in **Section 3.5.5, Hazardous Materials and Solid Waste.**

3.3.5.1 No Build Alternative

Under the No Build Alternative, the HSR system would not be constructed. Existing surface water, ground water, and water supply resources would not be disturbed because no construction activities would occur. Therefore, there would be no greater risk to the Study Area than that which is already present. Potential impacts could still occur under the No Build Alternative as new developments would continue due to natural growth in the area that would generate construction and increase impervious cover, thus increase stormwater runoff. However, the No Build Alternative would not contribute to this impact.

3.3.5.2 Build Alternatives

The Project is designed with the goals of maintaining drainage patterns, ensuring that on-site runoff would be captured, detained, and conveyed, mitigating any potential impacts to flooding upstream and downstream, and minimizing potential contamination to surface water, groundwater and public water supply sources.[65] The specific impacts to resources will be determined when a Tier II analysis is prepared prior to construction of any Build Alternative. Impacts to surface water quality, groundwater quality and water supply would require permits and approvals from the TCEQ and USACE under the Clean Water Act

[64] Texas Commission on Environmental Quality, "Texas Surface Water Quality Monitoring and Assessment Strategy FY 2012-2017, Rev. 1," Austin, TX: TCEQ Water Quality Planning Division, December 2013. https://www.tceq.texas.gov/assets/public/waterquality/swqm/monitor/swqm_strategy.pdf.
[65] TCRR, "*Texas Central Partners Texas High Speed Rail Final Draft Conceptual Engineering Report-FDCERv7*," September 15, 2017.

(**Section 3.3.2.1**). As discussed in **Section 3.3.6** below, TCRR, in coordination with the TCEQ and USACE, would avoid and minimize impacts to surface water quality, groundwater quality, and water supply, as practicable, and obtain the appropriate permits.

Impacts would occur to surface water quality, groundwater quality and water supply during construction and operation of any of the Build Alternatives. The following sections describe potential construction and operational impacts to surface water quality, groundwater quality and water supply sources.

3.3.5.2.1 Construction Impacts

Construction of the Build Alternatives would involve ground disturbances, such as excavation and grading, which are anticipated to contribute to short-term impacts from erosion and sedimentation; therefore, the volume of sediment in stormwater would increase. Agricultural lands, including lands used for crop production and livestock operations, are common throughout the Build Alternative Study Area (**Section 3.13, Land Use)**. Soils and sediment in construction areas in agricultural land may include pesticides, herbicides and solid waste from livestock. Other soils may be previously contaminated with petroleum derivatives from vehicles or contaminated sites (**Section 3.5, Hazardous Materials and Solid Waste**). Sedimentation and stormwater runoff from construction may also contain bacteria, nutrients, particles and other constituents attached to sediment or carried separately by stormwater which contribute to pollutant loading. Increased pollutant loading in runoff may significantly impact surface water and groundwater quality. While this could impact all water bodies, threatened or impaired water bodies and reservoirs or other public water supplies would be more sensitive to construction stormwater runoff. A discussion of these construction impacts by surface water quality, groundwater quality, and water supply is provided below.

Surface Water Quality

Construction of the Build Alternatives would result in temporary impacts to surface water quality. Impacts to water quality would consist of altering the concentration of one or more pollutants in the water body (**Section 3.3.4.1, Water Quality – Impaired Waters**). If a concentration of a pollutant is increased above the water quality standards, the water resource would be impacted if the water body no longer meets its designated use. Threatened and impaired waters are close to or already exceed water quality standards for one or more pollutants; a smaller increase of pollutants may impact the ability of the water to meet its designated use than a water body where pollutant concentration is historically low.

Table 3.3-7 identifies the linear feet of streams on the 303(d) list that would be impacted by the Build Alternatives.

Table 3.3-7: Length of 303(d) Listed Streams Within the Study Area

Basin/Alternative Segment	Length (Feet) of 303(d) Listed Streams per Alternative						Counties
	A	B	C	D	E	F	
Upper Trinity							
Segment 1	478.9	478.9	478.9	478.9	478.9	478.9	Dallas
Segment 2A	--	--	--				Ellis
Segment 2B				--	--	--	Ellis
Chambers							
Segment 2A	--	--	--				Ellis
Segment 2B				--	--	--	Ellis
Segment 3A	--			--			Navarro
Segment 3B		--			--		Navarro
Segment 3C			--			--	Navarro
Richland							
Segment 3A	--			--			Navarro
Segment 3B		--			--		Navarro
Segment 3C			--			--	Navarro
Lower Trinity-Tehuacana							
Segment 3A	--			--			Navarro Freestone
Segment 3B		--			--		
Segment 3C			--			--	Navarro Freestone Leon
Segment 4	--	--		--	--		Freestone
Lower Trinity - Kickapoo							
Segment 3C			--			--	Leon Madison Grimes
Segment 4	--	--		--	--		
Segment 5	--	--	--	--	--	--	Grimes
Navasota							
Segment 4	--	--		--	--		Freestone Limestone Leon
Segment 5	--	--	--	--	--	--	Grimes
West Fork San Jacinto							
Segment 5	--	--	--	--	--	--	Grimes
Spring							
Segment 5	303.3	303.3	303.3	303.3	303.3	303.3	Waller
Segment 5	131.6	131.6	131.6	131.6	131.6	131.6	Harris
Buffalo-San Jacinto							
Segment 5	--	--	--	--	--	--	Harris

Source: AECOM, 2017

TMDL implementation plans have been developed by the TCEQ for water bodies impaired with bacteria within the Study Area. Stormwater runoff mitigation measures are outlined in TMDL implementation plans for these water bodies and are summarized in **Section 3.3.6.**[66, 67, 68] For bacteria, the implementation plans collectively conclude that for construction sites, compliance with the TCEQ GCP is

[66] Ibid.
[67] TCEQ. "Fifteen Total Daily Maximum Loads for Indicator Bacteria in Watersheds Upstream of Lake Houston Segments 1004E, 1008, 1008H, 1009, 1009C, 1009D, 1009E, 1010, and 1011," Austin, Texas, Adopted April 6, 2011, Approved by EPA June 29, 2011.
[68] TCEQ. "Implementation Plan for Dallas and Tarrant counties Legacy Pollutant TMDLs for Segment 0805, 0841, and 0841A," Austin, Texas, August 2001.

an adequate measure to contain stormwater runoff within the TMDLs.[69] The GCP is further described in **Section 3.3.6.** TMDLs are not available for waters impaired with dioxins, PCBs or DO. Due to the presence and proximity of agricultural and industrial land to the Study Area, construction of the Build Alternatives could result in the introduction of nitrogen and phosphorus to listed water bodies. Because of the impact these chemicals have on algal growth, there is potential for a reduction in DO levels. This impact would be minimized by implementing a SWPPP and sedimentation controls, as discussed below, to prevent nitrogen and phosphorus from entering water bodies. None of the Build Alternatives would introduce dioxins or PCBs to the environment and further contribute to impairment of 303(d) listed water bodies within the water quality Study Area. As discussed in **Section 3.5, Hazardous Materials and Solid Waste**, industrials sites that could possibly contain dioxins or PCBs would be investigated and remediated in accordance with federal, state and local standards prior to construction.

Erosion and sedimentation best management practices (WQ-MM#1), SWPPP controls and other requirements would be implemented to avoid and minimize impacts caused by soil erosion and sedimentation during construction. Due to potential discharge of pollutants to surface water, a TPDES permit, issued by the TCEQ, would be required to comply with Clean Water Act Section 402. By implementing avoidance, minimization and mitigation measures and complying with permits, as described in **Section 3.3.6**., sedimentation and runoff would be controlled and the impact to water quality would not be significant.

Groundwater Quality

Sedimentation and runoff from construction of the Build Alternatives could result in potential significant impacts to groundwater due to the 13 groundwater wells located within the water quality Study Area since these wells provide a more direct pathway for runoff to flow to groundwater. Potential impacts would include the introduction of contaminants from stormwater runoff via wellheads, and displacement of wellheads. In areas of MSDs, known contamination of groundwater and potentially soils exists. Construction in these areas would provide a path for contaminants to be transported via sedimentation and stormwater. Hazardous materials, such as petroleum and oil products used for fueling and maintenance of construction equipment, could also impact surface water and groundwater quality if spilled near waterbodies, wellheads or if they are spilled near a shallow aquifer; therefore, potentially leaching through soil into groundwater.

Of the 13 groundwater wells in the water quality Study Area, 7 would be located within the LOD for Segment 1 (1) and Segment 5 (6), and would therefore be impacted by all Build Alternatives. Segments 2A, 3A and 4 would impact one well each. Segment 3B would impact three wells. Build Alternative B would potentially impact the greatest number of groundwater wells (12) and Build Alternative F would potentially impact the least amount of groundwater wells (7). One groundwater well would be located within the LOD of the Industrial Site and Northwest Mall Terminal Options. The Northwest Transit Center Terminal Option would have no impact on groundwater wells.

As discussed in **Section 3.5.5, Hazardous Materials and Solid Waste** best management practices would be implemented during construction activities to prevent or minimize potential hazardous materials spills and contain areas of known contamination, including both soil and groundwater.

[69] TCEQ. "Implementation Plan for Seventy-Two Total Maximum Daily Loads for Bacteria in the Houston-Galveston Region," Austin, Texas, January 2013.

By implementing best management practices and mitigation discussed in **Section 3.3.6**, the pathway for contamination to reach groundwater would be removed; therefore, impacts to groundwater quality would be not significant.

Water Supply

As stated in **Section 3.3.4**, Lake Limestone Reservoir is located near Segment 4 of the Study Area. Lake Limestone would experience indirect impacts related to sedimentation and stormwater during construction of Build Alternatives A, B, D or E. While no portions of the Lake Limestone Reservoir intersect Build Alternatives A, B, D and E, tributaries to Lake Limestone intersect Segment 4 at Big Creek, Sanders Creek and Lamb Creek. The Brazos River Authority was contacted to determine if the Build Alternatives would impact Lake Limestone. In a response letter dated January 14, 2016, the Brazos River Authority indicated that there would be no potential direct impacts to operation of Lake Limestone during construction (**Appendix C**). Additionally, the portions of Segment 4 that would intersect the tributary arm to Lake Limestone would be constructed on viaduct, which would minimize ground disturbance and the need for added fill, thereby minimizing potential indirect impacts from stormwater runoff. It is anticipated that the Build Alternatives C and F would have no impacts to Lake Limestone.

A coordination letter regarding the Richland-Chamber Reservoir was sent to the San Jacinto River Authority on January 12, 2016. On January 21, 2016, the San Jacinto River Authority indicated via electronic mail they had received the letter, had no concerns about potential impacts and did not suggest any mitigation (**Appendix C**).

Threats to water quality for surface water supplies and groundwater supplies are discussed above. Significant permanent physical impacts would occur to groundwater wells, including public water system wells, where construction of the HSR would overlap the location of the wells. To avoid sediments and contamination from reaching the groundwater supply, plugging and abandonment and/or relocation of the wells would be necessary. Prior to the start of construction, wells would be plugged and abandoned according to TCEQ regulations. The Texas Department of Licensing and Regulation regulates public water system wells. Any necessary modifications, such as relocation, to public water system wells would occur according to Texas Department of Licensing and Regulation specifications, as described in **Section 3.3.6**.

Increased water demand would occur during construction. Aside from drinking water for construction crews, water would be used for construction activities such as dust suppression and mixing concrete. Water demand during construction would not be anticipated to require construction or expansion of a water treatment facility, or expanded water entitlements. Therefore, water demand during construction would not be significant (**Section 3.9.5, Utilities and Energy)**.

3.3.5.2.2 Operational Impacts

Operational impacts would result from stormwater runoff and operation activities, such as maintenance of culverts or bridges, fueling and train maintenance activities, and obtaining water supplies for the operational facilities and trains. A discussion of these operational impacts by surface water quality, groundwater quality, and water supply is provided below.

Surface Water Quality

New transportation infrastructure, including rail ROW, maintenance facilities and terminal stations, would increase the amount of impervious surface (pavement), influencing surface water flow and potentially slowing the recharge of surface water to groundwater. Placement of culverts, viaduct support structures and other fill where the Build Alternatives would be on embankment may also influence drainage patterns, which could potentially affect water resources. Long-term impacts to surface water quality from operation and maintenance of the Build Alternatives would include increased runoff as a result of the new impervious areas. Overall, the Build Alternatives would not cause changes to the flow regime of impacted streams. Stormwater runoff may have a slightly longer flow path and/or would be stored temporarily prior to discharge into a stream, but the use of fully spanned bridges, spanned bridges with piers, and culvert crossings would generally allow flow to maintain its pre-construction path without expected additions of organic material (phosphorus/nitrogen) resulting from the Build Alternatives.

Operation of the railway would have permanent impacts on surface water quality including impaired stream segments. With the use of soil erosion preventative measures, efforts to keep runoff rates similar to existing conditions, and measures to prevent collected sediment and contamination from entering water in all watersheds (WQ-MM#5), impacts to water quality would be not significant.

Groundwater Quality

Operational activities, such as fueling and maintenance, would require the use of substances that contain hazardous substances and petroleum products. Groundwater contamination could occur if hazardous substances or petroleum products are spilled and subsequently leach into the groundwater through the ground. Contamination would be more likely in areas of porous soils and shallow groundwater or aquifer outcrop, such as areas with Wolfpen-Pickton-Cuthbert soils over the Carrizo-Wilcox Aquifer in Leon County (**Appendix E, Soils and Geology Technical Memorandum**). Groundwater wells could also provide a direct route for spills to access groundwater.

As discussed in **Section 3.5.5, Hazardous Materials and Solid Waste,** best management practices would be implemented during operation to prevent or minimize potential hazardous materials spills, including the potential for these materials to leach into groundwater. By implementing hazardous materials best management practices and eliminating wellheads as a conduit for pollution by plugging and/or displacement as discussed in Section 3.5.6.2, the potential for contaminants entering groundwater sources would be reduced. Therefore, the impacts to groundwater quality would be not significant.

Water Supply

Long-term increase in water demand would occur during operations at the stations and TMFs from food and beverage service, restrooms, meal preparation and train washing. Anticipated water demand during operations is depicted in **Table 3.3-8**.

Table 3.3-8: Build Alternatives Water Demand			
County	**Facility**	**Demand (gallons per day)**	**TOTAL (gallons per day)**
Dallas	Dallas Terminal	90,900	90,900
Grimes	Brazos Valley Station	29,654	29,654
Harris	Houston Terminal	93,060	93,060
Dallas and Harris	Two TMFs	30,720 (each)	61,440
Various	Five MOW Facilities	550 (each)	2,750
		TOTAL	**277,804**

Source: TCRR, 2016

The primary source of increased demand for potable water would be from operation of the terminal stations. The terminal stations would connect to a municipal water supply. A majority of the water supply would be from Dallas Water Utilities and the City of Houston. Design plans for the Build Alternatives would include reusing water in innovative ways such as reclaimed wastewater, condensation and rainwater for irrigation or toilet flushing. The MOWs would obtain potable water from local water supply facilities presented in **Table 3.9-3.** Each facility would also generate wastewater. Additional potable water required to supply the Build Alternatives and wastewater generated by the Build Alternatives is discussed in **Section 3.9.5, Utilities and Energy.**

Land subsidence resulting from increased groundwater drawdown has led to transitioning local water supplies in Harris County from the Gulf Coast Aquifer to surface water resources. HGSD implements restrictions on groundwater that become more stringent towards the southern end of the Study Area and would be applicable to the Houston Terminal Station options. As stated in **Section 3.9, Utilities and Energy**, the Houston Terminal Station options would meet their water supply needs using City of Houston water. City of Houston is in the ongoing process of transitioning water supply from groundwater to surface water in compliance with HGSD regulations. Obtaining water from the municipality would eliminate the need for additional groundwater wells; therefore, impacts of the Build Alternatives and Houston Terminal Station options on land subsidence would not be significant. See also **Section 3.8.5, Floodplains.**

The Brazos River Authority sent a response letter regarding Lake Limestone Reservoir as discussed in **Section 3.3.5.2.1**. The only concern the Brazos River Authority had at the time of correspondence was whether natural flow to Lake Limestone and its water supply would be impacted during operation of Build Alternatives A, B, D or E (**Appendix C**). The portions of Segment 4 that would intersect the tributary arm to Lake Limestone would be constructed on viaduct, which would minimize impervious cover and impacts to the natural path; therefore, the water supply capacity of Lake Limestone Reservoir would not be altered.

Impacts to water supply would be not significant. Impacts would require permits and approvals from the TCEQ and USACE that would include permit provisions to avoid, minimize and mitigate impacts, as detailed in **Section 3.3.6**.

3.3.6 Avoidance, Minimization and Mitigation

During construction of the Build Alternatives, impacts to water quality would be minimized by adhering to compliance measures and permitting described below. Drainage features, such as swales, culvert crossings, viaduct sections, and detention basins, have been incorporated into the design of the Build Alternatives to maintain water flow, provide natural filters for stormwater runoff and to ensure that off-site cross-drainage patterns would not be changed where practicable.[70] In addition, TCRR included design features to avoid and minimize impacts to water quality including placing approximately 60 percent of any of the Build Alternatives on viaduct in order to be able to span waters of the U.S. Construction on viaduct would reduce the need for pesticides and fertilizer as there would be no ground cover to maintain on viaduct sections; therefore, potential influx of pesticides and fertilizers to nearby waterbodies would be avoided. Necessary permits as described in **Section 3.3.6.1, Compliance Measures and Permitting**, shall be acquired before initiating construction.

3.3.6.1 Compliance Measures

The following Compliance Measures (CM) and permits for water quality would be required for Build Alternatives A through F.

WQ-CM#1: Section 401 Water Quality Certification. Prior to construction, TCRR shall obtain a Clean Water Act Section 401 Water Quality Certification from the TCEQ as part of the Section 404 process described in **Section 3.7, Waters of the U.S.** TCRR shall complete the Section 401 documentation for review by TCEQ concurrent to the USACE's review of the Section 404 permit application. TCEQ may request additional information from TCRR. If the submittal is sufficient, the USACE and TCEQ may issue a Joint Public Notice during the Draft EIS review period to inform the public and government agencies about the Project. The USACE would not render a decision for a Section 404 permit until TCRR obtains the Section 401 certification.[71]

WQ-CM#2: TPDES General Construction Permit (TXR150000). General Construction Permits regulate stormwater discharges by providing administrative controls of the quantities, locations and types of discharges during construction activities to reduce the amount of erosion, sedimentation and pollution entering surface waters. The TCEQ reviews and enforces General Construction Permits in Texas. Provisions of the General Construction Permit state a permittee must develop and implement measures to reduce erosion, sedimentation and pollutant discharge; immediately stabilize soils upon completion of earth disturbing activities and adhere to dewatering and surface outlet controls. The General Construction Permit also outlines which discharges are allowed and which are prohibited.

Prior to construction, TCRR shall obtain a General Construction Permit from the TCEQ. TCRR shall adhere to the following requirements as part of the process to obtain a General Construction Permit:

1) Prepare a SWPPP
2) Submit an original completed Notice of Intent for stormwater discharges associated with construction activity under the General Construction Permit to the TCEQ and pay the general permit construction storm water discharge Notice of Intent application fee.
3) Before starting construction, post a copy of the Site Notice at the construction site. Leave the notice posted until construction is completed
4) After obtaining coverage TCRR must:
    - Adhere to permit requirements

[70] Drainage design details for each crossing are included in Appendix E, Waters of the U.S. Technical Memorandum and the *Texas Central Partners Texas High Speed Rail Final Draft Conceptual Engineering Report-FDCERv7*," September 15, 2017.
[71] TCEQ, "401 Certification Reviews," Accessed July 2016.
https://www.tceq.texas.gov/permitting/401certification/401certification_definition.html

- Submit a Notice of Termination within 30 days after one or more of the following occurs:
    i. final stabilization has occurred
    ii. another permitted operator has assumed control over all areas of the site that have not been finally stabilized, and all temporary erosion control measures have either been removed, scheduled for removal, or transferred to a new operator as described in the SWPPP
    iii. authorization was granted under an individual permit

WQ-CM#3: Stormwater Management/Stormwater Pollution Prevention Plan. Prior to construction and submittal of the Notice of Intent, TCRR shall prepare and submit a SWPPP to the TCEQ to address authorized discharges that would reach waters of the U.S., including discharges to MS4s and privately owned separate storm sewer systems that drain to waters of the U.S., to identify and address potential sources of pollution that are reasonably expected to affect the quality of discharges from the construction site. TCRR or its construction contractor shall be responsible for implementing the SWPPP throughout the construction period.

As part of the Section 401 Water Quality Certification requirements and SWPPP, TCRR and/or its construction contractor shall identify and implement temporary stormwater controls. To confine sediment prior to the start of construction, the construction area shall be isolated from waterbodies and wetlands using the control measures below. Dredged and fill material shall be stored in a way that prevents sedimentation runoff to water bodies. These control measures shall be submitted to TCEQ for approval as part of the SWPPP during the pre-construction planning period, and may include the following:

1) Sand Bag Berm
2) Silt Fence
3) Triangular Filter Dike
4) Rock Berm
5) Hay Bale Dike
6) Brush Berms
7) Stone Outlet Sediment Traps
8) Erosion Control Compost
9) Compost Filter Socks
10) Sediment Basins
11) Mulch Filter Socks
12) Bypass pump-around system, or similar alternative – to be used in conjunction with berms for effective dewatering.

Disturbed areas shall be stabilized during construction to prevent sediment from entering adjacent water bodies and wetlands during wet conditions. Prior to construction, stormwater control measures shall be submitted to TCEQ for approval as part of the SWPPP.

1) Temporary Vegetation
2) Blankets/Matting
3) Mulch
4) Sod
5) Interceptor Swale
6) Diversion Dike
7) Erosion Control Compost
8) Mulch Filter Socks
9) Compost Filter Socks

Additionally, during construction, TCRR and/or its construction contractors shall restrict all construction activities to permanent and temporary workspaces and easements. This control measure shall be submitted to TCEQ for approval as part of the SWPPP.

WQ-CM#4: Compliance with MS4 Requirements. Prior to construction TCRR shall provide the City of Houston and the City of Dallas, and the MS4 operators, with a SWPPP and a notice of intent. During the construction phase the MS4 operators shall conduct inspections of the construction site every 14 calendar days, and TCRR or the construction site operator shall conduct regular inspections, maintenance and recordkeeping to determine if appropriate controls measures have been installed and implemented.

3.3.6.2 Mitigation Measures

The following Mitigation Measures (MM) would be implemented to minimize impacts to water quality as a result of Build Alternatives A through F.

WQ-MM#1: Maintenance and Inspection of Temporary Erosion and Sediment Controls. Prior to construction, TCRR and/or its contractors shall include inspection and maintenance measures in the site best management practice plans to be implemented during construction activities. These control measures shall be submitted to TCEQ for approval as part of the SWPPP during the pre-construction planning period. [72,73]

1) Silt and sediment shall be removed from devices when the capacity of the device reached 50 percent of the original capacity.
2) Deteriorated materials shall be repaired or replaced when discovered.
3) Within 24 hours of a rain event consisting of greater than or equal to 0.5 inch, the contractor and engineer shall inspect the entire project to evaluate the condition of erosion and sediment controls.

WQ-MM#2: Crew Training. Prior to and throughout construction, TCRR shall hire and maintain a qualified representative to train construction crews and contractors and oversee the installation and maintenance of erosion and sediment controls and other best management practices.

[72] Texas Department of Transportation. *Storm Water Management Guidelines for Construction Activities.* TxDOT Environmental Affairs Division, July 2002.
[73] Texas Commission on Environmental Quality, *Description of BMPs*, TCEQ, August 21, 2003.

WQ-MM#3: Site-restoration and Revegetation. Upon completing construction activities, TCRR or their qualified representative shall restore temporary construction areas to similar to (or better if feasible) preexisting conditions. Additionally, where feasible, seed mixes approved by U.S. Department of Agriculture shall be used to minimize the introduction of invasive species.

WQ-MM#4: Well Modifications. Prior to the start of construction, TCRR shall identify and coordinate all well plugging and abandonment or relocations (drilling) with TCEQ. Additionally, TCRR shall hire licensed drillers in accordance with Texas Department of Licensing specifications outlined in 16 TAC 76.74

WQ-MM#5: New Well Permits/Registrations in GCD. Prior to construction, should wells be relocated by the Build Alternative within the Bluebonnet, Prairielands and Mid-East Texas GCD, TCRR and the well-owner shall coordinate with TCEQ and permit and/or register the relocated wells with the Bluebonnet, Prairielands and Mid-East Texas GCD .

See also **HM-MM#2: Hazardous Materials Management** and **HM-MM#4: Waste Management** in **Section 3.5.6.2, Hazardous Materials and Solid Waste.**

WQ-MM#6. Total Suspended Solids/Stormwater Runoff Control (Permanent). Once construction is completed and the area is stabilized, TSS and sediment will be controlled by TCRR so they do not enter adjacent water bodies.

1) Retention/irrigation systems
2) Extended Detention Basin
3) Vegetative Filter Strips
4) Grassy Swales
5) Erosion Control Compost
6) Compost Filter Socks
7) Sedimentation Chambers
8) Constructed Wetlands
9) Wet Basins
10) Compost Filter Socks
11) Vegetation lined drainage ditches
12) Sand Filter Systems
13) Mulch Filter Socks

See also **FP-CM#2, Construction Floodplain Best Management Practices** in **Section 3.8.6.1, Floodplains** and Section 3.8.5.2.3 for discussion of detention basins that would also provide a filter for sedimentation and contaminants from reaching surface water.

3.3.7 Build Alternative Comparison

In general, the potential impacts to water quality and water supply are similar for all Build Alternatives. **Table 3.3-19** provides a summary of all resources analyzed in this section.

[74] Water Well Drillers and Water Well Pump Installers. *Texas Administrative Code.* Title 16. Chapter 76.

Table 3.3-9: Potential Impacts by Build Alternative

Resource	Build Alternatives						Houston Terminal Station Options		
	ALT A	ALT B	ALT C	ALT D	ALT E	ALT F	Northwest Transit Center Terminal	Northwest Mall Terminal	Industrial Site Terminal
Impaired Waterbodies – 303(d) List (Feet)	913.8	913.8	913.8	913.8	913.8	913.8	0	0	0
Impaired Waterbodies with TMDLs (Feet)	1044.2	1044.2	1044.2	1044.2	1044.2	1044.2	0	0	0
Impaired Waterbodies Total (Feet)	1044.2	1044.2	1044.2	1044.2	1044.2	1044.2	0	0	0
Active Public Water System Wells	2	2	3	2	2	3	0	0	0
Groundwater Wells	9	11	7	8	10	6	0	1	1
Reservoir/Dam Crossings	0	0	0	0	0	0	0	0	0

Source: AECOM, 2016

Based on the data presented in **Table 3.3-9**, waterbodies included on the 303(d) List and waterbodies with active TMDLs intersect the LOD in Segments 1 and 5 only; therefore, the same impacts would occur regardless of the Build Alternative.

Build Alternative B would potentially impact the greatest number of groundwater wells (11) and Build Alternative F would potentially impact the least number of groundwater wells (6). In addition, one groundwater well would be located within the LOD of the Industrial Site and Northwest Mall Terminal Station options, while no groundwater wells would be located within the Northwest Transit Center Terminal Option.

Build Alternatives A, B, D and E would impact two public water supply wells, and Build Alternatives C and F would impact three public water supply wells.

Build Alternatives C and F would not be located near any reservoirs or dams. Build Alternatives A, B, D and E would cross tributaries draining to Lake Limestone, a water supply reservoir, resulting in indirect water quality impacts to Lake Limestone.

The increase demand for water supply would be the same for all Build Alternatives. Based on the information presented in **Section 3.3.5, Environmental Consequences** and **Table 3.3-9**, there is no notable difference in anticipated impacts to surface water quality, groundwater quality and water supply as a result of the Build Alternatives.

This page intentionally left blank.

3.4 Noise and Vibration

3.4.1 Introduction

This section describes the assessment of potential noise and vibration impacts from construction and operation of the Build Alternatives, as well as recommended mitigation measures to eliminate or reduce these impacts.

3.4.1.1 Noise Basics

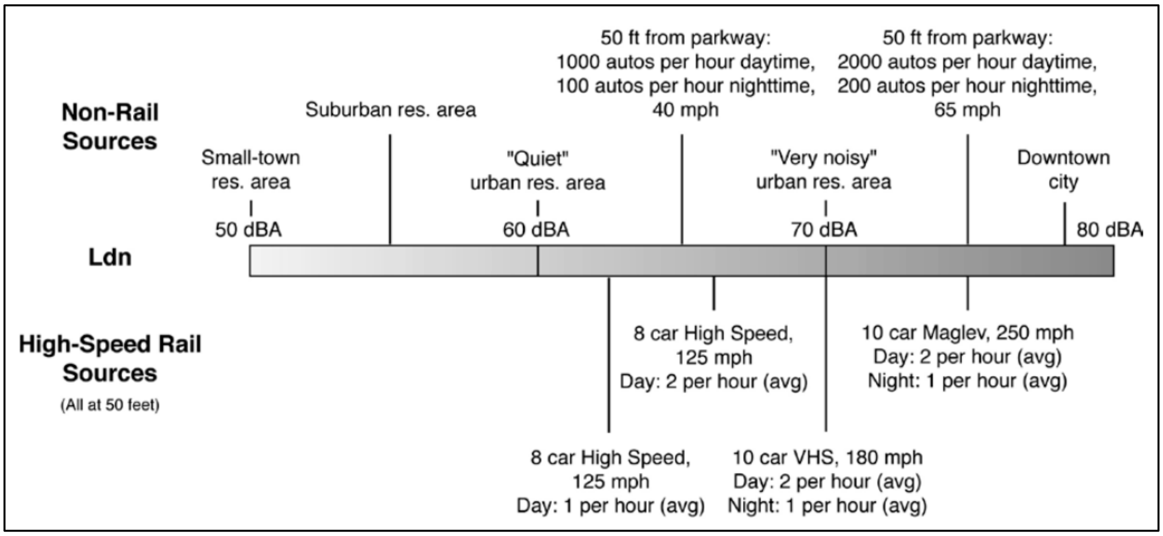
Sound is characterized by small changes in air pressure above and below the standard atmospheric pressure and noise is unwanted sound. The three parameters that describe noise include:

- **Level**–The level of sound is the amount of air pressure change above and below atmospheric pressure, and is expressed in decibels (dB) with a reference value of 20 micro-Pascals. Typical sounds fall within a range from 0 dB (the lower limits of human hearing) to 120 dB (the highest sound levels experienced in the environment). A 3 dB change in sound level is perceived as a barely noticeable change outdoors and a 10 dB change in sound level is perceived as a doubling (or halving) of the loudness of a sound.

- **Frequency**–The frequency (pitch or tone) of sound is the rate of air pressure fluctuation and is expressed in cycles per second, or Hertz (Hz). Human ears can detect a wide range of frequencies from about 20 Hz to 20,000 Hz. However, human hearing is not as effective at high and low frequencies, and thus the A-weighting system (dBA) was developed to better correlate noise with human response. The A-weighting system reduces the sound levels of higher and lower frequency sounds—similar to what humans hear. The A-weighted sound level has been widely adopted by acousticians as the most appropriate descriptor for environmental noise.

- **Time Pattern**–Because environmental noise is constantly changing, it is common to condense all of this information into a single number, called the “equivalent” sound level (Leq). The Leq represents the continuously changing sound level over a period of time, typically 1 hour or 24-hours for rail transportation noise assessments. For rail projects, the Day-Night Sound Level (Ldn) is the noise descriptor commonly used, and has been adopted by FRA and FTA as the best way to describe how people respond to noise in a residential environment. Ldn is a 24-hour cumulative A-weighted noise level that includes all noises that occur over a full day, with a 10 dB penalty for nighttime noise (between 10 PM and 7 AM). This nighttime penalty means that noise events at night are equivalent to ten similar events during the day. Typical Ldn values for high-speed rail sources and non-rail sources are shown in **Figure 3.4-1**.

Figure 3.4-1: Typical Ldn Values



Source: FRA, "High-Speed Ground Transportation Noise and Vibration Impact Assessment," Final Report DOT/FRA/ORD-12/15, September 2012

3.4.1.2 Vibration Basics

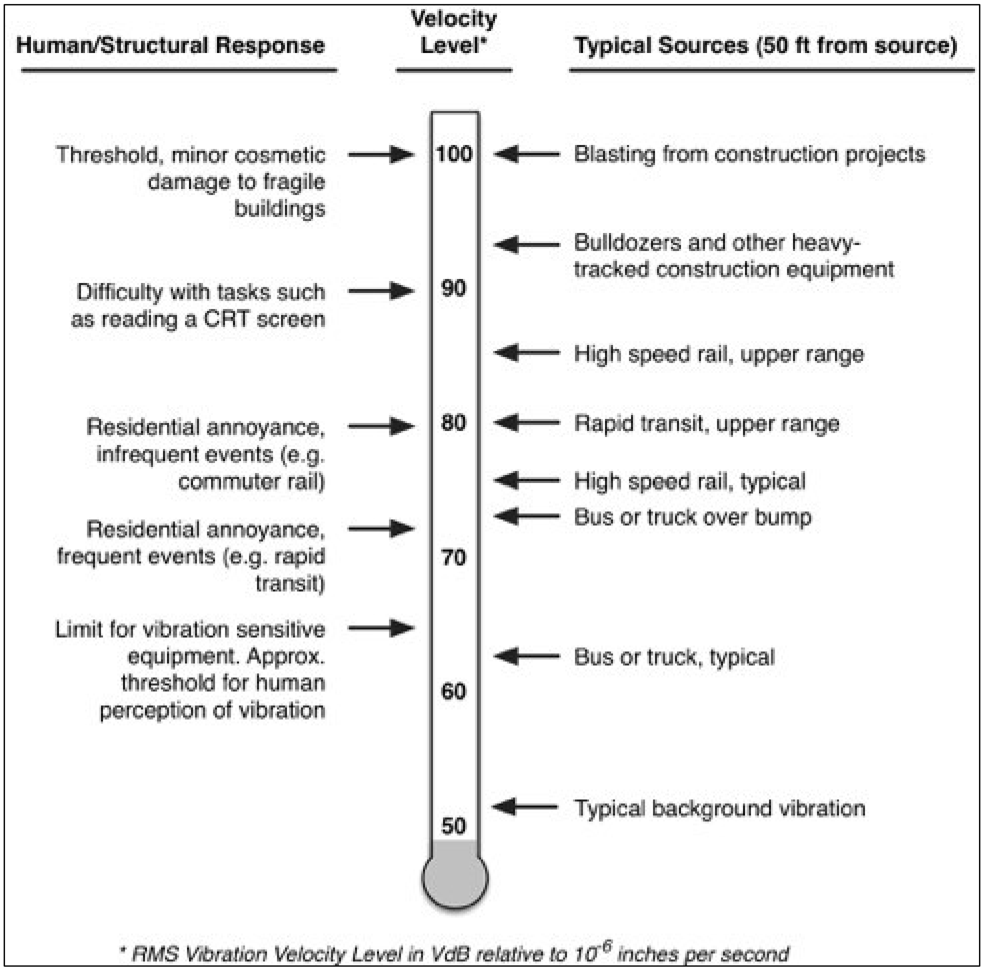
Ground-borne vibration is the motion of the ground transmitted into a building that can be described in terms of displacement, velocity, or acceleration. Vibration velocity is used for rail system projects and is defined by the following:

- **Level**—Vibration is expressed in terms of root mean square vibration velocity level, using vibration decibels (VdB), with a reference value of one micro-inch per second. The level of vibration velocity represents how fast the ground is moving. The root mean square level, representing a "smoothed" vibration signal, is used rather than the instantaneous level because the human body responds to an average of the vibration impulses. The threshold of human perception to vibration from rail operations is approximately 65 VdB and annoyance begins to occur for frequent events at vibration levels over 70 VdB.
- **Frequency**—Vibration frequency is expressed in Hertz (Hz). Human response to ground-borne vibration is typically greatest at frequencies from about 5 Hz to 200 Hz.
- **Time Pattern**—Environmental vibration changes with time and human response is roughly correlated to the number of vibration events over the day. The more events that occur, the more annoyed humans are by the vibrations.

Common vibration sources and human and the structural response to ground-borne vibration are illustrated in **Figure 3.4-2**.

The vibration of floors and walls may cause perceptible vibration, rattling of items such as windows or dishes on shelves, or a rumbling sound caused by the vibration of room surfaces (similar to the way a loudspeaker works). This rumbling sound inside buildings is called ground-borne noise, and the annoyance potential of ground-borne noise is usually characterized by using the A-weighted sound level. However, because ground-borne noise is dominated by low-frequency components that sound louder than broadband noise with the same A-weighted level, ground-borne noise limits are set lower than for broadband noise whose energy is distributed over a wide section of the audible range.

Figure 3.4-2: Typical Levels of Ground-borne Vibration



Source: FRA, "High-Speed Ground Transportation Noise and Vibration Impact Assessment," Final Report DOT/FRA/ORD-12/15, September 2012

3.4.2 Regulatory Context

Federal

Several federal laws and guidelines are relevant to the assessment of ground transportation noise impacts:

- FRA Railroad Noise Emission Compliance Regulations (49 C.F.R. Part 210) prescribes minimum compliance regulations for enforcement of the Railroad Noise Emission Standards established by the Environmental Protection Agency in 40 C.F.R. Part 201
- The Noise Control Act of 1972 (42 U.S.C. § 4901 et seq.) was the first comprehensive statement of national noise policy. It declared "it is the policy of the U.S. to promote an environment for all Americans free from noise that jeopardizes their health or welfare."
- HUD Environmental Standards (24 C.F.R. Part 51) establishes standards for noise exposure used to assess the suitability of sites for new residential development

- OSHA Occupational Noise Exposure; Hearing Conversation Amendment (FR 48 (46), 9738—9785) establishes noise exposure limits in the work place
- EPA Railroad Noise Emission Standards (40 C.F.R. Part 201) establishes standards for noise emissions from railroads

For vibration, federal standards for safe vibration levels for residential buildings are limited to the safe blasting levels established by the U.S. Bureau of Mines (USBM RI 8507).

State

There are no state-wide noise or vibration regulations that apply to transportation systems. The TxDOT *Guidelines for Analysis and Abatement of Roadway Traffic Noise* applies to vehicular traffic. Texas does not have separate guidance for rail noise and vibration.

Local

Local noise and vibration regulations are contained in city ordinances and general plans. Although noise and vibration from transportation systems are typically exempt from local regulations, noise and vibration from project construction activities and stationary sources (e.g., traction power substations) shall comply with the following local regulations:

City of Lancaster

Ordinance #2006-04-13 of the Lancaster Development Code includes environmental performance standards for both noise and vibration. Section 14.704 of the ordinance specifies noise limits of 56 dBA during daytime hours (7 AM – 7 PM) and 49 dBA during nighttime hours (7 PM – 7 AM) near property lines, which could be applied to stationary sources. Although there are no specific noise limits for construction activities, such noise is restricted to the hours between 6 AM and 9 PM. In addition, Section 14.708 of the ordinance includes property-line vibration standards based on frequency and ground displacement that could be applied to construction activities.

City of Wilmer

Section 8.06 of the Wilmer Code of Ordinances includes property-line limits on environmental sound levels from stationary sources in terms of A-weighted, statistical percentile noise metrics measured over a 10-minute to 30-minute period. These metrics include the L_1 (level exceeded 1 percent of the period), the L_{10} (level exceeded 10 percent of the period) and the L_{90} (level exceeded 90 percent of the period). The L_1 (near maximum) noise level from stationary sources is limited to 15 dBA above the ambient L_{90} (background) noise level. There are also L_{10} and L_{90} limits based on land use and time of day. For residential land use, the L_{10} and L_{90} limits are 65 dBA and 55 dBA, respectively, during daytime hours (7AM – 10 PM) and 60 dBA and 50 dBA, respectively, during nighttime hours (10 PM – 7 AM). For construction work, the L_{10} and L_{90} limits are 85 dBA and 75 dBA, respectively, at any time.

City of Houston

Chapter 30 of the City of Houston Code of Ordinances specifies noise limits of 65 dBA and 58 dBA at residential property lines for daytime and nighttime periods, respectively. However, noise from railroad equipment on railroad ROWs is exempted. Noise from construction between the hours of 7 AM and 8 PM is also exempted, provided the noise levels do not exceed 75 dBA at residential property lines.

3.4.3 Methodology

3.4.3.1 Analysis Methods

Noise-sensitive and vibration-sensitive land uses in the Study Area were initially identified based on GIS data, aerial photography, drawings, plans and a field survey. Procedures from the FRA guidance manual[1] were applied for establishing the extent of the Study Area to be evaluated for the noise and vibration impact analyses. The screening distances applicable to these analyses are 1,300 feet for noise impact (new HSR corridor in a rural area) and 275 feet for vibration (frequent operation at speeds of 200 to300 mph near residential land use). These distances from the FRA guidance manual are based on assumptions for the HSR operations and existing environment, and are meant to provide a distance within which any potential impacts from HSR operations would be identified. Beyond these distances, no impacts would occur.

Noise measurements of the A-weighted sound level for both long-term (24-hour) and short-term (one-hour) periods were then collected at representative locations to document existing noise conditions at sensitive receivers (e.g., residences and institutional sites). In some areas of the Study Area limited access to the property required short-term measurements. The measurement locations were selected to represent the existing noise conditions in areas adjacent to each segment of the Build Alternatives in each county within the Study Area (see **Figures 3.4-5 through 3.4-8** for noise measurement locations). Because the FRA noise criteria (see **Section 3.4.3.2**) are based on the existing noise levels, measuring the existing noise and characterizing noise levels at sensitive locations in the Study Area was the first step in the impact assessment.

Ground-borne vibration tests were also performed at representative locations in the Study Area to determine how vibration travels through the ground near vibration-sensitive locations (e.g., residential or institutional buildings). The test sites were selected to represent the soil conditions along the Build Alternatives in each county within the Study Area (see **Figures 3.4-9 through 3.4-12** for vibration measurement locations). At each location, tests were conducted by impacting the ground with an instrumented weight and measuring the response of the soil at various distances. The results of the ground vibration tests were combined with vehicle (train) information to predict vibration levels from operations at sensitive locations along each of the Build Alternatives. More information about the vibration testing procedures, instrumentation and detailed results is provided in the **Appendix E, Noise and Vibration Technical Memorandum**.

Project information for use in the analysis was obtained from TCRR[2], consisting of: (1) plan and profile maps of the Build Alternatives including crossover locations, MOW facility plans, layover/storage locations, station locations and TPSS locations; (2) trainset characteristics and operational data and; (3) sound data gathered in Japan for the Tokaido Shinkansen N700-A train. Available information about the Shinkansen system and the results of field noise and vibration measurements were used in the prediction and assessment when applying the methodology from the FRA guidance manual.[3] The FTA guidance manual[4] was used to supplement the FRA guidance manual.

[1] FRA, "High-Speed Ground Transportation Noise and Vibration Impact Assessment," Final Report DOT/FRA/ORD-12/15, September 2012.
[2] Texas Central Partners, "Texas High Speed Rail Revised Draft Conceptual Engineering Report – RDCE," April 29, 2016.
[3] FRA, "High-Speed Ground Transportation Noise and Vibration Impact Assessment," Final Report DOT/FRA/ORD-12/15, September 2012.
[4] FTA, "Transit Noise and Vibration Impact Assessment," Final Report FTA-VA-90-1003-06, May 2006.

FRA noise and vibration impact criteria, described below, were used to assess noise and vibration impacts and to identify noise-sensitive locations close to the tracks where increased annoyance could occur from a sudden increase in noise (the startle effect) from the rapid approach of a train. For HSR trains, FRA methodology, consisting of a General Noise Assessment as described in Chapter 4 of the FRA guidance manual and a Detailed Vibration Assessment as described in Chapter 9 of the FRA guidance manual, were applied at residences, schools, hotels/motels, medical facilities or other sensitive receivers within the Study Area described above. For sources of noise and vibration not addressed in the FRA guidance manual (which only addresses HSR operational noise and vibration, and defers to the FTA guidance manual for other sources), such as stations and MOW facilities, the screening procedures described in the FTA guidance manual were used.

3.4.3.2 Impact Criteria

Noise and vibration impact guidelines have been adopted by the FRA that present methods for analyzing and assessing noise and vibration impacts. The impact criteria are based on maintaining a noise environment considered acceptable for land uses where noise may have an effect. The FRA guidance manual[3] provides noise and vibration criteria for both construction and HSR operation as described below.

3.4.3.2.1 Construction Noise Impact Criteria

Table 3.4-1 presents the FRA general assessment criteria for construction noise. The criteria are given in terms of 1-hour Leq for residential, commercial and industrial land use. The 1-hour Leq is estimated by combining the noise levels from the 2 noisiest pieces of equipment, assuming they would both operate at the same time during a 1-hour period.

Table 3.4-1: FRA General Assessment Criteria for Construction Noise

Land Use	1-Hour Leq (dBA)	
	Day	Night
Residential	90	80
Commercial	100	100
Industrial	100	100

Source: FRA, "High-Speed Ground Transportation Noise and Vibration Impact Assessment," Final Report DOT/FRA/ORD-12/15, September 2012

3.4.3.2.2 Construction Vibration Impact Criteria

Guidelines in the FRA guidance manual[5] provided the basis for the construction vibration impact assessment. FRA's construction vibration criteria are designed primarily to prevent building damage, and to assess whether vibration might interfere with vibration-sensitive building activities or temporarily annoy building occupants during the construction period. The FRA criteria include two ways to express vibration levels: (1) root-mean-square VdB for annoyance and activity interference, and (2) peak particle velocity (PPV), which is the maximum instantaneous peak of a vibration signal used, for assessments of damage potential.

[5] FRA, "High-Speed Ground Transportation Noise and Vibration Impact Assessment," Final Report DOT/FRA/ORD-12/15, September 2012.

To avoid temporary annoyance to building occupants during construction or construction interference with vibration-sensitive equipment inside special-use buildings, such as recording studios, FRA recommends using the long-term vibration criteria.

Table 3.4-2 shows the FRA vibration damage criteria from construction activities for four building categories. These limits are used to detect potential problems that would require mitigation during final design.

Table 3.4-2: Construction Vibration Damage Criteria

Building Category	PPV (inch/sec)	Approximate L_v*
I. Reinforced concrete, steel or timber (no plaster)	0.5	102
II. Engineered concrete and masonry (no plaster)	0.3	98
III. Non-engineered timber and masonry buildings	0.2	94
IV. Buildings extremely susceptible to vibration damage	0.12	90
* Root mean square vibration velocity level in VdB relative to 1 micro-inch/second.		

Source: FRA, "High-Speed Ground Transportation Noise and Vibration Impact Assessment," Final Report DOT/FRA/ORD-12/15, September 2012

3.4.3.2.3 *Operational Noise Impact Criteria*

The operational noise impact criteria are based on the information in Chapter 3 of the FRA guidance manual.[6] The FRA noise impact criteria are based on well-documented research of community response to noise and are based on both the existing level of noise and the change in noise exposure due to a project. The FRA noise criteria compare the noise generated by the Build Alternatives with the existing noise rather than the No Build Alternative noise levels because these may be different in the analysis year (2040) due to changes in the noise environment that could be caused by other projects in the vicinity.

The FRA noise criteria are based on the land use category of the sensitive receiver, and use the Ldn metric for locations where people sleep (Category 2) and the Leq metric for locations with daytime and/or evening use (Category 1 or 3), as shown in **Table 3.4-3**.

Table 3.4-3: Federal Railroad Administration Land Use Categories for Noise Impact Assessments

Land Use Category	Noise Metric (dBA)	Land Use Category
1	Outdoor $L_{eq}(h)$*	Tracts of land where quiet is an essential element in their intended purpose. This category includes lands set aside for serenity and quiet, and such land uses as outdoor amphitheaters and concert pavilions, as well as National Historic Landmarks with significant outdoor use.
2	Outdoor L_{dn}	Residences and buildings where people normally sleep. This category includes

[6] FRA, "High-Speed Ground Transportation Noise and Vibration Impact Assessment," Final Report DOT/FRA/ORD-12/15, September 2012.

		homes, hospitals and hotels where nighttime sensitivity to noise is assumed to be of utmost importance.
3	Outdoor $L_{eq}(h)^{*}$	Institutional land uses with primarily daytime and evening use. This category includes schools, libraries and churches, where it is important to avoid interference with such activities as speech, meditation and concentration. Buildings with interior spaces where quiet is important, such as medical offices, conference rooms, recording studios and concert halls fall into this category, as well as places for meditation or study associated with cemeteries, monuments and museums. Certain historical sites, parks and recreational facilities are also included.

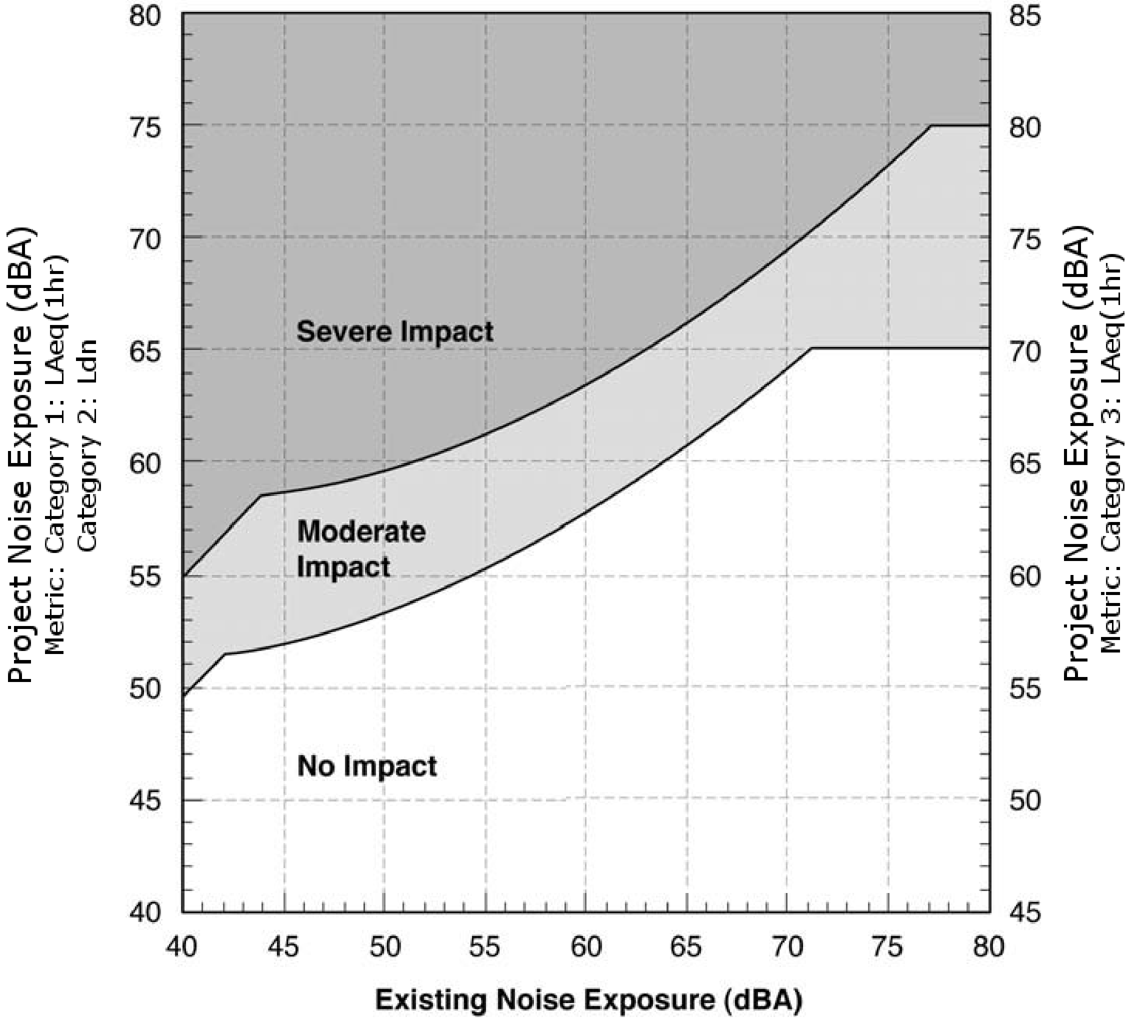
Source: FRA, “High-Speed Ground Transportation Noise and Vibration Impact Assessment,” Final Report DOT/FRA/ORD-12/15, September 2012
Note: * L_{eq} for the noisiest hour of transit-related activity during hours of noise sensitivity.

The noise impact criteria are based on changes in noise exposure using a sliding scale and are defined by the two curves shown in **Figure 3.4-3**. As shown in the figure, higher noise levels are allowed in areas with higher levels of existing noise, and the criteria curves incorporate a maximum limit for noise. However, when considering the total noise exposure (combining the project-generated noise with the existing noise), the criteria actually allow smaller increases in total noise with increasing levels of existing noise. The FRA noise impact criteria include the following three levels of impact, as shown in **Figure 3.4-3**:

- **No Impact**—In this range, the Build Alternatives would have no impact since the introduction of the Build Alternatives would result in an increase in the noise levels that are below the threshold defined by the criteria in **Table 3.4-3**.
- **Moderate Impact**—Within the moderate impact range in **Figure 3.4-3**, changes in the noise level are noticeable, but the change is not high enough to cause major annoyance or strong, adverse reactions from the community. In this transitional area, other Project-specific factors must be considered to determine the need for mitigation, such as the existing noise level, the predicted increase over existing noise levels and the types and numbers of noise-sensitive land uses affected. For example, in areas where there are more moderate impacts, there may be a greater need for mitigation since more people would be affected.
- **Severe Impact**—Within the severe impact range in **Figure 3.4-3**, changes in the noise due to the Build Alternatives would have the potential to be highly annoying and to cause strong, adverse reactions from the community. Severe noise impacts should be avoided if possible. Noise mitigation should be applied for severe impacts wherever feasible.

To provide a sense for what the above noise impact levels represent in everyday terms, consider the example of family members relaxing and conversing in their backyard on a quiet weekend. If someone down the street begins to mow their lawn, it would probably be noticeable but not loud enough to be particularly annoying or to interfere with conversation - this condition might be characterized as “moderate noise impact.” However, if a next door neighbor begins to use a leaf blower or chain saw, it would likely disrupt normal conversation and be highly annoying. The latter case could be characterized as “severe noise impact.”

Figure 3.4-3: FRA Noise Impact Criteria



Source: FRA, "High-Speed Ground Transportation Noise and Vibration Impact Assessment," Final Report DOT/FRA/ORD-12/15, September 2012

To supplement the noise impact criteria in **Figure 3.4-3**, FRA[7] provides guidelines for identifying noise-sensitive locations where increased annoyance can occur due to a sudden increase in noise (the startle effect) from the rapid approach of HSR trains. This effect is separate from the impact criteria defined above, and is dependent on the train speed and trainset and would be confined to an area very close to the tracks. For example, 200 mph train operations would have the potential for increased annoyance within about 40 feet of the track centerline. Thus, the area where rapid onset rates of train noise may cause startle would typically be within the ROW limits of the rail corridor.

FRA also addresses impacts on wildlife (mammals and birds) and domestic animals (livestock and poultry). Noise exposure limits for each are a Sound Exposure Level[8] of 100 dBA from passing trains, as shown in **Table 3.4-4**.

[7] FRA, "High-Speed Ground Transportation Noise and Vibration Impact Assessment," Final Report DOT/FRA/ORD-12/15, September 2012.

[8] The Sound Exposure Level (SEL) describes a receiver's cumulative noise exposure from a single noise event (a passing train in this case). It is represented by the total A-weighted sound energy during the event, normalized to a one-second interval.

Table 3.4-4: FRA Interim Criteria for Train Noise Effects on Animals

Animal Category	Class	Noise Metric	Noise Level (dBA)
Domestic	Mammals (Livestock)	SEL	100
	Birds (Poultry)	SEL	100
Wild	Mammals	SEL	100
	Birds	SEL	100

Source: FRA, "High-Speed Ground Transportation Noise and Vibration Impact Assessment," Final Report DOT/FRA/ORD-12/15, September 2012

3.4.3.2.4 Operational Vibration Impact Criteria

The operational vibration impact criteria were based on the information contained in Chapter 7 of the FRA guidance manual.[9] The criteria for a general vibration assessment are based on land use and train frequency, as shown in **Table 3.4-5**. Some buildings, such as concert halls, recording studios and theaters, can be very sensitive to vibration (or ground-borne noise), but do not fit into the three categories listed in **Table 3.4-5**. **Table 3.4-6** shows the FRA criteria for acceptable levels of vibration for several types of special buildings.

Tables 3.4-5 and 3.4-6 include additional criteria for ground-borne noise. The criteria for ground-borne noise are much lower than for airborne noise to account for the low-frequency character of ground-borne noise. However, because airborne noise often masks ground-borne noise for above ground (at-grade or elevated) HSR systems, ground-borne noise is typically assessed only for locations such as recording studios that are well insulated from airborne noise.

[9] FRA, "High-Speed Ground Transportation Noise and Vibration Impact Assessment," Final Report DOT/FRA/ORD-12/15, September 2012.

Table 3.4-5: Ground-Borne Vibration and Noise Impact Criteria

Land Use Category	Ground-Borne Vibration Impact Levels (VdB re 1 micro-inch /sec)			Ground-Borne Noise Impact Levels (dBA re 20 micro Pascals)		
	Frequent Events[1]	Occasional Events[2]	Infrequent Events[3]	Frequent Events[1]	Occasional Events[2]	Infrequent Events[3]
Category 1: Buildings where vibration would interfere with interior operations	65 VdB[4]	65 VdB[4]	65 VdB[4]	N/A[5]	N/A[5]	N/A[5]
Category 2: Residences and buildings where people normally sleep	72 VdB	75 VdB	80 VdB	35 dBA	38 dBA	43 dBA
Category 3: Institutional land uses with primarily daytime use	75 VdB	78 VdB	83 VdB	40 dBA	43 dBA	48 dBA

Source: FRA, "High-Speed Ground Transportation Noise and Vibration Impact Assessment," Final Report DOT/FRA/ORD-12/15, September 2012
Notes:
[1] *Frequent Events* is defined as more than 70 vibration events of the same kind per day
[2] *Occasional Events* is defined as between 30 and 70 vibration events of the same kind per day
[3] Infrequent Events is defined as fewer than 30 vibration events of the same kind per day
[4] This criterion limit is based on levels that are acceptable for most moderately sensitive equipment such as optical microscopes. For vibration-sensitive manufacturing or research equipment, a Detailed Vibration Analysis must be performed.
[5] Vibration-sensitive equipment is generally not sensitive to ground-borne noise

Table 3.4-6: Ground-Borne Vibration and Noise Impact Criteria for Special Buildings

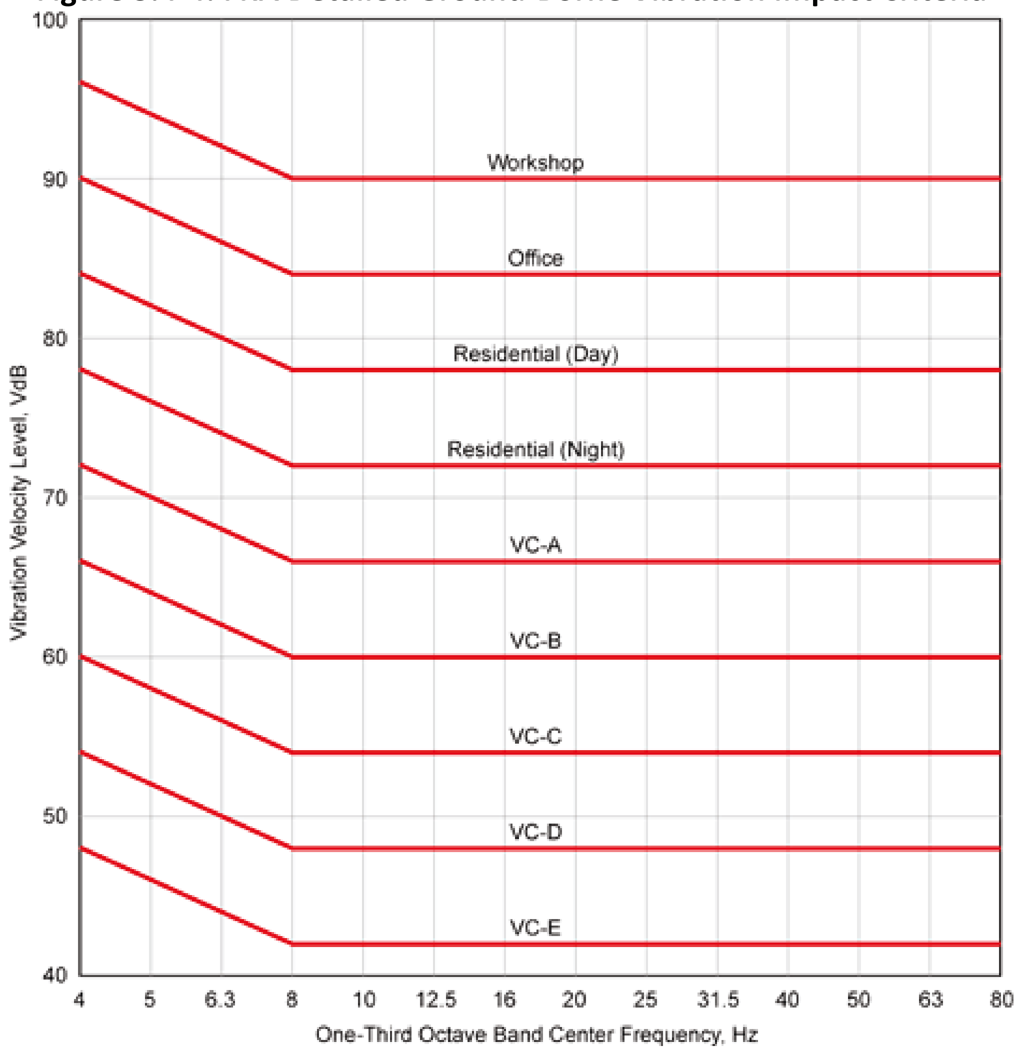
Type of Building or Room	Ground-Borne Vibration Impact Levels (VdB re 1 micro-inch/sec)		Ground-Borne Noise Impact Levels (dBA re 20 micro-Pascals)	
	Frequent Events[1]	Occasional or Infrequent Events[2]	Frequent Events[1]	Occasional or Infrequent Events[2]
Concert Halls	65 VdB	65 VdB	25 dBA	25 dBA
TV Studios	65 VdB	65 VdB	25 dBA	25 dBA
Recording Studios	65 VdB	65 VdB	25 dBA	25 dBA
Auditoriums	72 VdB	80 VdB	30 dBA	38 dBA
Theaters	72 VdB	80 VdB	35 dBA	43 dBA

Source: FRA, "High-Speed Ground Transportation Noise and Vibration Impact Assessment," Final Report DOT/FRA/ORD-12/15, September 2012.
Notes:
[1] *Frequent Events* is defined as more than 70 vibration events per day
[2] *Occasional or Infrequent Events* is defined as fewer than 70 vibration events per day

For a detailed vibration analysis, more refined impact criteria are required than for a general assessment. A frequency distribution, or spectrum, of the vibration energy determines whether the vibrations are likely to generate a significant response in a building or structure. Therefore, the criteria for a detailed vibration assessment are expressed in terms of a one-third octave band frequency spectrum over the frequency range of 8 Hz to 80 Hz, based on international and industry standards.[10,11] The criteria use a frequency spectrum because vibration impacts generally occur due to frequency-dependent resonances of the structural components of a building or vibration-sensitive equipment.

The criteria for a detailed vibration assessment are shown in **Figure 3.4-4** and descriptions of the curves are shown in **Table 3.4-7**. The curves in **Figure 3.4-4** were applied to the projected vibration spectrum for the Build Alternatives. If the entire proposed vibration spectrum of the Build Alternatives would be below the curve, there would be no impact.

Figure 3.4-4: FRA Detailed Ground-Borne Vibration Impact Criteria



Source: FRA, "High-Speed Ground Transportation Noise and Vibration Impact Assessment," Final Report DOT/FRA/ORD-12/15, September 2012

[10] International Standards Organization, "Evaluation of Human Exposure to Whole-Body Vibration, Part 2: Continuous and Shock-Induced Vibrations in Buildings (1-80 Hz), ISO-2631-2, 1989.
[11] Institute of Environmental Sciences and Technology, "Considerations in Clean Room Design, RR-CC012.1, 1993.

Table 3.4-7: Interpretation of Vibration Criteria for Detailed Analysis

Criterion Curve (See Fig. 3.4-8)	Max Lv (VdB)[1]	Description of Use
Workshop	90	Distinctly feelable vibration. Appropriate to workshops and non-sensitive areas.
Office	84	Feelable vibration. Appropriate to offices and non-sensitive areas.
Residential Day	78	Barely feelable vibration. Adequate for computer equipment and low-power optical microscopes (up to 20X).
Residential Night, Operating Rooms	72	Vibration not feelable, but ground-borne noise may be audible inside quiet rooms. Suitable for medium-power optical microscopes (100X) and other equipment of low sensitivity.
VC-A	66	Adequate for medium- to high-power optical microscopes (400X), microbalances, optical balances and similar specialized equipment.
VC-B	60	Adequate for high-power optical microscopes (1000X), inspection and lithography equipment to 3-micron line widths.
VC-C	54	Appropriate for most lithography and inspection equipment to 1-micron detail size.
VC-D	48	Suitable in most instances for the most demanding equipment, including electron microscopes operating to the limits of their capability.
VC-E	42	The most demanding criterion for extremely vibration-sensitive equipment.

Source: FRA, "High-Speed Ground Transportation Noise and Vibration Impact Assessment," Final Report DOT/FRA/ORD-12/15, September 2012
Note: [1] As measured in 1/3-octave bands of frequency over the frequency range 8 to 80 Hz.

3.4.4 Affected Environment

The existing noise and vibration environment includes urban and suburban areas with single-family and multi-family residences near Dallas and Houston and rural areas with scattered residences along most of the Build Alternatives in between Dallas and Houston. In addition to residences, other sensitive land uses in the Study Area include schools, churches and parks. Existing noise sources affecting these receivers include IH-45, IH-610, local roads, freight trains, farm activity and livestock. The only existing significant source of ground-borne vibration in the Study Area is freight train traffic.

Noise measurements were conducted during January 2016 to characterize the existing conditions along the Build Alternatives. **Table 3.4-8** summarizes the existing noise measurements and **Figures 3.4-5 through 3.4-8** show the locations of the 23 long-term noise monitoring sites (LT) and 19 short-term noise monitoring sites (ST) within the Study Area. The results of the existing noise measurements were used to characterize the existing noise levels at all noise-sensitive locations within the Study Area.

Table 3.4-8: Summary of Existing Noise Measurements

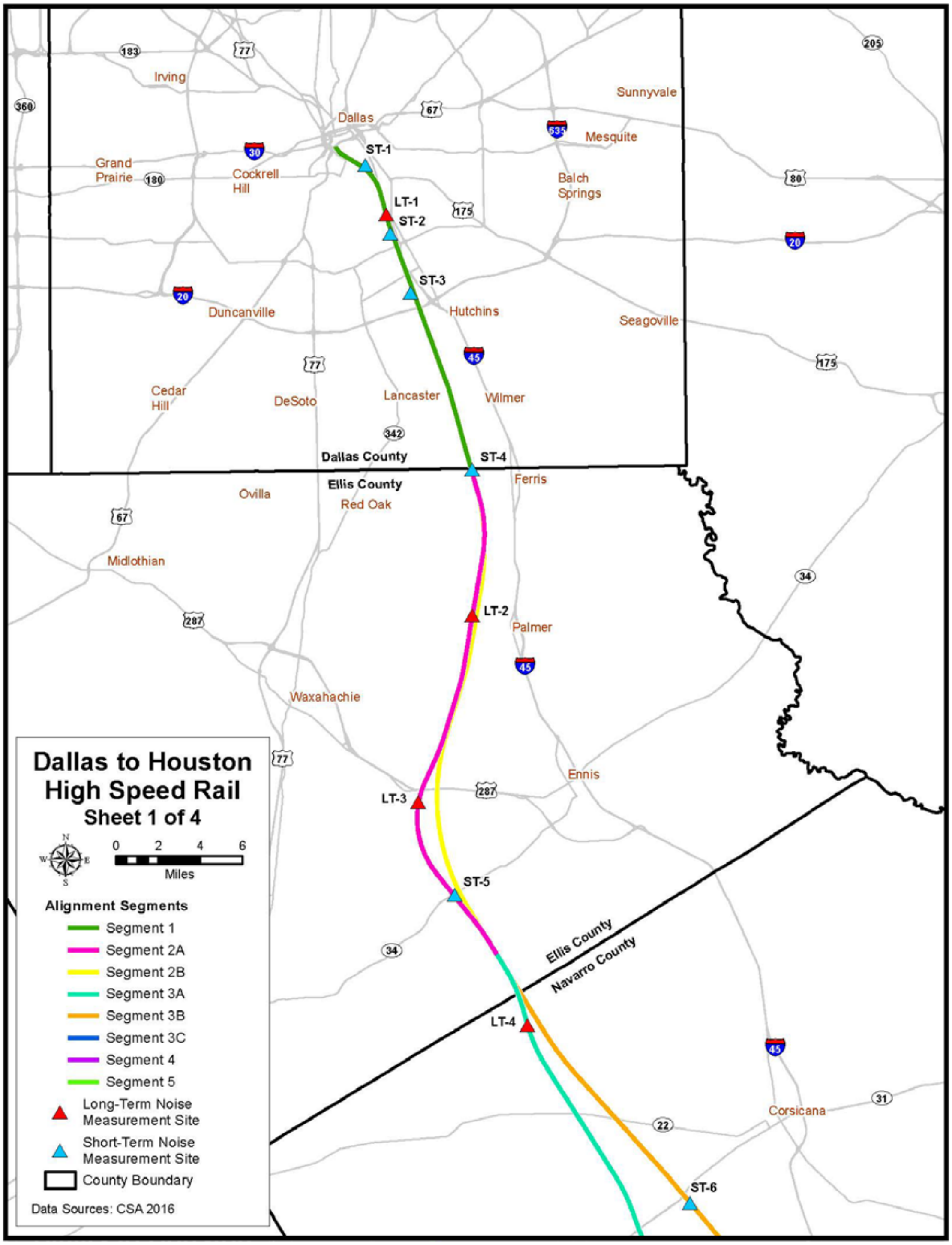
Site No.	Measurement Location	County	Seg.	Measurement Start		Meas. Dur. (hr)	Noise Level (dBA)	
				Date	Time		Leq	Ldn
LT-1	4019-4099 Bulova St, Dallas (Residences)	Dallas	1	1/21/2016	14:00	24	75	72
LT-1A	5125 Cleveland Rd, Dallas (Residences)	Dallas	1	5/11/2017	11:20	3**	50	53
LT-1B	1345 E Belt Line Rd, Lancaster (Residences)	Dallas	1	5/12/2017	2:49	3**	68	70
LT-1C	1786 Nail Dr, Lancaster (Residences)	Dallas	1	5/11/2017	14:00	3**	44	45
LT-2	911 FM 813, Palmer (Residence)	Ellis	2A	1/21/2016	9:09	24	62	55
LT-3	508 Old Waxahachie Rd, Waxahachie (Residence)	Ellis	2A	1/20/2016	16:00	24	58	53
LT-4	NW Co Rd 1320, Ennis (Residence)	Navarro	3A	1/20/2016	11:00	24	48	36
LT-5	SW 2120, Richland (Residence)	Navarro	3C	1/19/2016	15:17	24	50	46
LT-6	FM 1366, Wortham (Residential Parcel)	Freestone	4	1/19/2016	14:07	24	44	43
LT-7	132-264 CR 890, Teague (Ranch House)	Freestone	4	1/19/2016	14:00	24	49	42
LT-8	N Fwy Service Rd, Teague (Ranch)	Freestone	3C	1/18/2016	12:23	24	58	50
LT-9	633 LCR 882, Jewett (Ranch House)	Limestone	4	1/18/2016	12:00	24	52	48
LT-10	Beddingfield Rd, Marquez (Residence)	Leon	4	1/18/2016	11:00	24	53	42
LT-11	N Fwy Service Rd, Buffalo (Ranch)	Leon	3C	1/18/2016	10:00	24	63	55
LT-12	534 FM 39 (Residence)	Leon	4	1/18/2016	14:00	24	60	62
LT-13	2076-2765 W Feeder Rd (Residence)	Leon	3C	1/18/2016	16:00	24	53	55
LT-14	7652 Greenbriar Rd (Residence)	Madison	3C	1/18/2016	13:00	24	63	65
LT-15	1977 Poteet Rd (Residence)	Madison	4	1/18/2016	17:00	24	48	50
LT-16	6113 FM 1696 (Residence)	Grimes	5	1/19/2016	14:00	24	45	47
LT-17	10735 TX-90 (Ranch)	Grimes	5	1/20/2016	16:00	24	47	49
LT-18	5126 FM 1774 (Residence)	Grimes	5	1/19/2016	20:00	24	60	62
LT-19	119 Plantation Drive, Todd Mission (Residence)	Waller	5	1/22/2016	12:39	24	47	49*
LT-20	21512 Binford Rd (Residence)	Harris	5	1/22/2016	10:56	24	49	51*
LT-21	1218 Canyon Arbor Way (Residence)	Harris	5	1/20/2016	19:00	24	67	69*
LT-22	14812 Hempstead Rd (Residence)	Harris	5	1/19/2016	21:00	24	44	46*
LT-23	11217 Todd St., Houston (Residence)	Harris	5	1/21/2016	14:00	24	47	49
ST-1	1213 Coleman Ave, Dallas (Residence)	Dallas	1	1/22/2016	11:40	1	63	61

Table 3.4-8: Summary of Existing Noise Measurements

Site No.	Measurement Location	County	Seg.	Measurement Start		Meas. Dur. (hr)	Noise Level (dBA)	
				Date	Time		Leq	Ldn
ST-2	4412 Kolloch Dr, Dallas (Residence)	Dallas	1	1/21/2016	15:00	1	62	60
ST-3	6350 J. J. Lemmon Rd, Dallas (College Park Baptist Church)	Dallas	1	1/21/2016	17:10	1	54	52
ST-4	2607 Ferris Rd, Lancaster (Residence)	Ellis	2A	1/22/2016	10:00	1	52	50
ST-5	369 Farmer Rd, Ennis (Residential Area)	Ellis	2B	1/20/2016	16:31	1	62	60
ST-6	SW 1000, Corsicana (Residence)	Navarro	3B	1/20/2016	11:00	1	41	39
ST-7	117-123 CR 1041, Wortham (Residential Area)	Freestone	3C	1/19/2016	17:30	1	31	29
ST-8	N Fwy Service Rd & CR 1090, Streetman (Residential Area)	Freestone	3C	1/19/2016	16:00	1	54	52
ST-9	Old Mexia-Fairfield Rd, Fairfield (Parcel Adjacent to Several Hotels)	Freestone	3C	1/18/2016	13:50	1	70	68
ST-10	164 & FM 39, Groesbeck (Residential Area)	Limestone	4	1/18/2016	15:30	1	63	61
ST-11	N Fwy Service Rd & CR 306, Buffalo (Parcel Adjacent to Several Hotels)	Leon	3C	1/18/2016	17:00	1	68	66
ST-12	20559 IH-45 Frontage Rd (Residence)	Leon	3C	1/19/2016	9:06	1	61	59
ST-13	5192 Dawkins Rd (Residence)	Madison	4	1/19/2016	11:12	1	54	52
ST-14	3159 Clark Rd (Residence)	Madison	4	1/20/2016	12:00	1	56	54
ST-15	15619 TX-90 (Residence)	Grimes	5	1/20/2016	14:47	1	53	51
ST-16	CR 341, Plantersville (Residence)	Grimes	5	1/21/2016	9:20	1	50	48
ST-17	31205 Hegar Rd (Residence)	Waller	5	1/21/2016	9:11	1	47	45
ST-18	6734 Limestone St (Residence)	Harris	5	1/21/2016	15:17	1	57	55
ST-19	20710 May Showers Circle (Residence)	Harris	5	1/21/2016	17:23	1	61	59

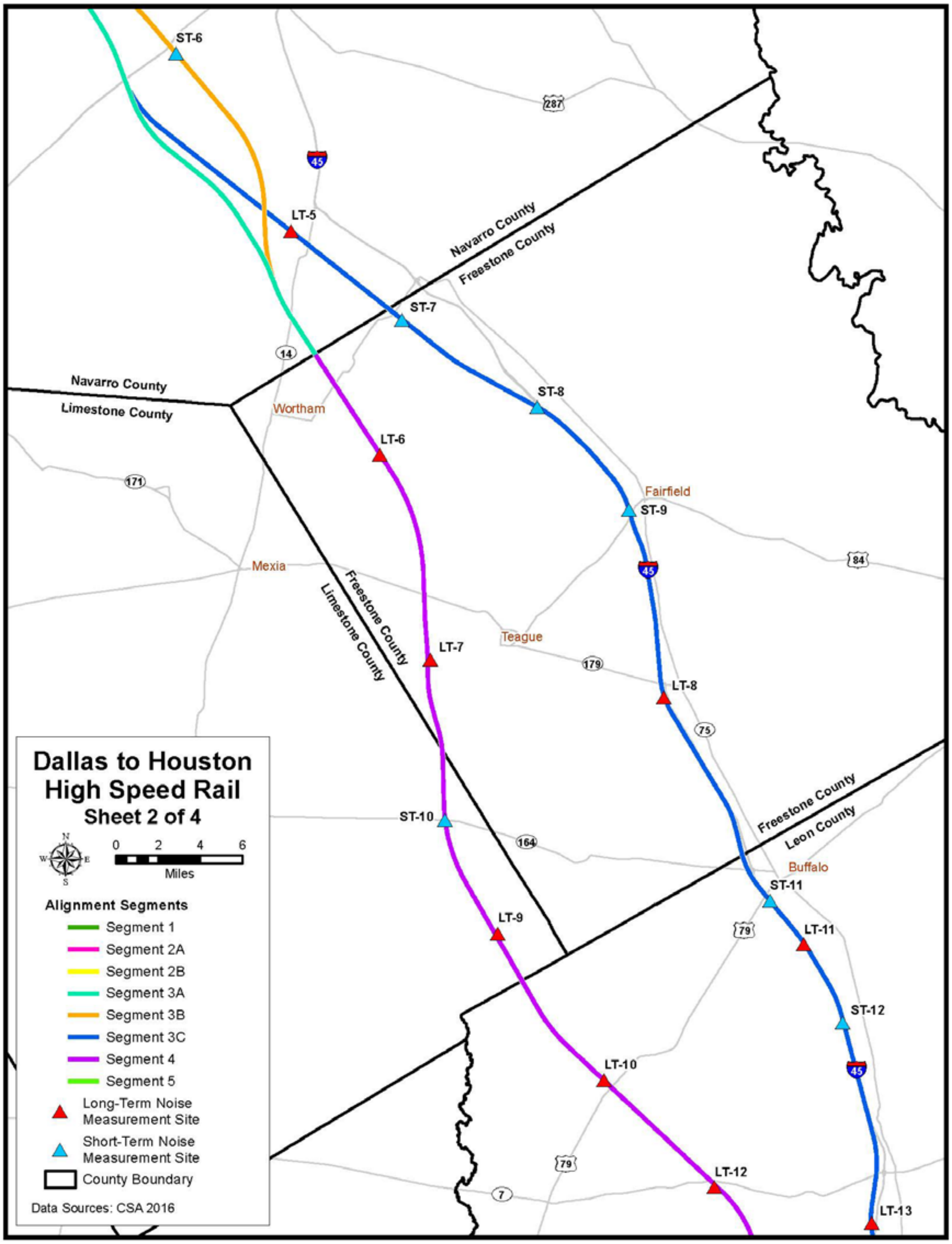
Source: Cross-Spectrum Acoustics, 2016
* Measurements were interrupted before 24 hours due to a noise monitor battery connection problem. Ldn was estimated using methods contained in the FRA guidance manual.
**Due to limited access, three one hour measurements were made at these sites. The Ldn was estimated using methods contained in the FRA guidance manual.

Figure 3.4-5: Existing Noise Measurement Locations



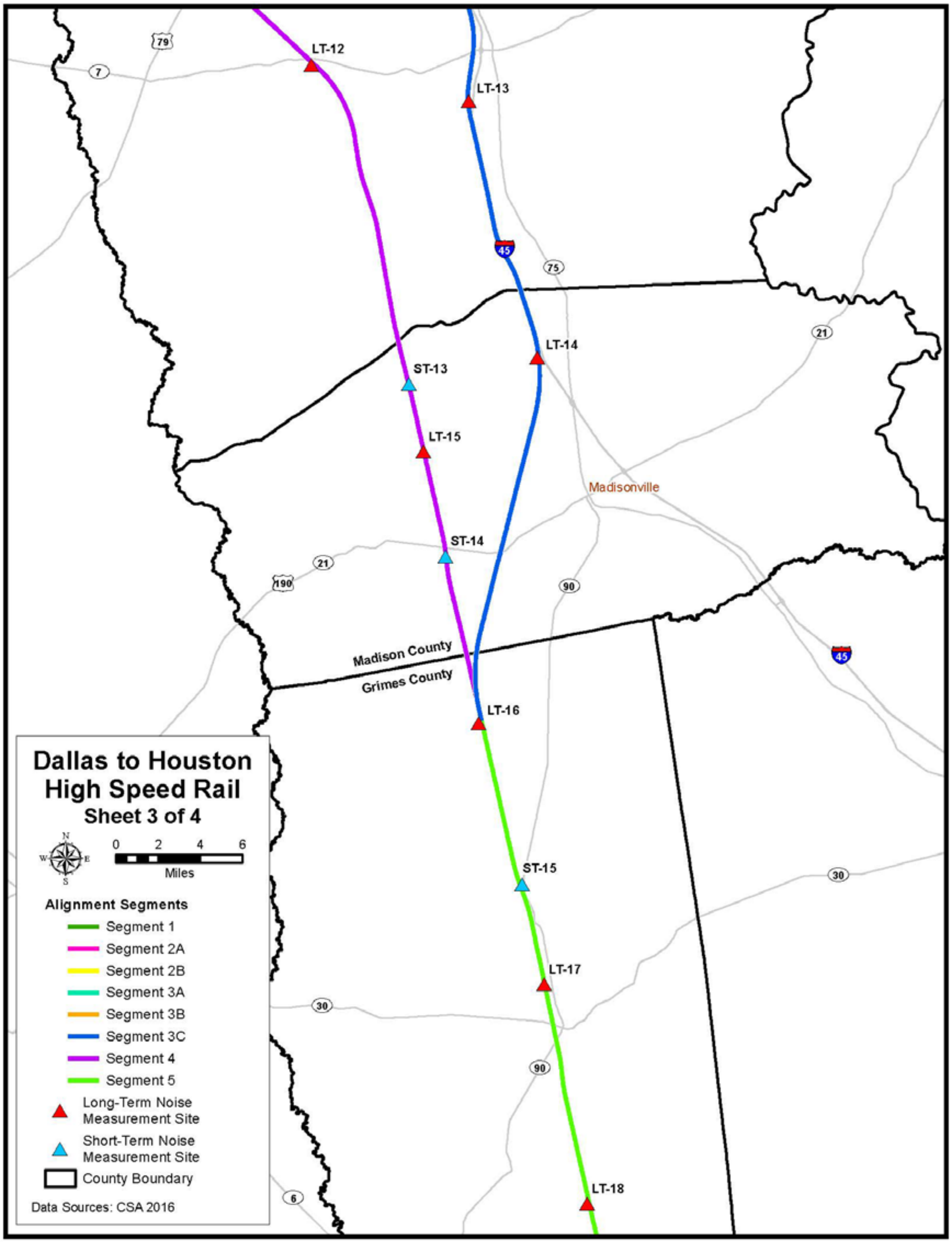
Source: CSA, 2016

Figure 3.4-6: Existing Noise Measurement Locations



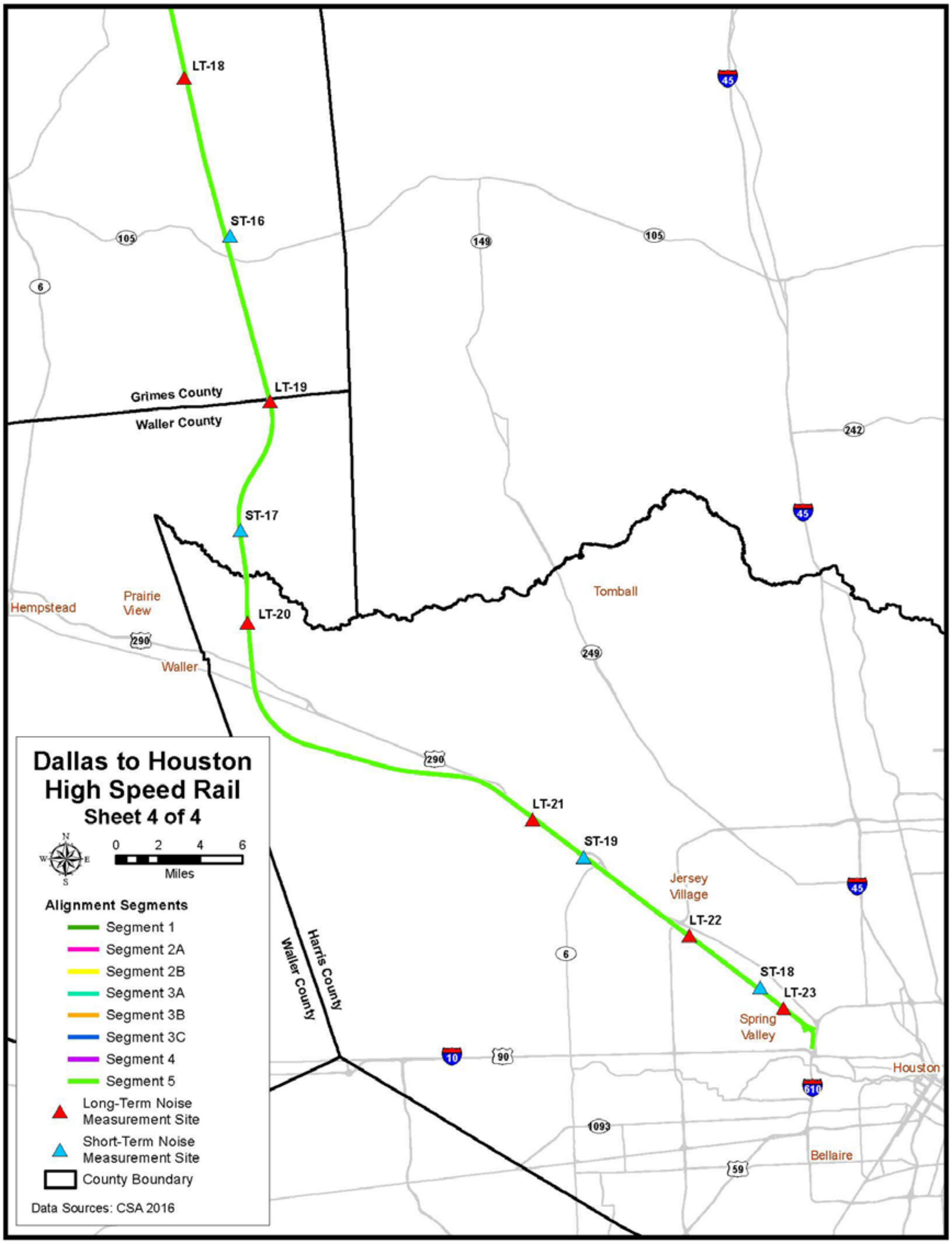
Source: CSA, 2016

Figure 3.4-7: Existing Noise Measurement Locations



Source: CSA, 2016

Figure 3.4-8: Existing Noise Measurement Locations



Source: CSA, 2016

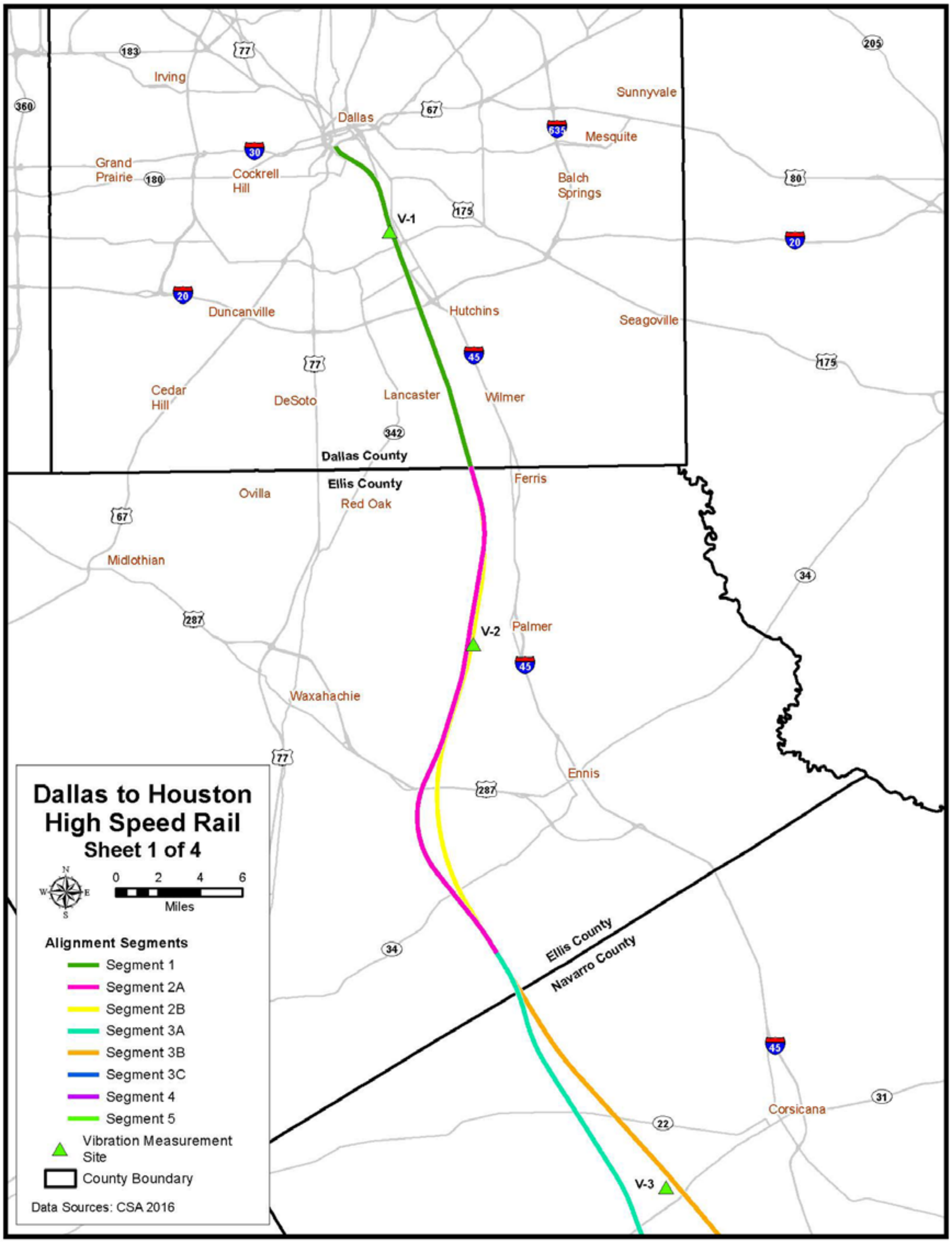
For vibration, propagation measurements were conducted within the Study Area in January 2016 to determine the vibration response characteristics of the ground near vibration-sensitive locations. **Table 3.4-9** and **Figures 3.4-9 through 3.4-12** describe the locations of the 11 vibration measurement sites. Detailed results of the vibration propagation tests are included in **Appendix E, Noise and Vibration Technical Memorandum**.

Table 3.4-9: Summary of Vibration Propagation Measurement Sites

Site No.	Measurement Location	County	Segments	Date
V-1	4360 Kolloch Drive, Dallas (Church)	Dallas	1	1/18/2016
V-2	103 Coffee Rd.	Ellis	2A, 2B	1/18/2016
V-3	710 FM 2100	Navarro	3A, 3B, 3C	1/19/2016
V-4	N Fwy Service Rd., Fairfield	Freestone	3C, 4	1/19/2016
V-5	LCR 828, Personville	Limestone	4	1/20/2016
V-6	6734 FM 977 (Residence)	Leon	4	1/20/2016
V-7	10290 Greenbriar Rd. (Residential Parcel)	Madison	3C	1/20/2016
V-8	10063 CR 311 (Residence)	Grimes	5	1/21/2016
V-9	Plantation Dr., Todd Mission	Waller	5	1/21/2016
V-10	Josey Ranch Rd., Houston	Harris	5	1/22/2016
V-11	21610 US 290 Frontage Rd., Houston	Harris	5	1/22/2016

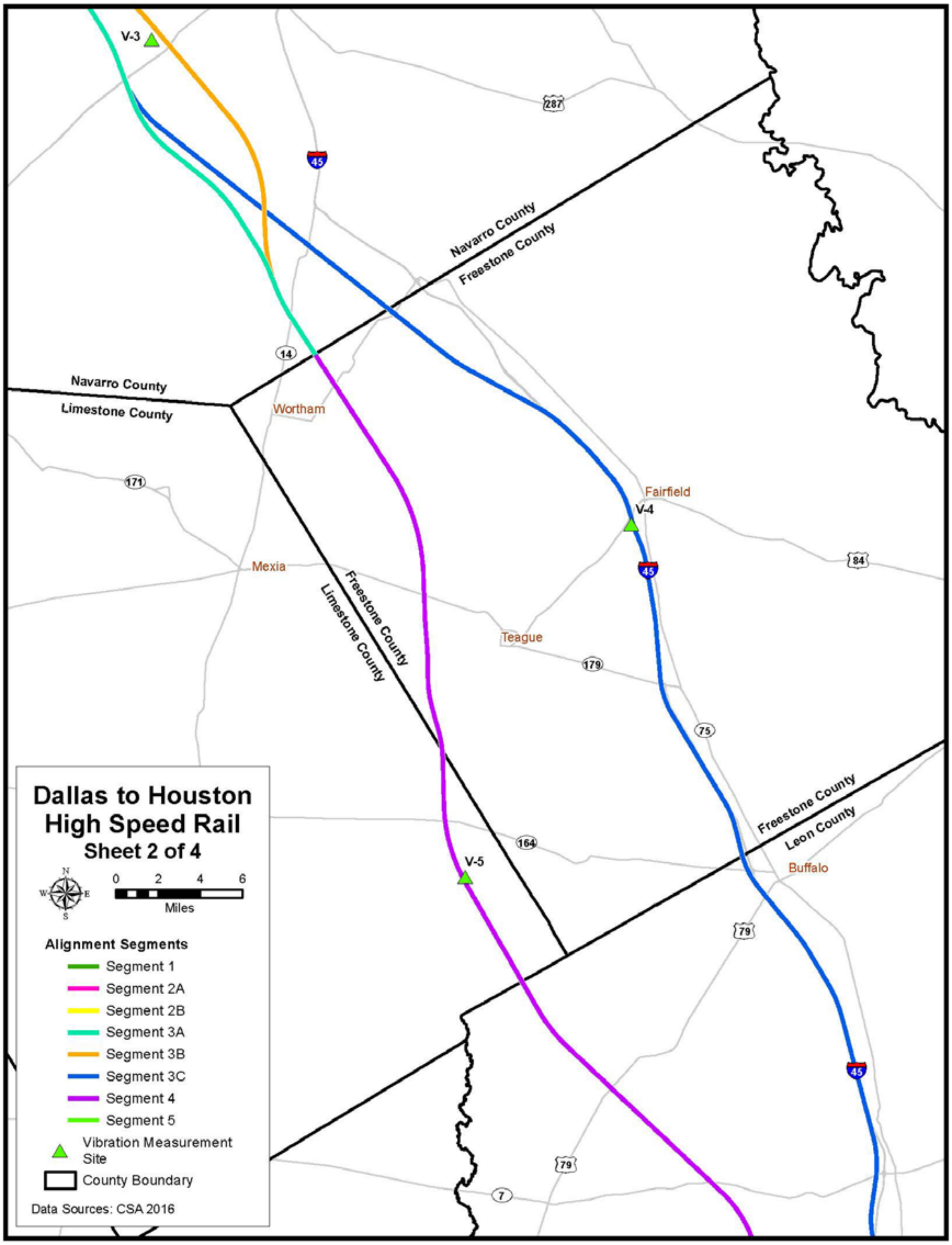
Source: Cross-Spectrum Acoustics, 2016

Figure 3.4-9: Vibration Propagation Measurement Locations



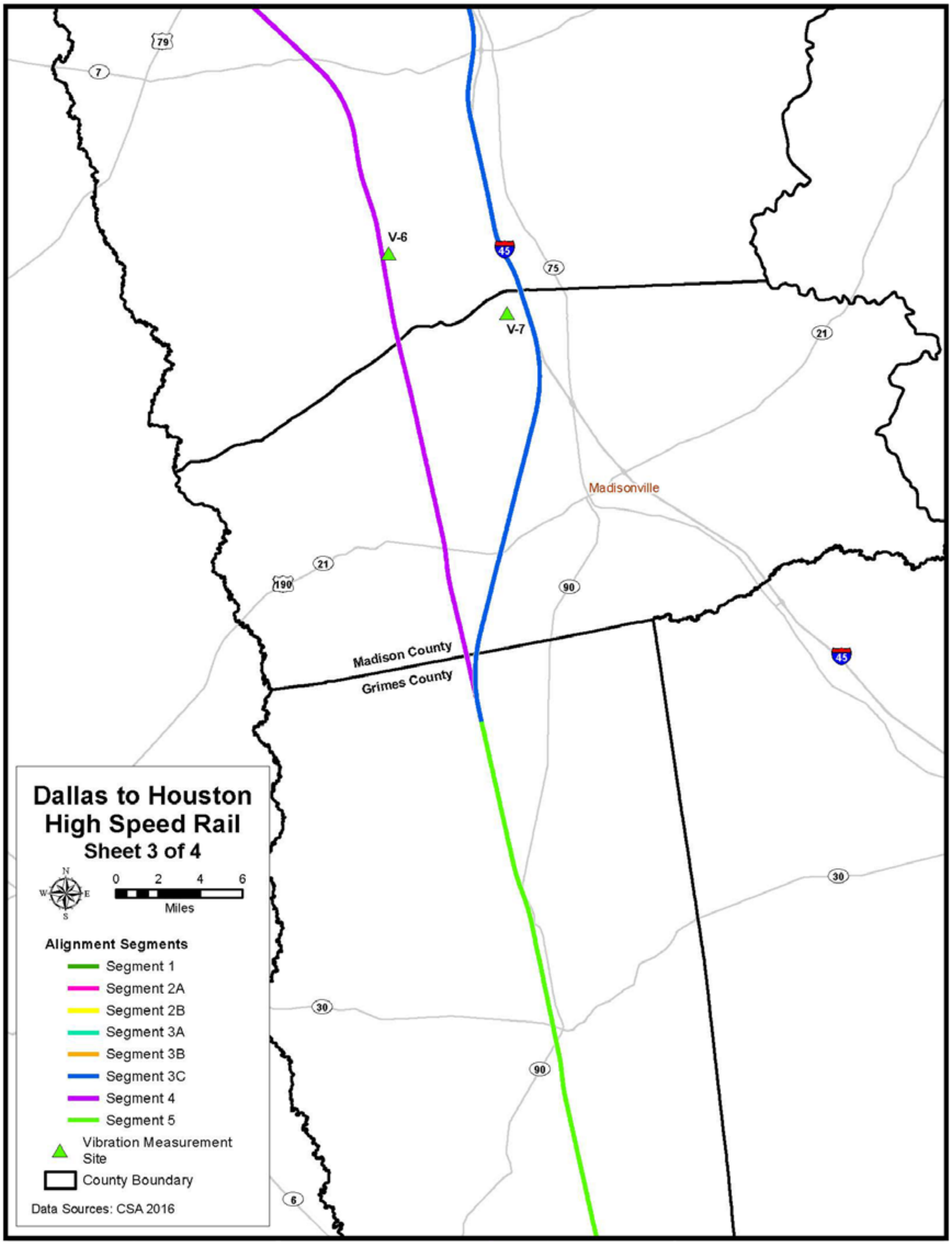
Source: CSA, 2016

Figure 3.4-10: Vibration Propagation Measurement Locations



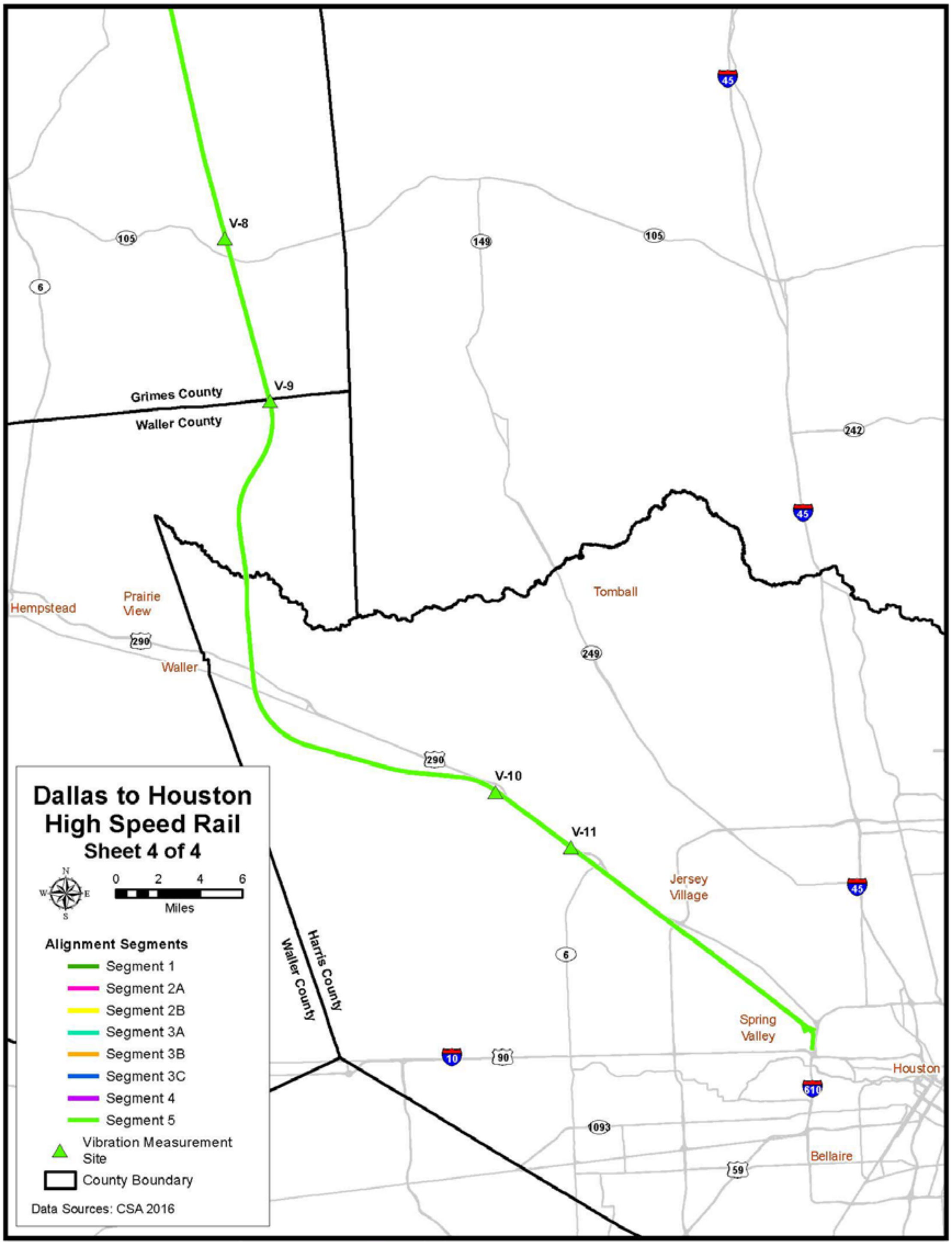
Source: CSA, 2016

Figure 3.4-11: Vibration Propagation Measurement Locations



Source: CSA, 2016

Figure 3.4-12: Vibration Propagation Measurement Locations



Source: CSA, 2016

Descriptions of the noise and vibration sensitive land uses and noise and vibration sources, along with the corresponding measurement sites and areas they represent, are provided below by county and segment. Detailed results of the vibration measurements are included in **Appendix E, Noise and Vibration Technical Memorandum**.

3.4.4.1 Dallas County

The noise and vibration sensitive land uses in the Study Area in Dallas County from the northern terminus to Loop 12 (South Great Trinity Forest Avenue) are typically dense, urban commercial/industrial land uses along the existing freight tracks and IH-45. Several urban residential neighborhoods are located in the areas north of South Lamar Street, along Kolloch Drive from East Illinois Avenue to Loop 12, and along Le May and Le Forge avenues. Multi-family residential complexes are located near East Overton Rd and Southern Oaks Boulevard and at Kolloch Drive and Linfield Road.

The Imperial Institute of America, a school with institutional land use, is located on Mayforge Drive near East Illinois Avenue. South of Loop 12 to IH-20, the Build Alternatives runs parallel to existing freight tracks and IH-45 through a largely wooded area with a few dense suburban residential neighborhoods to the west along Golden Gate Drive and J.J. Lemmon Road. Several parks and churches are located in this suburban area as well. South of IH-20 to the Dallas/Ellis County line is typically rural farm land with scattered single-family residences within the Study Area.

3.4.4.1.1 Noise Measurements (Segment 1)

Site LT-1: 4019-4099 Bulova Street, Dallas. The Ldn measured at this location was 72 dBA. The dominant noise source was traffic on IH-45. Noise levels were measured for 24 hours near the gate to this parcel.

Site LT-1A: 5125 Cleveland Rd, Dallas. The Ldn measured at this location was 53 dBA. The dominant noise sources were rural sounds and local traffic. Noise levels were measured during three separate one hour periods throughout the day along Cleveland Rd in front of the property.

Site LT-1B: 1345 E. Beltline Road, Lancaster. The Ldn measured at this location was 70 dBA. The dominant noise source was traffic on E Beltline Rd. Noise levels were measured during three separate one hour periods throughout the day along E Beltline Rd in front of the property.

Site LT-1C: 1786 Nail Drive, Lancaster. The Ldn measured at this location was 45 dBA. The dominant noise source was rural sounds. Noise levels were measured during three separate one hour periods throughout the day along Nail Drive in front of the property.

Site ST-1: 1213 Coleman Avenue, Dallas. The Leq measured at this location was 63 dBA. The dominant noise sources were traffic on Lamar Street, traffic on Cedar Crest Boulevard and freight train activity. Noise levels were measured for one hour on the side of the road within the public ROW.

Site ST-2: 4412 Kolloch Drive, Dallas. The Leq measured at this location was 62 dBA. The dominant noise sources were traffic on IH-45 and freight train activity. Noise levels were measured for one hour in the side yard of this residence.

Site ST-3: 6350 J.J. Lemmon Road, Dallas (College Park Baptist Church). The Leq measured at this location was 54 dBA. The dominant noise sources were traffic on J.J. Lemmon Road and distant traffic on IH-45. Noise was measured for one hour in the rear parking area of the church.

3.4.4.1.2 Vibration Measurements (Segment 1)

A description of the vibration measurement site that is taken to represent the vibration propagation characteristics of the soil along Segment 1 in Dallas County is as follows:

Site V-1: 4360 Kolloch Drive. The vibration propagation measurement was conducted in the parking lot of Friendship Missionary Baptist Church. The measurement site is representative of the ground-borne vibration propagation conditions of the soil in this area, including all vibration-sensitive land use along the IH-45 corridor in Dallas between South Lamar Street and the IH-20 junction along Segment 1.

3.4.4.2 Ellis County

The noise and vibration sensitive land use along the Segments 2A and 2B in Ellis County is typically rural farm land with scattered single-family residences.

3.4.4.2.1 Noise Measurements (Segments 2A and 2B)

Site LT-2: FM 813, Palmer. The Ldn measured at this location was 55 dBA. The dominant noise source was local community traffic. Noise levels were measured for 24 hours in the back yard of this residence.

Site LT-3: 508 Old Waxahachie Road, Waxahachie. The Ldn measured at this location was 53 dBA. The dominant noise sources were local traffic on Old Waxahachie Road and distant traffic on Route 287. Noise levels were measured for 24 hours in the front yard of the residence.

Site ST-4: 2607 Ferris Road, Lancaster. The Leq measured at this location was 52 dBA. The dominant noise sources were wind and livestock. Noise levels were measured for one hour in the field behind the residence.

Site ST-5: 369 Farmer Rd, Ennis. The Leq measured at this location was 62 dBA. The dominant noise source was traffic on Route 34. Noise levels were measured for one hour on the side of the road within the public ROW.

3.4.4.2.2 Vibration Measurements (Segments 2A and 2B)

Site V-2: 103 Coffee Road. The vibration propagation measurement was conducted along Coffee Road with the sensors placed in the adjacent field. The measurement site is representative of the ground-borne vibration propagation conditions of the soil in this area, including all vibration-sensitive land use west of IH-45 from Hutchins to Bardwell, spanning both Segments 2A and 2B.

3.4.4.3 Navarro County

The noise and vibration sensitive land use along Segment 3A, 3B, 3C and 4 in Navarro County is typically rural farm land with scattered single-family residences.

3.4.4.3.1 Noise Measurements (Segment 3A)

Site LT-4: NW County Road 1320, Ennis. The Ldn measured at this location was 36 dBA. The dominant noise sources were distant traffic and livestock. Noise levels were measured for 24 hours in the front yard of the residence.

3.4.4.3.2 Noise Measurements (Segment 3B)

Site ST-6: SW 1000, Corsicana. The Leq measured at this location was 41 dBA. The dominant noise source was traffic from Route 31. Noise levels were measured for one hour in the back yard of the residence.

3.4.4.3.3 Noise Measurements (Segments 3C and 4)

Site LT-5: SW 2120, Richland. The Ldn measured at this location was 46 dBA. The dominant noise sources were farm activity and distant freight trains/horns. Noise levels were measured for 24 hours in the field behind the ranch house.

3.4.4.3.4 Vibration Measurements (Segments 3A, 3B, 3C and 4)

Site V-3: 710 FM 2100. The vibration propagation measurement was conducted along FM 2100 with the sensors in the front yard of the property. The measurement site is representative of the ground-borne vibration propagation conditions of the soil in this area, including all vibration-sensitive land use in Navarro County along the northern portions of Segments 3A, 3B, 3C and 4, including the towns of Barry and Oak Valley.

3.4.4.4 Freestone County

The noise and vibration sensitive land use along Segments 3C and 4 in Freestone County is typically rural farm land with scattered single-family residences. Segment 3C runs parallel to IH-45 from just south of FM 833 until the Freestone/Leon County line. This area remains typically rural farm land until the City of Fairfield, where the land use becomes slightly denser and largely commercial/industrial. South of Fairfield, the land use returns to rural farm land and oil fields with scattered single-family residences.

3.4.4.4.1 Noise Measurements (Segment 3C)

Site LT-8: N Fwy Service Road, Teague. The Ldn measured at this location was 50 dBA. The dominant noise sources were traffic on IH-45 and farm activity. Noise levels were measured for 24 hours adjacent to the pond on this ranch.

Site ST-7: 117-123 County Road 1041, Wortham. The Leq measured at this location was 31 dBA. The dominant noise source was distant wildlife. Noise levels were measured for one hour on the side of the road within the public ROW.

Site ST-8: N Freeway Service Road at County Road 1090, Streetman. The Leq measured at this location was 54 dBA. The dominant noise source was traffic on IH-45. Noise levels were measured for one hour on the side of the road within the public ROW.

Site ST-9: N Freeway Service Road at Old Mexia-Fairfield Road, Fairfield. The Leq measured at this location was 70 dBA. The dominant noise source was traffic on IH-45. Noise levels were measured for one hour on the side of the road within the public ROW.

3.4.4.4.2 Noise Measurements (Segment 4)

Site LT-6: FM 1366, Wortham. The Ldn measured at this location was 43 dBA. The dominant noise sources were local community traffic and farm activity. Noise levels were measured for 24 hours adjacent to the back house on this parcel.

Site LT-7: Approximately 132-264 CR 890, Teague. The Ldn measured at this location was 42 dBA. The dominant noise sources were local community traffic and farm activity. Noise levels were measured for 24 hours adjacent to the ranch house.

3.4.4.4.3 Vibration Measurements (Segments 3C and 4)

Site V-4: North Freeway Service Road, Fairfield. The vibration propagation measurement was conducted along the western edge of the gas field with the sensors in the adjoining field. The measurement site is representative of the ground-borne vibration propagation conditions of the soil in this area, including all vibration-sensitive land use between Fairfield and Teague in Freestone County following Route 179 on the east and Segment 4 on the west.

3.4.4.5 Limestone County

The noise and vibration sensitive land use along the proposed Segment 4 in Limestone County is typically rural farm land/oil fields with scattered single-family residences.

3.4.4.5.1 Noise Measurements (Segment 4)

Site LT-6: FM 1366, Wortham. The Ldn measured at this location was 43 dBA. The dominant noise sources were local community traffic and farm activity. Noise levels were measured for 24 hours adjacent to the back house on this parcel.

Site LT-7: Approximately 132-264 CR 890, Teague. The Ldn measured at this location was 42 dBA. The dominant noise sources were local community traffic and farm activity. Noise levels were measured for 24 hours adjacent to the ranch house.

Site LT-9: 633 Local County Road 882, Jewett. The Ldn measured at this location was 48 dBA. The dominant noise sources were local community traffic and farm activity. Noise levels were measured for 24 hours adjacent to the ranch house.

Site ST-10: FM 39 at East Yeagua Street, Groesbeck. The Leq measured at this location was 63 dBA. The dominant noise sources were traffic on FM 39 and traffic on East Yeagua Street. Noise levels were measured for one hour on the side of the road within the public ROW.

3.4.4.5.2 Vibration Measurements (Segment 4)

Site V-5: LCR 828, Personville. The vibration propagation measurement was conducted in the front pasture of the property along the driveway. The measurement site is representative of the ground-borne vibration propagation conditions of the soil in this area, including all vibration-sensitive land use along Segment 4 west of the towns of Donie and Jewett.

3.4.4.6 Leon County

The noise and vibration sensitive land uses for Segment 3C in Leon County include mostly rural areas with single-family residences and the cities of Buffalo and Centerville. The City of Buffalo is a mixture of single-family houses and commercial areas with a church close to the proposed route. The noise and vibration sensitive land uses for Segment 4 in Leon County include scattered single-family residences. Segment 4 also includes Leon High School.

3.4.4.6.1 Noise Measurements (Segment 3C)

Site LT-6: FM 1366, Wortham. The Ldn measured at this location was 43 dBA. The dominant noise sources were local community traffic and farm activity. Noise levels were measured for 24 hours adjacent to the back house on this parcel.

Site LT-7: Approximately 132-264 CR 890, Teague. The Ldn measured at this location was 42 dBA. The dominant noise sources were local community traffic and farm activity. Noise levels were measured for 24 hours adjacent to the ranch house.

Site LT-11: N Freeway Service Road, Buffalo. The Ldn measured at this location was 55 dBA. The dominant noise sources were traffic on IH-45 and distant freight trains/horns. Noise levels were measured for 24 hours adjacent to the driveway of this ranch.

Site LT-13: 2076-2765 West Feeder Road. The measured Ldn at this location was 53 dBA. This 24-hour measurement was taken at the southern edge of the property facing a small pond. The dominant noise sources were local traffic from West Feeder Road, IH-45 and neighborhood activity.

Site ST-11: N Freeway Service Road at County Road 306, Buffalo. The Leq measured at this location was 68 dBA. The dominant noise source was traffic on IH-45. Noise levels were measured for one hour on the side of the road within the public ROW.

Site ST-12: 20559 IH-45 Frontage Road. The measured Leq at this location was 61 dBA. The dominant noise sources were local traffic from the frontage road and IH-45. Noise levels were measured in the front yard of the property for a period of one hour.

3.4.4.6.2 Vibration Measurements (Segment 3C)

Site V-7: 10290 Greenbriar Road. The vibration propagation measurement was conducted along Greenbriar Rd. with the sensors in the field to the north of the house. The measurement site is representative of the ground-borne vibration propagation conditions of the soil in this area, including all vibration-sensitive land use along the southern part of Segment 3C in south Leon County and north Madison County, including the cities of Centerville and Leona.

3.4.4.6.3 Noise Measurements (Segment 4)

Site LT-10: Beddingfield Road, Marquez. The Ldn measured at this location was 42 dBA. The dominant noise sources were local community traffic and farm activity. Noise levels were measured for 24 hours in the back yard of the residence.

Site LT-12: 534 FM 39. The measured Ldn at this location was 60 dBA. The dominant noise source was distant local traffic. Noise levels were measured for 24 hours on the north side of a dirt road that accesses the property.

3.4.4.6.4 Vibration Measurements (Segment 4)

Site V-6: 6734 FM 977. The vibration propagation measurement was conducted in the front yard of the property. The measurement site is representative of the ground-borne vibration propagation conditions of the soil in this area, including all vibration-sensitive land use along the southern part of Segment 4 in southern Leon County and northern Madison County.

3.4.4.7 Madison County

The noise and vibration sensitive land uses for Segments 3C and 4 in Madison County include rural areas with scattered single-family residences.

3.4.4.7.1 Noise Measurements (Segment 3C)

Site LT-14: 7652 Greenbrier Road. The measured Ldn at this location was 63 dBA. Noise levels were measured for 24 hours. This measurement was taken in the front yard of the property. The major noise sources were local traffic on IH-45, farming activity and noise from the manufacturing facility located at the northern edge of the property.

3.4.4.7.2 Noise Measurements (Segment 4)

Site LT-15: 1977 Poteet Road. The measured Ldn at this location was 48 dBA. The dominant noise source was local traffic on Poteet Road. Noise levels were measured for 24 hours on the south side of the property facing a corral.

Site ST- 13: 5192 Dawkins Road. The measured Leq at this location was 54 dBA. The dominant noise source was local traffic. Noise levels were measured in front of the residence by the gate facing Dawkins Road for a period of one hour.

Site ST-14: 3159 Clark Road. The measured Leq at this location was 56 dBA. The dominant noise sources were local traffic on Clark Road, wind, farming activities and electrical noise from power lines. Noise levels were measured at the main gate for a period of one hour.

3.4.4.7.3 Vibration Measurements (segments 3C and 4)

The vibration measurement site used to characterize Segments 3C and 4 in Madison County is the same as that used for Segment 3C in Leon County.

3.4.4.8 Grimes County

The noise and vibration sensitive land uses for Segments 3C and 4 in Grimes County include rural areas with scattered single-family residences. The noise and vibration sensitive land uses for Segment 5 in Grimes County include rural areas with scattered single-family residences and the Town of Singleton. Singleton is a mixture of single-family residences and commercial and industrial areas.

3.4.4.8.1 Noise Measurements (Segments 3C and 4)

Site LT-16: 6113 FM 1696. The Ldn measured at this location was 45 dBA. Noise levels were measured for 24 hours and the measurement was performed at northeast edge of the property overlooking at the power lines. The dominant noise sources were wind and farming activities.

3.4.4.8.2 Vibration Measurements (Segments 3C and 4)

The vibration measurement site used to characterize Segment 3C in Grimes County is the same as that used for Segment 3C in Leon County.

3.4.4.8.3 Noise Measurements (Segment 5)

Site LT-17: 10735 Route 90. The Ldn measured at this location was 47 dBA. Noise levels were measured for 24 hours and the measurement was conducted at the eastern side of the property at a distance of about 150 feet from a metallic shed. The dominant noise source was distant local traffic.

Site LT-18: 5126 FM 1774. The measured Ldn at this location was 60 dBA. The dominant noise sources were barking dogs and local traffic from FM 1774. Noise levels were measured for 24 hours on the northern side of the property at a distance of 150 feet from FM 1774.

Site ST-15: 15619 TX-90. The measured Leq at this location was 53 dBA. The dominant noise source was local traffic from TX 90, livestock and other farm animals and farming activities. Noise levels were measured in front of the house near the driveway for a period of one hour.

Site ST-16: County Road 341, Plantersville. The measured Leq at this location was 50 dBA. The dominant noise source was local traffic from County Road 341. Noise levels were measured at the back of the property near a shed for a period of one hour.

3.4.4.8.4 Vibration Measurements (Segment 5)

Site V-8: 10063 County Road 311. The vibration propagation measurement was conducted along County Road 311 with the sensors in the front yard of the property. The measurement site is representative of the ground-borne vibration propagation conditions of the soil in this area, including all vibration-sensitive land use along Segment 5 in Grimes County from Roans Prairie to SH 105.

3.4.4.9 Waller County

The noise and vibration sensitive land uses for Segment 5 in Waller County include rural areas with scattered single-family residences.

3.4.4.9.1 Noise Measurements (Segment 5)

Site LT-19: 119 Plantation Drive, Todd Mission. The measured Ldn at this location was 47 dBA. Noise levels were measured for 24 hours at the front northern edge of the property. The dominant noise sources were local traffic from Plantation Drive and neighborhood activity.

Site ST-17: 31205 Hegar Road. The measured Leq at this location was 47 dBA. The major noise sources were local traffic from Hegar Road and Joseph Road. Noise levels were measured in the front yard of the residence for a period of one hour.

3.4.4.9.2 Vibration Measurements (Segment 5)

Site V-9: Plantation Drive, Todd Mission. The vibration propagation test was conducted along Plantation Drive with the sensors in an empty lot. This site is representative of the ground-borne vibration propagation conditions of the soil in this area, including all vibration-sensitive land use along Segment 5 in south Grimes County and north Waller County.

3.4.4.10 Harris County

The noise and vibration sensitive land uses for Segment 5 in Harris County include some rural areas, industrial and commercial areas and residential neighborhoods. Between the county's northern boundaries where Segment 5 crosses SH 99, the land use is mostly rural with scattered single-family residences. Between SH 99 and Fry Road, Segment 5 runs through a mostly rural area with scattered single-family residences and commercial uses.

Between Fry Road and SH 6 North, both sides of Segment 5 include a mixture of commercial and industrial areas with residential neighborhoods. The neighborhoods have both single- and multi-family residences. Within this vicinity are four churches and Cy-Fair High School. Between SH 6 North and the West Sam Houston Parkway, there is a mix of commercial and residential areas north of Segment 5. The residential areas are a mixture of single- and multi-family housing. South of Segment 5 is a mixture of industrial and commercial usage. There are also two churches along this stretch of Segment 5.

Between the West Sam Houston Parkway and IH-610, the land use around the Study Area is mostly commercial and industrial with a few residential areas with single-family houses. Also within this stretch of Segment 5 are six places of worship and Bane Elementary School. Along IH-610, Segment 5 extends through a mixture of industrial and commercial areas.

3.4.4.10.1 Noise Measurements (Segment 5)

Site LT-20: 21512 Binford Road. The measured Ldn at this location was 49 dBA. Noise levels were measured for 24 hours at the northern edge of the property at the setback distance of the residence. Traffic noise from Binford Road was not significant during the measurement period.

Site LT-21: 12118 Canyon Arbor Way. The measured Ldn at this location was 67 dBA. Noise levels were measured for 24 hours at the northern edge of the property near a residence. The dominant noise source was local traffic from US-290.

Site LT-22: 14812 Hempstead Road. The measured Ldn at this location was 44 dBA. Noise levels were measured for 24 hours at the front yard of the property facing Hempstead Road. The dominant noise sources were local traffic on Hempstead Road and UPRR trains, located parallel to Hempstead Road.

Site LT-23: 11217 Todd Street. The measured Ldn at this location was 47 dBA. The dominant noise sources were local traffic on Todd Street, Harland Drive and Hempstead Road, plus Union Pacific trains. Noise levels were measured for 24 hours on the northern edge of the property.

Site ST-18: 6734 Limestone Street. The measured Leq at this location was 57 dBA. The dominant noise source was local traffic on Limestone Street and Hempstead Road. Noise levels were measured in front of the residence for a period of one hour.

Site ST-19: 20710 May Showers Circle. The measured Leq at this location was 61 dBA. The major noise sources were local traffic on Hempstead Road, Huffmeister Road and residential activities in May Showers Circle. Noise levels were measured in the front yard of the property for a period of one hour.

3.4.4.10.2 Vibration Measurements (Segment 5)

Site V-10: Josey Ranch Road, Houston. The vibration propagation measurement was conducted along Josey Ranch Road with the sensors in the field to the west. The measurement site is representative of the ground-borne vibration propagation conditions of the soil in this area, including all vibration-sensitive land use along US 290 close to Fry Road for Segment 5.

Site V-11: 21610 US 290 Frontage Road. The vibration propagation measurement was conducted in the field northeast of the train tracks. The measurement site is representative of the ground-borne vibration propagation conditions of the soil in this area, including all vibration-sensitive land use along US 290 between Lee Way Drive and Huffmeister Road in Houston.

3.4.5 Environmental Consequences

3.4.5.1 No Build Alternative

Under the No Build Alternative, the Build Alternatives would not be constructed, and no new short-term or long-term noise or vibration impacts would occur. The existing noise and vibration sources throughout the Study Area, which include highways and freight trains, would continue to generate noise and vibration. Current transportation infrastructure may be expanded or capacity added to address growth in areas within and adjacent to the Study Area that could create new short-term and/or long-term noise and vibration impacts.

3.4.5.2 Build Alternatives

3.4.5.2.1 Construction Noise and Vibration Impacts

Based on the limited information currently available, construction impacts have been evaluated in terms of screening distances for different types of construction activities. During final design, TCRR would conduct an assessment of the detailed construction scenarios to identify specific impacts. By using the FRA criteria provided in **Table 3.4-1** and the construction equipment noise emission levels from the FRA guidance manual, and assuming that construction noise is reduced by 6 dB for each doubling of distance from the center of the work site, the screening distances for potential construction noise impact at residential locations were estimated. These estimates, shown in **Table 3.4-10**, provide an indication of the intensity of noise impact for each construction activity and show that the potential for construction noise impact at residential sites would extend to distances of 40 to 200 feet from daytime construction and to distances of 125 to 630 feet from nighttime construction. The greater impact distances apply to the construction of structures, stations, MOW facilities and trainset maintenance facilities which would include pile driving. Therefore, construction activities that include pile driving or use of other large machinery would be relegated to daytime hours only.

During construction, some activities may cause perceptible ground-borne vibration, most notably pile driving for structures and vibratory compaction for ground improvements. While it is unlikely that these activities would occur within 50 feet of sensitive structures where damage effects could be of concern, there could be some potential for vibration annoyance or interference with the use of sensitive equipment. **Table 3.4-11** provides an indication of the intensity of vibration impact for each construction activity in terms of the approximate distances within which receivers in different land use categories could experience vibration annoyance effects. These estimates suggest that the potential for construction vibration impact would extend to Category 3 (institutional) receivers within distances of 65 to 230 feet, to Category 2 (residential) receivers within distances of 80 to 290 feet, and to Category 1 (high-sensitivity) receivers within distances of 135 to 500 feet, depending on the activity. The greater impact distances apply to the construction of structures, stations, MOW facilities and trainset maintenance facilities that would include pile driving.

Descriptions of the types of equipment that would be used for each construction activity are included in **Appendix E, Noise and Vibration Technical Memorandum**.

Table 3.4-10: Construction Noise Impact Screening Distances for Residences

Construction Activity	1-Hr Leq at 50 feet (dBA)	Residential Noise Impact Screening Distance (feet)	
		Daytime (90 dBA Limit)	Nighttime (80 dBA Limit)
Clearing and Grubbing	88	40	125
Demolition	91	55	175
Earthworks	88	40	125
Highways/Roadways	88	40	125
Drainage	88	40	125
Structures	102	200	630
Utility Relocations	88	40	125
Trackwork	88	40	125
Stations	102	200	630
MOW Facilities	102	200	630
Trainset Maintenance	102	200	630

Source: Cross-Spectrum Acoustics, 2016

Table 3.4-11: Construction Vibration Impact Screening Distances

Construction Activity	Maximum Vibration Level at 25 feet (VdB)	Vibration Impact Screening Distance (feet)		
		Category 1 (65 VdB Limit)	Category 2 (72 VdB Limit)	Category 3 (75 VdB Limit)
Clearing and Grubbing	87	135	80	65
Demolition	87	135	80	65
Earthworks	94	230	135	105
Highways/Roadways	94	230	135	105
Drainage	94	230	135	105
Structures	104	500	290	230
Utility Relocations	94	230	135	105
Trackwork	94	230	135	105
Stations	104	500	290	230
MOW Facilities	104	500	290	230
Trainset Maintenance	104	500	290	230

Source: Cross-Spectrum Acoustics, 2016

3.4.5.2.2 Station Operational Noise Impacts

The station locations include one Terminal Station option in Dallas, one in Grimes County and three Terminal Station options in Houston. Excluding noise impacts from train operations (addressed below), sources of potential operational noise impacts in the vicinity of stations includes auto and bus traffic on access roads and parking facilities. For these sources, FTA guidance suggests impact screening distances in the range of 100 to 225 feet. For the station sites under consideration, however, there are no noise-sensitive land uses within these distances. Thus, noise impacts would not occur due to station activities.

3.4.5.2.3 Maintenance Facility Operational Noise Impacts

There are 2 proposed TMF sites and 5 MOW sites along each Build Alternative. For the MOWs, FTA guidance (Chapter 3 of the FTA Guidance Manual)[12] suggests an impact screening distance of 1,000 feet from the center of the facility. For all the TMF and MOW sites, there are no noise-sensitive land uses within this distance. Therefore, no operational noise impacts would occur.

3.4.5.2.4 HSR Operational Noise Impacts

Based on a FRA General Noise Assessment, the evaluation of noise impacts from operations (assuming a maximum speed of 205 mph) is summarized by county and segment in **Table 3.4-12** for FTA Category 2 (residential) land use and in **Table 3.4-13** for FTA Category 3 (institutional) land use. The results include a tabulation of location information for each sensitive receiver group, the existing noise levels, the projections of future noise levels, the impact criteria and a conclusion of noise impacts. Existing and Project noise levels are two independent measurements. Existing noise reflects the ambient conditions in the environment without the Build Alternatives. The Project Noise Level (not future noise) is the calculation of the noise due to the implementation of the Build Alternatives – not a combination of Project and existing (or future noise). The FRA criteria are based on a comparison of the Project noise to the existing noise.

The tables also show the total number of moderate and severe noise impacts for each location, without mitigation measures and a discussion of the factors contributing to the noise impacts. The impacts are due primarily to operational noise from trains passing near receivers close to the tracks and low existing noise levels because, per the FRA criteria, impacts are more likely in areas with low existing noise levels. The results of the noise impact assessment indicate that that the impact locations tend to be scattered geographically as shown on the noise impact maps in **Appendix D, Cultural and Community Resources Mapbook**. The projected noise impacts are described by county and segment in **Appendix E, Noise and Vibration Technical Memorandum.**

For potential increased annoyance due to the startle effect of noise from passing HSR trains, this effect would only occur within about 45 feet of the HSR tracks. This distance is within the fenced ROW; therefore, increased noise annoyance due to startle would not occur as access to this area would not be permitted.

For noise from passing HSR trains on animals, the FRA noise exposure criterion limit is a Sound Exposure Level of 100 dBA. For the HSR trains operating at the maximum speed of 205 mph, this limit would only be exceeded within 15 feet from the HSR tracks. No animals would be this close to the tracks where the HSR tracks would be at-grade because this area would be within the fenced ROW. Where the HSR tracks

[12] FTA, "Transit Noise and Vibration Impact Assessment," Final Report FTA-VA-90-1003-06, May 2006.

would be on viaduct or embankment and there would be a wildlife or livestock crossing enclosed in a culvert, noise levels would be reduced by shielding either below the viaduct or within the culvert. Therefore, noise impact on wildlife would not be significant.

Table 3.4-12: Summary of Operational Noise Impacts for Residential Land Uses

County/ Segment	Location	Side of Track	Sensitive Receiver Distance to Near Track (feet)	Existing Noise Level (Ldn)	Project Noise Levels – Ldn (dBA)			Number and Type of Impacts				Mapbook Page
					HSR	FRA Criteria						
						Mod.	Sev.	Mod.	Sev.	Impact Type	Reason	
Dallas (1)	Dallas Station to IH-20	NB	243-415	72	54-57	65	71	0	0	--	--	--
				53		54	60	0	0			--
Dallas (1)	Dallas Station to IH-20	SB	348-1001	72	48-55	65	71	0	0	--	--	--
				53		54	60	0	0			--
Dallas (1)	IH-20 to Bluff Springs Rd	NB	270-793	53	49-56	54	60	1	0	Single-Family Residences	Operations and Low Existing Noise Levels	7
				70		64	69	0	0			--
				45		52	59	5	0			10-11
Dallas (1)	IH-20 to Bluff Springs Rd	SB	223-970	53	48-58	54	60	0	0	Single-Family Residences	Operations and Low Existing Noise Levels	--
				70		64	69	0	0			--
				45		52	59	3	0			11
Ellis (1)	IH-20 to Bluff Springs Rd	NB	188-910	45	49-59	52	59	8	1	Single-Family Residences	Operations and Low Existing Noise Levels	11-12
Ellis (1)	IH-20 to Bluff Springs Rd	SB	174-2612	45	42-65	52	59	9	1	Single-Family Residences	Operations and Low Existing Noise Levels	11-12
Ellis (2A)	Bluff Springs Rd to FM 813	NB	527-2986	45	39-52	52	59	1	0	Single-Family Residences	Operations and Low Existing Noise Levels	13
				55		55	61	0	0			--

Table 3.4-12: Summary of Operational Noise Impacts for Residential Land Uses

County/ Segment	Location	Side of Track	Sensitive Receiver Distance to Near Track (feet)	Existing Noise Level (Ldn)	Project Noise Levels – Ldn (dBA)			Number and Type of Impacts				Mapbook Page
					HSR	FRA Criteria						
						Mod.	Sev.	Mod.	Sev.	Impact Type	Reason	
Ellis (2A)	Bluff Springs Rd to FM 813	SB	199-2715	45	41-59	52	59	4	0	Single-Family Residences	Operations and Low Existing Noise Levels	13-16
				55		55	61	4	0			13-16
Ellis (2A)	FM 813 to TX 287	NB	824-1690	55	44-49	55	61	0	0	--	--	--
				53		55	61	0	0			--
Ellis (2A)	FM 813 to TX 287	SB	211-989	55	46-58	55	61	1	0	Single-Family Residences	Operations and Low Existing Noise Levels	18
Ellis (2A)	FM 813 to TX 287	SB		53		55	61	0	0			--
Ellis (2A)	TX 287 to TX 34	NB	281-2148	53	43-56	55	61	1	0	Single-Family Residences	Operations and Low Existing Noise Levels	23
				52		54	60	0	0			--
Ellis (2A)	TX 287 to TX 34	SB	289-805	53	48-56	55	61	1	0	Single-Family Residences	Operations and Low Existing Noise Levels	22
				52		54	60	0	0			--
Ellis (2A)	TX 34 to TX 22	NB	No noise sensitive receivers.							--	--	--
Ellis (2A)	TX 34 to TX 22	SB	167-905	53	49-60	55	61	2	0	Single-Family Residences	Operations and Low Existing Noise Levels	25
				36		50	55	0	0			--
Ellis (2B)	Bluff Springs Rd to FM 813	NB	385-2987	55	39-54	55	61	2	0	Single-Family Residences	Operations and Low Existing Noise Levels	29
				45		52	59	0	0			--

Table 3.4-12: Summary of Operational Noise Impacts for Residential Land Uses

County/ Segment	Location	Side of Track	Sensitive Receiver Distance to Near Track (feet)	Existing Noise Level (Ldn)	Project Noise Levels – Ldn (dBA)			Number and Type of Impacts				Mapbook Page
					HSR	FRA Criteria						
						Mod.	Sev.	Mod.	Sev.	Impact Type	Reason	
Ellis (2B)	Bluff Springs Rd to FM 813	SB	205-2715	55	41-58	55	61	0	0	Single-Family Residences	Operations and Low Existing Noise Levels	--
Ellis (2B)	Bluff Springs Rd to FM 813	SB		45		52	59	1	0			30
Ellis (2B)	FM 813 to TX 287	NB	179-947	55	48-59	55	61	1	0	Single-Family Residences	Operations and Low Existing Noise Levels	33
Ellis (2B)	FM 813 to TX 287	NB		53		55	61	0	0			--
Ellis (2B)	TX 287 to TX 34	NB	455-2908	53	39-53	55	61	0	0	--	--	--
				60		58	63	0	0			--
Ellis (2B)	TX 287 to TX 34	SB	959	53	46	55	61	0	0	--	--	--
				60		58	63	0	0			--
Ellis (2B)	TX 34 to TX 22	NB	No noise sensitive receivers.							--	--	--
Ellis (2B)	TX 34 to TX 22	SB	1388-1556	53	44-46	55	61	0	0	--	--	--
Ellis (3A)	TX 34 to TX 22	NB	No noise sensitive receptors.							--	--	--
Ellis (3A)	TX 34 to TX 22	SB	977	36	46	50	55	0	0	--	--	--
Ellis (3B)	TX 34 to TX 22	NB	No noise sensitive receptors.							--	--	--
Ellis (3B)	TX 34 to TX 22	SB	1311	36	44	50	55	0	0	--	--	--
Ellis (3C)	TX 34 to TX 22	NB	No noise sensitive receptors.							--	--	--
Ellis (3C)	TX 34 to TX 22	SB	977	36	46	50	55	0	0	--	--	--
Navarro (3A)	TX 34 to TX 22	NB	396-923	36	47-52	50	55	1	0	Single-Family Residence	Operations and Low Existing Noise Levels	45
Navarro (3A)	TX 34 to TX 22	SB	360-2879	36	39-53	50	55	1	0	Single-Family	Operations and Low	46

Table 3.4-12: Summary of Operational Noise Impacts for Residential Land Uses

County/ Segment	Location	Side of Track	Sensitive Receiver Distance to Near Track (feet)	Existing Noise Level (Ldn)	Project Noise Levels – Ldn (dBA)			Number and Type of Impacts				Mapbook Page
					HSR	FRA Criteria						
						Mod.	Sev.	Mod.	Sev.	Impact Type	Reason	
										Residences	Existing Noise Levels	
Navarro (3A)	TX 22 to TX 31	NB	290-632	39	49-54	50	55	1	0	Single-Family Residences	Operations and Low Existing Noise Levels	51
				36		50	55	0	0			--
Navarro (3A)	TX 22 to TX 31	SB	560-1034	39	46-52	50	55	0	0	--	--	--
				36		50	55	0	0			--
Navarro (3A)	TX 31 to FM 3194	NB	261-546	46	50-57	52	59	1	0	Single-Family Residence	Operations and Low Existing Noise Levels	55
Navarro (3A)	TX 31 to FM 3194	SB	740	46	45-55	52	59	0	0	--	--	--
Navarro (3A)	FM 3194 to Navarro County Line	NB	656	46	51	52	59	0	0	--	--	--
Navarro (3A)	FM 3194 to Navarro County Line	SB	No noise sensitive receptors.							--	--	--
Navarro (3B)	TX 34 to TX 22	NB	611-2905	36	39-51	50	55	1	0	Single-Family Residence	Operations and Low Existing Noise Levels	65
Navarro (3B)	TX 34 to TX 22	SB	222-1002	36	46-58	50	55	3	1	Single-Family Residences	Operations and Low Existing Noise Levels	65-67

Table 3.4-12: Summary of Operational Noise Impacts for Residential Land Uses												
County/ Segment	Location	Side of Track	Sensitive Receiver Distance to Near Track (feet)	Existing Noise Level (Ldn)	Project Noise Levels – Ldn (dBA)			Number and Type of Impacts				Mapbook Page
					HSR	FRA Criteria						
						Mod.	Sev.	Mod.	Sev.	Impact Type	Reason	
Navarro (3B)	TX 22 to TX 31	NB	261-996	46	48-57	52	59	1	0	Single-Family Residence	Operations and Low Existing Noise Levels	70
				39		50	55	0	0			--
Navarro (3B)	TX 22 to TX 31	SB	324-759	46	48-55	52	59	3	0	Single-Family Residences	Operations and Low Existing Noise Levels	70
Navarro (3B)	TX 31 to Bonner Ave	NB	228-1001	46	43-56	52	59	2	0	Single-Family Residences	Operations and Low Existing Noise Levels	70-73
Navarro (3B)	TX 31 to Bonner Ave	SB	204-1017	46	43-56	52	59	2	0	Single-Family Residences	Operations and Low Existing Noise Levels	70
				39		50	55	4	0			70
Navarro (3B)	Bonner Ave to Navarro County Line	NB	142-1016	46	48-61	52	59	1	1	Single-Family Residence	Operations and Low Existing Noise Levels	73-75
Navarro (3B)	Bonner Ave to Navarro County Line	SB	No noise sensitive receivers.							--	--	--
Navarro (3C)	TX 34 to TX 22	NB	396-923	36	47-52	50	55	1	0	Single-Family Residences	Operations and Low Existing Noise Levels	83

Table 3.4-12: Summary of Operational Noise Impacts for Residential Land Uses

County/ Segment	Location	Side of Track	Sensitive Receiver Distance to Near Track (feet)	Existing Noise Level (Ldn)	Project Noise Levels – Ldn (dBA)			Number and Type of Impacts				Mapbook Page
					HSR	FRA Criteria						
						Mod.	Sev.	Mod.	Sev.	Impact Type	Reason	
Navarro (3C)	TX 34 to TX 22	SB	360-2879	36	39-53	50	55	1	0	Single-Family Residences	Operations and Low Existing Noise Levels	84
Navarro (3C)	TX 22 to TX 31	NB	290-632	36	49-54	50	55	0	0	Single-Family Residences	Operations and Low Existing Noise Levels	--
				39		50	55	1	0			89
Navarro (3C)	TX 22 to TX 31	SB	566-1034	39	46-52	20	55	0	0	--	--	--
Navarro (3C)	TX 31 to TX 14	NB	786-2780	46	37-50	52	59	0	0	--	--	--
Navarro (3C)	TX 31 to TX 14	SB	No noise sensitive receptors.							--	--	--
Navarro (3C)	TX 14 to Navarro County Line	NB	176-1000	46	37-55	52	59	0	1	Single-Family Residence	Operations and Low Existing Noise Levels	95
Navarro (3C)	TX 14 to Navarro County Line	SB	571-940	46	47-51	52	59	0	0	--	--	--
Freestone (3C)	Navarro County Line to FM 1090	NB	177-885	29	47-60	50	55	2	2	Single-Family Residence	Operations and Low Existing Noise Levels	99-100
Freestone (3C)	Navarro County Line to FM 1090	SB	568-989	29	47-50	50	55	0	0	--	--	--
Freestone (3C)	FM 1090 to US 84	NB	No noise sensitive receivers.							--	--	--

Table 3.4-12: Summary of Operational Noise Impacts for Residential Land Uses

County/ Segment	Location	Side of Track	Sensitive Receiver Distance to Near Track (feet)	Existing Noise Level (Ldn)	Project Noise Levels – Ldn (dBA)			Number and Type of Impacts				Mapbook Page
					HSR	FRA Criteria						
						Mod.	Sev.	Mod.	Sev.	Impact Type	Reason	
Freestone (3C)	FM 1090 to US 84	SB	232-511	52	51-57	54	60	3	0	Single-Family Residences	Operations and Low Existing Noise Levels	102-104
				68		63	68	0	0			--
Freestone (3C)	US 84 to TX 179	NB	No noise sensitive receivers.							--	--	--
Freestone (3C)	US 84 to TX 179	SB	226-452	50	52-58	53	60	1	0	Single-Family Residences	Operations and Low Existing Noise Levels	106
				68		63	68	0	0			--
Freestone (3C)	TX 179 to Freestone County Line	NB	No noise sensitive receivers.							--	--	--
Freestone (3C)	TX 179 to Freestone County Line	SB								--	--	--
Freestone (4)	Navarro County Line to FM 930	NB	785-905	42	47-48	52	57	0	0	--	--	--
				43		52	58	0	0			--
Freestone (4)	Navarro County Line to FM 930	SB	739	43	48	52	58	0	0	--	--	--
Freestone (4)	FM 930 to Freestone County Line	NB	812-989	42	49-50	52	57	0	0	--	--	--
Freestone (4)	FM 930 to Freestone County Line	SB	125-993	42	47-62	52	57	2	4	Single-Family Residences	Operations and Low Existing Noise Levels	161-165

Table 3.4-12: Summary of Operational Noise Impacts for Residential Land Uses

County/ Segment	Location	Side of Track	Sensitive Receiver Distance to Near Track (feet)	Existing Noise Level (Ldn)	Project Noise Levels – Ldn (dBA)			Number and Type of Impacts				Mapbook Page
					HSR	FRA Criteria						
						Mod.	Sev.	Mod.	Sev.	Impact Type	Reason	
Limestone (4)	Limestone County	NB	345-862	48	50-54	53	59	3	0	Single-Family Residences	Operations and Low Existing Noise Levels	170-173
Limestone (4)	Limestone County	SB	452-832	48	48-54	53	59	0	0	--	--	--
Leon (3C)	Freestone County Line to CR 3051	NB	No noise sensitive receivers.							--	--	--
Leon (3C)	Freestone County Line to CR 3051	SB	322-503	55	51-56	55	61	1	0	Single-Family Residence	Operations and Low Existing Noise Levels	118
Leon (3C)	CR 3051 to TX 7	NB	221-334	55	57	55	61	1	0	Single-Family Residence	Operations and Low Existing Noise Levels	126
Leon (3C)	CR 3051 to TX 7	SB	220-428	55	52-58	55	61	3	0	Single-Family Residence	Operations and Low Existing Noise Levels	121-122
Leon (3C)	TX 7 to FM 977	NB	500	55	53	55	61	0	0	--	--	--
Leon (3C)	TX 7 to FM 977	SB	No noise sensitive receivers.							--	--	--
Leon (4)	Limestone County Line to US 79	NB	708	42	49	51	57	0	0	--	--	--
Leon (4)	Limestone County Line to US 79	SB	883-1003	42	47-49	51	57	0	0	--	--	--

Table 3.4-12: Summary of Operational Noise Impacts for Residential Land Uses

County/ Segment	Location	Side of Track	Sensitive Receiver Distance to Near Track (feet)	Existing Noise Level (Ldn)	Project Noise Levels – Ldn (dBA)			Number and Type of Impacts				Mapbook Page
					HSR	FRA Criteria						
						Mod.	Sev.	Mod.	Sev.	Impact Type	Reason	
Leon (4)	US 79 to TX 7	NB	296-885	42	47-57	51	57	0	1	Single-Family Residence	Operations and Low Existing Noise Levels	177
Leon (4)	US 79 to TX 7	SB	519	42	53	51	57	1	0	Single-Family Residence	Operations and Low Existing Noise Levels	179
				62		59	64	0	0			--
Leon (4)	TX 7 to FM 977	NB	347-797	42	49-54	51	57	1	0	Single-Family Residence	Operations and Low Existing Noise Levels	180
				62		59	64	0	0			--
Leon (4)	TX 7 to FM 977	SB	211-843	62	49-59	59	64	0	0	--	--	--
				52		54	60	0	0			--
Leon (4)	FM 977 to FM 2289	NB	307-604	52	50-54	54	60	1	0	Single-Family Residence	Operations and Low Existing Noise Levels	187
Leon (4)	FM 977 to FM 2289	SB	386-907	52	47-53	54	60	0	0	--	--	--
Madison (3C)	FM 977 to Waldrip Rd	NB	No noise sensitive receivers.							--	--	--
Madison (3C)	FM 977 to Waldrip Rd	SB	158-379	65	55-61	61	66	0	0	--	--	--

Table 3.4-12: Summary of Operational Noise Impacts for Residential Land Uses

County/ Segment	Location	Side of Track	Sensitive Receiver Distance to Near Track (feet)	Existing Noise Level (Ldn)	Project Noise Levels – Ldn (dBA)			Number and Type of Impacts				Mapbook Page
					HSR	FRA Criteria						
						Mod.	Sev.	Mod.	Sev.	Impact Type	Reason	
Madison (3C)	Waldrip Rd to FM 1452	NB	338	50	57	53	60	1	0	Single-Family Residence	Operations and Low Existing Noise Levels	144
Madison (3C)	Waldrip Rd to FM 1452	SB	532-640	50	51	53	60	0	0	--	--	--
Madison (3C)	FM 1452 to FM 1696	NB	787-970	54	47-50	55	61	0	0	--	--	--
Madison (3C)	FM 1452 to FM 1696	SB	No noise sensitive receptors.							--	--	--
Madison (4)	FM 977 to FM 2289	NB	288-420	52	52-55	54	60	1	0	Single-Family Residence	Operations and Low Existing Noise Levels	190
Madison (4)	FM 977 to FM 2289	SB	338-982	52	47-54	54	60	0	0	--	--	--
Madison (4)	FM 2289 to US 190	NB	353-715	50	50-55	53	60	0	0	Single-Family Residence	Operations and Low Existing Noise Levels	--
				54		55	61	1	0			196
Madison (4)	FM 2289 to US 190	SB	213-693	50	49-57	53	60	1	0	Single-Family Residence	Operations and Low Existing Noise Levels	192
Madison (4)	US 190 to FM 1696	NB	182-909	54	49-60	55	61	3	0	Single-Family Residences	Operations and Low Existing Noise Levels	196-197
Madison (4)	US 190 to FM 1696	SB	436-990	54	46-54	55	61	0	0	--	--	--

Table 3.4-12: Summary of Operational Noise Impacts for Residential Land Uses												
County/ Segment	Location	Side of Track	Sensitive Receiver Distance to Near Track (feet)	Existing Noise Level (Ldn)	Project Noise Levels – Ldn (dBA)			Number and Type of Impacts				Mapbook Page
					HSR	FRA Criteria						
						Mod.	Sev.	Mod.	Sev.	Impact Type	Reason	
Grimes (5)	FM 1696 to FM 39	NB	231-589	47	52-58	52	59	1	0	Single-Family Residences	Operations and Low Existing Noise Levels	210
				49		53	59	0	0			--
Grimes (5)	FM 1696 to FM 39	SB	No noise sensitive receivers.							--	--	--
Grimes (5)	FM 39 to TX 90	NB	313-1014	49	46-56	53	59	3	0	Single-Family Residence	Operations and Low Existing Noise Levels	211-212
Grimes (5)	FM 39 to TX 90	SB	332-852	49	47-56	53	59	1	0	Single-Family Residences	Operations and Low Existing Noise Levels	211
Grimes (5)	TX 90 to CR 215	NB	329-1001	49	44-55	53	59	0	0	--	--	--
Grimes (5)	TX 90 to CR 215	SB	422-798	49	45-53	53	59	1	0	Single-Family Residences	Operations and Low Existing Noise Levels	214
Grimes (5)	CR 215 to TX 105	NB	395-850	48	48-54	53	59	1	0	Single-Family Residences	Operations and Low Existing Noise Levels	222
Grimes (5)	CR 215 to TX 105	SB	391-1749	48	44-54	53	59	3	0	Single-Family Residences	Operations and Low Existing Noise Levels	222-223

Table 3.4-12: Summary of Operational Noise Impacts for Residential Land Uses

County/ Segment	Location	Side of Track	Sensitive Receiver Distance to Near Track (feet)	Existing Noise Level (Ldn)	Project Noise Levels – Ldn (dBA)			Number and Type of Impacts				Mapbook Page
					HSR	FRA Criteria						
						Mod.	Sev.	Mod.	Sev.	Impact Type	Reason	
Grimes (5)	TX 105 to Grimes County Line	NB	157-1010	49	46-60	53	59	5	1	Single-Family Residences	Operations and Low Existing Noise Levels	227
				48		53	59	0	0			--
Grimes (5)	TX 105 to Grimes County Line	SB	563-1958	49	42-52	53	59	0	0	--	--	--
Waller (5)	Waller County	NB	209-994	45	46-58	52	59	5	0	Single-Family Residence	Operations and Low Existing Noise Levels	228
				49		53	59	3	0			231-232
Waller (5)	Waller County	SB	157-1000	45	46-60	52	59	3	0	Single-Family Residence	Operations and Low Existing Noise Levels	228-229
				49		53	59	13	1			231
Harris (5)	Harris County Line to Old Hwy 290	NB	190-1006	51	48-59	54	60	3	0	Single-Family Residence	Operations and Low Existing Noise Levels	235
Harris (5)	Harris County Line to Old Hwy 290	SB	330-995	51	47-55	54	60	1	0	Single-Family Residence	Operations and Low Existing Noise Levels	235
Harris (5)	Old Hwy 290 to Grand Pkwy	NB	356-1009	51	46-54	54	60	1	0	Single-Family Residence	Operations and Low Existing Noise Levels	238

Table 3.4-12: Summary of Operational Noise Impacts for Residential Land Uses

County/ Segment	Location	Side of Track	Sensitive Receiver Distance to Near Track (feet)	Existing Noise Level (Ldn)	Project Noise Levels – Ldn (dBA)			Number and Type of Impacts				Mapbook Page
					HSR	FRA Criteria						
						Mod.	Sev.	Mod.	Sev.	Impact Type	Reason	
Harris (5)	Old Hwy 290 to Grand Pkwy	SB	210-1010	51	46-56	54	60	7	0	Single-Family Residence	Operations and Low Existing Noise Levels	239
										--	--	--
Harris (5)	Grand Pkwy to TX 6	NB	155-520	59	52-60	57	63	0	0	--	--	--
Harris (5)	Grand Pkwy to TX 6	NB		69		64	69	0	0			--
Harris (5)	Grand Pkwy to TX 6	SB	81-518	59	52-64	57	63	1	0	Single- and Multi-Family Residences	Operations	244
Harris (5)	Grand Pkwy to TX 6	SB		69		64	69	16	0			246-247
Harris (5)	TX 6 to Blalock Rd	NB	262-501	46	52-56	52	59	3	0	Single- and Multi-Family Residences	Operations and Low Existing Noise Levels	247-250
Harris (5)	TX 6 to Blalock Rd	SB	No noise sensitive receivers.							--	--	--
Harris (5)	Blalock Rd to Houston Station	NB	110-510	55	53-63	55	64	23*	0	Single- and Multi-Family Residences	Operations and Low Existing Noise Levels	251-252
Harris (5)	Blalock Rd to Houston Station	NB		46		52	59	2*	1			251
Harris (5)	Blalock Rd to Houston Station	NB		49		53	59	62*	7			251-252

Table 3.4-12: Summary of Operational Noise Impacts for Residential Land Uses

County/ Segment	Location	Side of Track	Sensitive Receiver Distance to Near Track (feet)	Existing Noise Level (Ldn)	Project Noise Levels – Ldn (dBA)			Number and Type of Impacts				Mapbook Page
					HSR	FRA Criteria						
						Mod.	Sev.	Mod.	Sev.	Impact Type	Reason	
Harris (5)	Blalock Rd to Houston Station	SB	227-524	55	52-57	55	64	81*	0	Single- and Multi-Family Residences	Operations and Low Existing Noise Levels	251-252
Harris (5)	Blalock Rd to Houston Station	SB		49		49	56	5*	0			252

Source: Cross-Spectrum Acoustics, 2016
*From Blalock Road to the Houston Station area, impacts located at some multi-family apartment complex are graphically shown as a single point, but are counted as impacts per dwelling unit.

Table 3.4-13: Summary of Operational Noise Impacts for Institutional Land Uses												
County/ Segment	Location	Side of Track	Sensitive Receiver Distance to Near Track (feet)	Existing Noise Level	Project Noise Levels – Leq (dBA)			Number and Type of Impacts				Mapbook Page
				Leq	HSR	FRA Criteria						
				(dBA)		Mod.	Sev.	Mod.	Sev.	Type	Reason	
Dallas (1)	Friendship Missionary Baptist Church	SB	362	75	53	70	73	0	0	--	--	4
Dallas (1)	The Church of Revelation	SB	411	75	52	70	73	0	0	--	--	4
Dallas (1)	College Park Baptist Church	SB	670	50	49	58	60	0	0	--	--	6
Dallas (1)	Full Faith Deliverance Church	SB	463	50	52	58	60	0	0	--	--	6
Ellis (2B)	Palmyra Studios	NB	963	62	45	64	65	0	0	--	--	31
Freestone (4)	Lebanon Church	NB	454	44	50	57	59	0	0	--	--	156
Freestone (4)	Furney-Richardson School	NB	837	49	48	58	59	0	0	--	--	162
Grimes (5)	Shiloh Church Cemetery	SB	988	45	46	57	59	0	0	--	--	202
Harris (5)	Fairbanks United Methodist Church	NB	451	44	52	57	59	0	0	--	--	250
Harris (5)	Christian Family Church	NB	177	44	58	57	59	1	0	Church	Operations and Low Existing Noise Levels	250
Harris (5)	Pentecostal Church New Jerusalem	SB	199	47	57	57	59	0	0	--	--	252

Source: Cross-Spectrum Acoustics, 2016

3.4.5.2.5 Operational Vibration Impacts

Based on a detailed vibration analysis, the assessment of vibration impacts from operations is summarized by county and segment in **Table 3.4-14** for FTA Category 2 (residential) land use and in **Table 3.4-15** for FTA Category 3 (institutional) land use. The results include a tabulation of location information for each sensitive receiver group, the projections of future vibration levels, the impact criteria and whether there would be vibration impacts.

As shown in **Table 3.4-14** and **Table 3.4-15**, operations would result in no vibration impacts at any residential or institutional locations. Mapbook pages reference where locations are displayed.

Table 3.4-14: Summary of Operational Vibration Impacts for Residential Land Uses

County	Segment	Location	Side of Track	Sensitive Receiver Distance to Near Track (feet)	Speed (mph)	Projected Vibration Levels (VdB)		Number of Impacts	Mapbook Page
						HSR	FRA Impact Criterion		
Dallas	1	Dallas Station to IH-20	NB	243-415	205	41	72	0	1-6
Dallas	1	Dallas Station to IH-20	SB	348-1001	205	37	72	0	1-6
Dallas	1	IH-20 to Bluff Springs Rd	NB	270-793	205	53	72	0	6-12
Dallas	1	IH-20 to Bluff Springs Rd	SB	223-970	205	53	72	0	6-12
Ellis	1	IH-20 to Bluff Springs Rd	NB	188-910	205	53	72	0	6-12
Ellis	1	IH-20 to Bluff Springs Rd	SB	174-2612	205	53	72	0	6-12
Ellis	2A	Bluff Springs Rd to FM 813	NB	527-2986	205	63	72	0	12-16
Ellis	2A	Bluff Springs Rd to FM 813	SB	199-2715	205	66	72	0	12-16
Ellis	2A	FM 813 to TX 287	NB	824-1690	205	54	72	0	16-22
Ellis	2A	FM 813 to TX 287	SB	211-989	205	67	72	0	16-22
Ellis	2A	TX 287 to TX 34	NB	281-2148	205	65	72	0	22-25
Ellis	2A	TX 287 to TX 34	SB	289-805	205	65	72	0	22-25
Ellis	2A	TX 34 to TX 22	NB	No sensitive receivers.					25-27
Ellis	2A	TX 34 to TX 22	SB	167-905	205	71	72	0	25-27
Ellis	2B	Bluff Springs Rd to FM 813	NB	385-2987	205	67	72	0	28-32
Ellis	2B	Bluff Springs Rd to FM 813	SB	205-2715	205	62	72	0	28-32
Ellis	2B	FM 813 to TX 287	NB	179-947	205	61	72	0	32-38
Ellis	2B	FM 813 to TX 287	SB	585-1784	205	66	72	0	32-38
Ellis	2B	TX 287 to TX 34	NB	455-2908	205	62	72	0	38-41
Ellis	2B	TX 287 to TX 34	SB	959	205	64	72	0	38-41
Ellis	2B	TX 34 to TX 22	NB	No sensitive receptors.					41-43
Ellis	2B	TX 34 to TX 22	SB	1388-1556	205	68	72	0	41-43
Ellis	3A	TX 34 to TX 22	NB	No sensitive receivers.					43-44
Ellis	3A	TX 34 to TX 22	SB	977	205	70	72	0	43-44
Ellis	3B	TX 34 to TX 22	NB	No sensitive receptors.					62-63
Ellis	3B	TX 34 to TX 22	SB	1311	205	70	72	0	62-63
Ellis	3C	TX 34 to TX 22	NB	No sensitive receptors.					81-82
Ellis	3C	TX 34 to TX 22	SB	977	205	70	72	0	81-82

Table 3.4-14: Summary of Operational Vibration Impacts for Residential Land Uses

County	Segment	Location	Side of Track	Sensitive Receiver Distance to Near Track (feet)	Speed (mph)	Projected Vibration Levels (VdB)		Number of Impacts	Mapbook Page
						HSR	FRA Impact Criterion		
Navarro	3A	TX 34 to TX 22	NB	396-923	205	66	72	0	43-48
Navarro	3A	TX 34 to TX 22	SB	360-2879	205	66	72	0	43-48
Navarro	3A	TX 22 to TX 31	NB	290-632	205	67	72	0	48-52
Navarro	3A	TX 22 to TX 31	SB	560-1034	205	64	72	0	48-52
Navarro	3A	TX 31 to FM 3194	NB	261-546	205	67	72	0	52-57
Navarro	3A	TX 31 to FM 3194	SB	740	205	64	72	0	52-57
Navarro	3A	FM 3194 to Navarro County Line	NB	656	205	54	72	0	57-61
Navarro	3A	FM 3194 to Navarro County Line	SB	No sensitive receptors.					57-61
Navarro	3B	TX 34 to TX 22	NB	611-2905	205	64	72	0	63-67
Navarro	3B	TX 34 to TX 22	SB	222-1002	205	64	72	0	63-67
Navarro	3B	TX 22 to TX 31	NB	261-996	205	64	72	0	67-70
Navarro	3B	TX 22 to TX 31	SB	324-759	205	64	72	0	67-70
Navarro	3B	TX 31 to Bonner Ave	NB	228-1001	205	68	72	0	70-73
Navarro	3B	TX 31 to Bonner Ave	SB	204-1017	205	69	72	0	70-73
Navarro	3B	Bonner Ave to Navarro County Line	NB	142-1016	205	61	72	0	73-80
Navarro	3B	Bonner Ave to Navarro County Line	SB	No sensitive receptors.					73-80
Navarro	3C	TX 34 to TX 22	NB	396-923	205	66	72	0	82-86
Navarro	3C	TX 34 to TX 22	SB	360-2879	205	66	72	0	82-86
Navarro	3C	TX 22 to TX 31	NB	290-632	205	67	72	0	86-90
Navarro	3C	TX 22 to TX 31	SB	566-1034	205	64	72	0	86-90
Navarro	3C	TX 31 to TX 14	NB	786-2780	205	56	72	0	90-95
Navarro	3C	TX 31 to TX 14	SB	No sensitive receivers.					90-95
Navarro	3C	TX 14 to Navarro County Line	NB	176-1000	205	66	72	0	95-97
Navarro	3C	TX 14 to Navarro County Line	SB	571-940	205	69	72	0	95-97

Table 3.4-14: Summary of Operational Vibration Impacts for Residential Land Uses

County	Segment	Location	Side of Track	Sensitive Receiver Distance to Near Track (feet)	Speed (mph)	Projected Vibration Levels (VdB)		Number of Impacts	Mapbook Page
						HSR	FRA Impact Criterion		
Freestone	3C	Navarro County Line to FM 1090	NB	177-885	205	56	72	0	97-102
Freestone	3C	Navarro County Line to FM 1090	SB	568-989	205	58	72	0	97-102
Freestone	3C	FM 1090 to US 84	NB	No sensitive receivers.					102-106
Freestone	3C	FM 1090 to US 84	SB	232-511	205	63	72	0	102-106
Freestone	3C	US 84 to TX 179	NB	No sensitive receivers.					106-111
Freestone	3C	US 84 to TX 179	SB	226-452	205	60	72	0	106-111
Freestone	3C	TX 179 to Freestone County Line	NB	No sensitive receivers.					111-116
Freestone	3C	TX 179 to Freestone County Line	SB						111-116
Freestone	4	Navarro County Line to FM 930	NB	785-905	205	56	72	0	153-160
Freestone	4	Navarro County Line to FM 930	SB	739	205	56	72	0	153-160
Freestone	4	FM 930 to Freestone County Line	NB	812-989	205	45	72	0	160-166
Freestone	4	FM 930 to Freestone County Line	SB	125-993	205	65	72	0	160-166
Limestone	4	Limestone County	NB	345-862	205	60	72	0	166-173
Limestone	4	Limestone County	SB	452-832	205	55	72	0	166-173
Leon	3C	Freestone County Line to CR 3051	NB	No sensitive receivers.					116-121
Leon	3C	Freestone County Line to CR 3051	SB	322-503	205	58	72	0	116-121
Leon	3C	CR 3051 to TX 7	NB	221-334	205	72	72	0	121-127
Leon	3C	CR 3051 to TX 7	SB	220-428	205	71	72	0	121-127

Table 3.4-14: Summary of Operational Vibration Impacts for Residential Land Uses									
County	Segment	Location	Side of Track	Sensitive Receiver Distance to Near Track (feet)	Speed (mph)	Projected Vibration Levels (VdB)		Number of Impacts	Mapbook Page
						HSR	FRA Impact Criterion		
Leon	3C	TX 7 to FM 977	NB	500	205	64	72	0	127-136
Leon	3C	TX 7 to FM 977	SB	No sensitive receptors.					127-136
Leon	4	Limestone County Line to US 79	NB	708	205	56	72	0	173-177
Leon	4	Limestone County Line to US 79	SB	883-1003	205	54	72	0	173-177
Leon	4	US 79 to TX 7	NB	296-885	205	66	72	0	177-180
Leon	4	US 79 to TX 7	SB	519	205	58	72	0	177-180
Leon	4	TX 7 to FM 977	NB	347-797	205	70	72	0	180-186
Leon	4	TX 7 to FM 977	SB	211-843	205	67	72	0	180-186
Leon	4	FM 977 to FM 2289	NB	307-604	205	70	72	0	186-189
Leon	4	FM 977 to FM 2289	SB	386-907	205	69	72	0	186-189
Madison	3C	FM 977 to Waldrip Rd	NB	No sensitive receivers.					136-140
Madison	3C	FM 977 to Waldrip Rd	SB	158-379	205	51	72	0	136-140
Madison	3C	Waldrip Rd to FM 1452	NB	338	205	34	72	0	140-149
Madison	3C	Waldrip Rd to FM 1452	SB	532-640	205	37	72	0	140-149
Madison	3C	FM 1452 to FM 1696	NB	787-970	205	28	72	0	149-152
Madison	3C	FM 1452 to FM 1696	SB	No sensitive receptors.					149-152
Madison	4	FM 977 to FM 2289	NB	288-420	205	70	72	0	189-191
Madison	4	FM 977 to FM 2289	SB	338-982	205	67	72	0	189-191
Madison	4	FM 2289 to US 190	NB	353-715	205	35	72	0	191-196
Madison	4	FM 2289 to US 190	SB	213-693	205	55	72	0	191-196
Madison	4	US 190 to FM 1696	NB	182-909	205	48	72	0	196-201
Madison	4	US 190 to FM 1696	SB	436-990	205	34	72	0	196-201
Grimes	5	FM 1696 to FM 39	NB	231-589	205	60	72	0	201-208
Grimes	5	FM 1696 to FM 39	SB	No sensitive receivers.					201-208
Grimes	5	FM 39 to TX 90	NB	313-1014	205	62	72	0	208-212
Grimes	5	FM 39 to TX 90	SB	332-852	205	60	72	0	208-212

Table 3.4-14: Summary of Operational Vibration Impacts for Residential Land Uses

County	Segment	Location	Side of Track	Sensitive Receiver Distance to Near Track (feet)	Speed (mph)	Projected Vibration Levels (VdB)		Number of Impacts	Mapbook Page
						HSR	FRA Impact Criterion		
Grimes	5	TX 90 to CR 215	NB	329-1001	205	59	72	0	212-218
Grimes	5	TX 90 to CR 215	SB	422-798	205	60	72	0	212-218
Grimes	5	CR 215 to TX 105	NB	395-850	205	60	72	0	218-223
Grimes	5	CR 215 to TX 105	SB	391-1749	205	51	72	0	218-223
Grimes	5	TX 105 to Grimes County Line	NB	157-1010	205	55	72	0	223-228
Grimes	5	TX 105 to Grimes County Line	SB	563-1968	205	51	72	0	223-228
Waller	5	Waller County	NB	209-994	205	54	72	0	228-233
Waller	5	Waller County	SB	157-1000	205	54	72	0	228-233
Harris	5	Harris County Line to Old Hwy 290	NB	190-1006	205	47	72	0	233-237
Harris	5	Harris County Line to Old Hwy 290	SB	330-995	205	42	72	0	233-237
Harris	5	Old Hwy 290 to Grand Pkwy	NB	356-1009	205	59	72	0	237-242
Harris	5	Old Hwy 290 to Grand Pkwy	SB	210-1010	205	62	72	0	237-242
Harris	5	Grand Pkwy to TX 6	NB	155-520	205	54	72	0	242-247
Harris	5	Grand Pkwy to TX 6	SB	81-518	205	60	72	0	242-247
Harris	5	TX 6 to Blalock Rd	NB	262-501	205	52	72	0	247-251
Harris	5	TX 6 to Blalock Rd	SB	No sensitive receivers.					247-251
Harris	5	Blalock Rd to Houston Station	NB	110-510	205	60	72	0	251-257
Harris	5	Blalock Rd to Houston Station	SB	227-524	205	53	72	0	251-257

Source: Cross-Spectrum Acoustics, 2016

Table 3.4-15: Summary of Operational Vibration Impacts for Institutional Land Uses

County	Seg.	Location	Side of Track	Sensitive Receiver Distance to Near Track (feet)	Speed (mph)	Project Vibration Levels (VdB)		Number of Impacts	Mapbook Page
						HSR	FRA Impact Criterion		
Dallas	1	Friendship Missionary Baptist Church	SB	363	205	37	78	0	4
Dallas	1	The Church of Revelation	SB	412	205	36	78	0	4
Dallas	1	College Park Baptist Church	SB	670	205	31	78	0	6
Dallas	1	Full Faith Deliverance Church	SB	463	205	34	78	0	6
Ellis	2B	Palmyra Studios	NB	963	205	64	65	0	31
Freestone	4	Lebanon Church	NB	454	205	59	78	0	156
Freestone	4	Furney-Richardson School	NB	837	205	45	78	0	162
Grimes	5	Shiloh Church Cemetery	SB	988	205	18	78	0	202
Harris	5	Fairbanks United Methodist Church	NB	451	205	48	78	0	250
Harris	5	Christian Family Church	NB	177	205	55	78	0	250
Harris	5	Pentecostal Church New Jerusalem	SB	199	205	55	78	0	252

Source: Cross-Spectrum Acoustics, 2016

3.4.6 Avoidance, Minimization and Mitigation

TCRR applied design features to avoid and minimize impacts to the natural, social, physical and cultural environment. In developing the Build Alternatives, TCRR identified co-location opportunities with transportation and utility corridors to minimize impacts to sensitive receivers. Within the 6 end-to-end Build Alternatives, 53 percent of the LOD, on average, would be located adjacent to existing road, rail or utility infrastructure. In some cases, it would be necessary to diverge from this infrastructure to avoid large concentrations of sensitive receivers. For example, the LOD would deviate from paralleling a utility line to extend just west of the City of Ferris and east of the City of Red Oak, avoiding two areas of sensitive receivers.[13]

Other design features include maximizing the use of viaduct to minimize the startle effect on wildlife and livestock. Approximately 60 percent of the Build Alternatives would be on viaduct. In most places, the height of the viaduct would exceed the minimum distance for startle effect impacts.

During final design, TCRR shall conduct additional noise and vibration assessments of the sensitive receivers on the preferred alternative. This evaluation shall determine if potential mitigation measures would be feasible and minimize noise and vibration impacts to a level that is not severe. These evaluations shall be reviewed by FRA prior to construction. Any feasible mitigation shall be documented in the post-ROD Mitigation Monitoring Program, which shall be independently managed by FRA.

3.4.6.1 Compliance Measures

The following Compliance Measure (CM) would be required for Build Alternatives A through F:

NV-CM#1: Compliance with local regulations. TCRR and its construction contractor shall complete all construction activities in compliance with the local noise and vibration regulations described in **Section 3.4.2.3.** This shall include:

- Install temporary construction site sound barriers near noise sources
- Limit or avoid nighttime construction near residential neighborhoods
- Locate stationary construction equipment as far as possible from noise-sensitive sites
- Re-route construction-related truck traffic along roadways that will cause the least disturbance to residents
- During nighttime work, use smart back-up alarms, which automatically adjust the alarm level based on the background noise level, or switch off back-up alarms and replace with spotters
- Use low-noise emission equipment
- Implement noise-deadening measures for truck loading and operations
- Monitor and maintain equipment to meet noise limits
- Line or cover storage bins, conveyors and chutes with sound-deadening material
- Use acoustic enclosures, shields or shrouds for equipment and facilities
- Use high-grade engine exhaust silencers and engine-casing sound insulation
- Minimize the use of generators to power equipment
- Limit use of public address systems
- Grade surface irregularities on construction sites

[13] TCRR, "Texas Central Partners Texas High Speed Rail Revised Draft Conceptual Engineering Report, Appendix F (Deliberative Draft)," May 2016.

- Use moveable sound barriers at the source of the construction activity

3.4.6.2 Mitigation Measures

The following Mitigation Measures (MM) would be implemented to lessen the impacts of Build Alternatives A through F:

NV-MM#1: Additional Noise and Vibration Assessments. During final design, TCRR shall conduct additional noise and vibration assessments of the sensitive receivers on the preferred alternative. This evaluation shall determine if potential mitigation measures would be feasible and minimize noise and vibration impacts to a level that is not severe. These evaluations shall be reviewed by FRA prior to construction. Any feasible mitigation shall be documented in the post-ROD Mitigation Monitoring Program, which shall be independently managed by FRA.

NV-MM#2: Noise Control Plan. TCRR shall be required to prepare a detailed Noise Control Plan. A noise control engineer or acoustician shall work with the contractor to prepare a Noise Control Plan in conjunction with the contractor's specific equipment and methods of construction. Key elements of the Plan shall include:

- Contractor's specific equipment types
- Schedule and methods of construction
- Maximum noise limits for each piece of equipment with certification testing
- Lot-line construction noise limits
- Prohibitions on certain types of equipment and processes during the nighttime hours without local agency coordination and approved variances
- Identification of specific sensitive sites near construction sites
- Methods for projecting construction noise levels
- Noise monitoring plan requirements
- Implementation of noise control measures where appropriate
- Public information and complaint response procedures

NV-MM#3: Operational Noise Mitigation. TCRR shall investigate the application of sound barriers at affected locations where feasible as the engineering design advances and the alternatives are refined. Where sound barriers are feasible, TCRR shall seek input from the impacted landowners and local jurisdictions on barrier types and designs. Where sound barriers are not practical, TCRR shall evaluate and install building sound insulation treatments where feasible.

Sound Barriers – Depending on the height and location relative to the tracks, sound barriers can achieve between 5 and 15 dB of noise reduction. The primary requirements for an effective sound barrier are that the barrier must (1) be high enough and long enough to break the line-of-sight between the sound source and the receiver, (2) be of an impervious material with a minimum surface density of four pounds per square foot and (3) not have any gaps or holes between the panels or at the bottom. Because many materials meet these requirements, aesthetics, durability, cost and maintenance considerations usually determine the selection of materials for sound barriers. Depending on the situation, sound barriers can become visually intrusive. Typically, the sound barrier style shall be selected with input from the public and local jurisdictions to reduce the visual effect of barriers on adjacent lands uses. For example, sound barriers could be solid or transparent, with various colors, materials and surface treatments. In certain cases, it may be possible to acquire limited property rights for the construction of sound barriers at locations where they will be most effective. The results of the noise impact assessment indicate that that the impact locations tend to be scattered geographically which suggests that the use of sound barriers as a practical mitigation measure will be limited.

Building Sound Insulation – Sound insulation of residences and institutional buildings to improve the outdoor-to-indoor noise reduction is a mitigation measure that can be provided by the Project when the use of sound barriers is not feasible in providing a reasonable level (5 to 7 dB) of noise reduction. Although this approach has no effect on noise in exterior areas, it may be the best choice for sites where sound barriers are not feasible or desirable and for buildings where indoor sensitivity is of most concern. Substantial improvements in building sound insulation (on the order of 5 to 10 dB) can often be achieved by adding an extra layer of glazing to windows, by sealing holes in exterior surfaces that act as sound leaks and by providing forced ventilation and air conditioning so that windows do not need to be opened.

3.4.7 Build Alternatives Comparison

Table 3.4-16 provides a comparison of the projected noise and vibration impacts from operation by the Build Alternative and land use type. Construction impacts are not a differentiating factor of the Build Alternatives and would be assessed in detail during final design as previously discussed in **Section 3.4.5.2.1**.

The noise impacts did not vary substantially by Build Alternative. There are slightly fewer severe noise impacts under Build Alternatives C and F, which include Segment 3C that roughly parallels IH-45. There would be no vibration impacts for Build Alternatives A through F. Based solely on noise and vibration impacts, no singular Build Alternative would be preferred.

Table 3.4-16: Comparison of Noise and Vibration Impacts by Build Alternative

Type of Impact		ALT A	ALT B	ALT C	ALT D	ALT E	ALT F
Severe Noise Impact	Residential	17	19	15	17	19	15
	Institutional	0	0	0	0	0	0
Moderate Noise Impact	Residential	247	261	242	236	250	231
	Institutional	1	1	1	1	1	1
Vibration Impact	Residential	0	0	0	0	0	0
	Institutional	0	0	0	0	0	0

Source: Cross-Spectrum Acoustics, 2016

This page intentionally left blank.

3.5 Hazardous Materials and Solid Waste

3.5.1 Introduction

The following sections describe the regulatory setting and affected environment for hazardous materials and wastes, the potential impacts on hazardous materials and solid waste and the mitigation measures that would reduce these impacts.

Hazardous materials refer to a broad category of hazardous waste, hazardous substances and toxic chemicals that can negatively impact human health or the environment, if released. Hazardous materials concerns commonly encountered on a transportation project include industrial sites, Superfund sites, aboveground storage tanks (AST), underground storage tanks (UST), leaking petroleum storage tanks (LPST), landfills, structures with asbestos or lead containing materials and contaminated soil and groundwater. Hazardous materials can result in contaminated conditions due to a variety of current or past activities including, but not limited to, manufacturing and dry-cleaning operations, spills and leaks and landfilling. Contaminants may also migrate to a site from offsite sources through groundwater flow.

Early evaluation of hazardous materials and waste is essential to protect the environment, construction worker safety and minimization of delays. The presence of hazardous materials within proximity of a project can pose health, safety, liability and cost concerns to a project's implementation. Therefore, hazardous materials concerns are carefully considered throughout the planning and development process in order to address these concerns as early as possible, as well as to ensure compliance with federal, state and local environmental health and safety regulations. The potential impacts from hazardous materials would depend on two factors: the nature and severity of existing contamination and the construction and operations activities that would occur near the sites. The sites that pose the greatest concern are those with soil or groundwater contamination in or adjacent to the LOD and those with groundwater contamination near areas where excavation down to groundwater would be necessary.

3.5.2 Regulatory Context

Federal

__Resource Conservation and Recovery Act__

The Resource Conservation and Recovery Act was enacted in 1976 and includes several amendments. It is the principal federal law regulating the management of solid waste and hazardous waste. Resource Conservation and Recovery Act regulates solid waste recycling and disposal; waste minimization; hazardous waste generators and transporters; USTs; and hazardous waste treatment, storage and disposal facilities. The Hazardous and Solid Waste Amendments of 1984 broadened the scope of Resource Conservation and Recovery Act and authorized the EPA to regulate USTs containing petroleum products and hazardous substances. The resulting UST program includes provisions governing design and installation of USTs, release detection, release response, corrective action, financial responsibility and closure. Hazardous waste cleanup under Resource Conservation and Recovery Act, referred to as the Corrective Action Program, regulates active facilities that are permitted to treat, store or dispose of hazardous waste. To obtain a Resource Conservation and Recovery Act operating permit, these active facilities are required to clean up contaminants that are released from their facilities or that have been released in the past.

Comprehensive Environmental Response Compensation and Liability Act

The Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), commonly referred to as Superfund, was enacted in 1980. It authorizes the EPA to respond to releases or threatened releases of hazardous substances, pollutants or contaminants that may endanger human health or the environment. Superfund was designed to remedy past hazardous waste management mistakes at abandoned sites or sites where a sole responsible party cannot be identified. It established the National Priorities List (NPL) of contaminated sites and the Superfund cleanup program. CERCLA requires that releases be reported, establishes the liability of persons responsible for releases of hazardous substances and initiates a trust fund to provide for cleanup when no responsible party can be identified.

Superfund Amendments and Reauthorization Act

The Superfund Amendments and Reauthorization Act of 1986 made several important changes to the Superfund program. Some of these changes included: stressing the importance of permanent remedies and innovative technologies in cleaning up hazardous waste sites; providing new enforcement authorities and settlement tools; increasing the focus on human health problems posed by hazardous waste sites; encouraging citizen participation in making decisions on how sites should be cleaned up; and increasing state involvement in every phase of the Superfund program.

Small Business Liability Relief and Brownfields Revitalization Act - 2002

EPA defines brownfield land as property where the reuse may be complicated by the presence of hazardous materials. The Brownfields Law amended CERCLA by providing funds to assess and clean up brownfields; clarified liability protections under CERCLA; and provided funds to enhance state and tribal response programs. Brownfields can be abandoned gas stations, dry-cleaning establishments, factories, foundries or virtually any industrial property. The FRA supports best practices of transportation investments to facilitate site remediation and brownfield economic redevelopment. Use of brownfield sites should occur only if those locations are consistent with the purpose and need of the transportation improvement being proposed and the cleanup and liability costs are reasonable when considering the cost and public benefit of the project.

Clean Air Act

The Clean Air Act of 1974 is discussed in **Section 3.2, Air Quality**. In accordance with Section 112 of the Clean Air Act, EPA establishes the National Emission Standards for Hazardous Air Pollutants. These regulations require an asbestos inspection to be conducted prior to renovation or demolition activities and specify work practice standards that control asbestos emissions.

Hazardous Materials Transportation Act

The Hazardous Materials Transportation Act includes provisions related to the packaging, marking and labeling of hazardous materials such as fuel oil and contaminated soil for transportation. The Act was passed to prevent spills and illegal dumping that endangers the public and the environment. Regulated by the U.S. Department of Transportation, hazardous materials are defined as materials of a particular quantity and form that may pose risk to health, safety or property. Hazardous materials may include, but not limited to, explosives, radioactive materials, flammable liquids or solids, oxidizing or corrosive materials and compressed gases.

Occupational Safety and Health Act

The Occupational Safety and Health Act was established for the regulation of site safety procedures and worker safety and health standards. It includes provisions for occupational safety and health standards, inspections and investigations, citations, procedure for enforcement, training and employee education. Under the Occupational Safety and Health Act, the employer is responsible for employee health and safety. Considerations for occupational safety and health are required when hazardous materials and waste are involved.

State

Texas Health and Safety Code

The Texas Health and Safety Code, Solid Waste Disposal Act, controls the management of solid and hazardous waste by requiring hazardous waste to be stored, processed and disposed of only at permitted hazardous industrial solid waste facilities.

Texas Health and Safety Code – Immunity from Liability - Innocent Owner or Operator - Chapter 361.751-361.754

This Texas Health and Safety Code also includes a provision stating a property owner is not liable for contamination that has migrated onto a property from a source of contamination not located on the property. This does not preclude the requirement to handle any contaminated material encountered during construction in an appropriate manner, but it does limit the liability for in-place contamination that migrates into the LOD. If all or a portion of the contamination source property is purchased, then the immunity does not apply. Texas Water Code

The EPA has delegated regulatory authority to the State of Texas to oversee releases from regulated storage tanks within the state. The statute creating and governing the Texas Petroleum Storage Tank Program is the Texas Water Code, Chapter 26, Subchapter I.

Title 25 Texas Administrative Code

Title 25 “Health Services” of the Texas Administrative Code includes provisions regulating asbestos related activities in public and commercial buildings and facilities. The purpose of these regulations is to control and minimize the public exposure to airborne asbestos fibers, a known carcinogen and dangerous health hazard. Asbestos abatement in workplaces and buildings is under the jurisdiction of the Texas Department of State Health Services.

Title 30 Texas Administrative Code

Title 30 “Environmental Quality” of the Texas Administrative Code includes provisions regulating underground and aboveground storage tanks, industrial solid waste and hazardous waste and spill prevention and control in the State of Texas.

Railroad Commission of Texas

The Railroad Commission of Texas has jurisdiction over the discharge, storage, handling, transportation or disposal of waste materials resulting from activities associated with the exploration, development or production of oil, gas or geothermal resources. The Commission is responsible for enforcing compliance with federal and state regulations for all intrastate natural gas, hazardous liquid, liquid petroleum-gas and production and gathering lines. The Railroad Commission responds to spills from pipelines under its jurisdiction and to other emergencies related to the production and transportation of oil and gas. It also handles citizen complaints regarding alleged groundwater contamination from oil and gas activities.

3.5.3 Methodology

3.5.3.1 Hazardous Materials

The Study Area for hazardous materials is defined by the search distances outlined in **Table 3.5-1**. It extends up to one mile beyond the Build Alternatives centerline. It also encompasses the entire LOD, including passenger stations, maintenance facilities and electrical substations. The LOD is based on the proposed area of construction disturbance and is not uniform along the Build Alternatives. An Initial Site Assessment of the Study Area was conducted following TxDOT guidelines[1] to identify potential hazardous material areas. The Initial Site Assessment consisted of a database search, a review of historic maps and a selective field reconnaissance. TxDOT guidelines outline a list of standard environmental regulatory databases that were reviewed to identify potential hazardous material issues within the Study Area. A list of these regulatory databases and the search distances is provided in **Table 3.5-1**. The database search was conducted using publicly accessible federal[2] and state databases.[3]

Table 3.5-1: Standard Environmental Database Sources

Regulatory Database	Search Distance (miles)
NPL list	1.0
Federal Delisted NPL list	0.5
Federal Comprehensive Environmental Response Compensation and Liability Information System list	0.5
Federal Comprehensive Environmental Response Compensation and Liability Information System No Further Remedial Action Planned site list	0.5
Federal Resource Conservation and Recovery Act generators	Property and adjoining properties
TCEQ Industrial Hazardous Waste Corrective Action sites	1.0
TCEQ Superfund sites	1.0
Closed and abandoned Municipal Solid Waste landfill sites	0.5
TCEQ leaking petroleum storage tank remediation lists (LPST)	0.5
TCEQ registered petroleum storage tank lists (PST)	Property and adjoining properties
TCEQ voluntary cleanup program sites	0.5
TCEQ Innocent Owner/Operator sites	0.5
TCEQ Dry Cleaners Remediation Database	0.5

[1] TxDOT Environmental Affairs Division, "Hazardous Materials Initial Site Assessment (ISA) Report," December 2014.
[2] EPA Envirofacts Multisystem Search Form. Accessed January 2016, http://www3.epa.gov/enviro/facts/multisystem.html.
[3] TCEQ Central Registry Query. Accessed January 2016, http://www15.tceq.texas.gov/crpub/index.cfm?fuseaction=home.welcome.

Table 3.5-1: Standard Environmental Database Sources

TCEQ Brownfields Database	0.5
Texas Railroad Commission voluntary cleanup program sites	0.5

Source: TxDOT Hazardous Materials ISA Report, December 2014

- NPL – Database includes EPA's NPL sites that fall under the EPA's Superfund program, established to fund the cleanup of the most serious uncontrolled or abandoned hazardous waste sites identified for possible long-term remedial action.
- Delisted NPL (DNPL) – This database includes EPA's Final NPL sites where remedies have proven to be satisfactory. It also includes sites where the original analyses were inaccurate, the sites are no longer appropriate for inclusion on the NPL and final publication in the Federal Register has occurred.
- Comprehensive Environmental Response Compensation and Liability Information System – This database is the repository for Superfund information. It contains an extract of sites that have been investigated or are in the process of being investigated for potential environmental risk.
- No Further Remedial Action Planned – This database includes sites, determined by the EPA following preliminary assessment, which no longer pose a significant risk or require further activity under CERCLA. After initial investigation either no contamination was found, contamination was quickly removed or contamination was not serious enough to require federal Superfund action or NPL consideration.
- Resource Conservation and Recovery Act Information – This database includes hazardous waste handlers, generators (large, small and conditionally exempt), transporters, Corrective Actions and treatment, storage and disposal facilities regulated under Resource Conservation and Recovery Act.
- Industrial and Hazardous Waste Corrective Action – Industrial waste is waste resulting from or incidental to, operations of industry, manufacturing, mining or agriculture. This database includes sites that are actively participating or completed cleanup due to contamination from industrial hazardous waste.
- TCEQ Superfund - The state Superfund program's mission is to remediate abandoned or inactive sites within the state that pose an unacceptable risk to public health and safety or the environment, but which do not qualify for action under the federal Superfund program.
- Municipal Solid Waste Landfill – Sites listed within a solid waste landfill database may include active landfills and inactive landfills, where solid waste is treated or stored.
- Closed and Abandoned Landfill – Includes unauthorized landfills that have no permit and are considered abandoned.
- Leaking Petroleum Storage Tank (LPST) – The LPST listing is derived from the Petroleum Storage Tank (PST) database and is maintained by the TCEQ. This database includes facilities with reported LPSTs.
- PST - The UST listing is derived from the PST database which is administered by the TCEQ. Both the UST and AST listings are included in this database.
- Voluntary Cleanup Program – This program provides administrative, technical and legal incentives to encourage the cleanup of contaminated sites in Texas. Since all non-responsible parties, including future lenders and landowners, receive protection from liability to the state of Texas for cleanup of sites under the voluntary cleanup program, most of the constraints for completing real estate transactions at those sites are eliminated. As a result, many unused or underused properties may be restored to economically productive or community beneficial uses.
- Innocent Owner/Operator – This program provides a certificate to innocent owners or operators if their properties are contaminated as a result of releases or migrations of contaminants from a source or sources not located on the properties and they did not cause or contribute to the source or sources of contamination.
- Dry Cleaners Remediation – This database includes information on sites that are under the remediation program. This program establishes a prioritization list of dry-cleaner sites and administers a fund to assist with remediation of contamination caused by dry-cleaning solvents.
- Brownfields Site Assessment – This database includes information on former contaminated industrial facilities or Brownfields that are being assessed for cleanup.
- Texas Railroad Commission – This program provides an incentive to remediate oil and gas related contamination by participants that did not cause or contribute to the contamination. Applicants to this program receive a release of liability to the state in exchange for a successful cleanup.

The database search was followed by a review of historic United State Geological Survey (USGS) topographic maps, historic aerial maps and Sanborn Fire Insurance Rate maps, as available, to develop an understanding of past land use practices that may have occurred within the Study Area. In addition, selective field reconnaissance was conducted in January 2016 from public access areas to identify any visible concerns such as significant staining, distressed vegetation, ASTs, USTs, groundwater monitoring wells, remediation systems and storage of hazardous materials and waste. The reconnaissance provided additional information that assisted in the risk evaluation of sites that appeared to pose a potentially high or moderate risk to the Build Alternatives. The selective field reconnaissance did not meet Phase I Environmental Site Assessment (ESA) standards since entire corridor was not visually surveyed for hazardous material sites, which is a deviation from standard TXDOT hazardous material identification process. There is a potential to discover previously unidentified hazardous materials sites, as discussed in **Section 3.5.6.2**.

Hazardous materials sites identified during the Initial Site Assessment were categorized as having a low, moderate or high -risk of environmental concern. The risk determination for each potential hazardous material site was based on the following criteria:

- **Low**: Facility or area of concern at which:
  - there is no evidence to suggest that there has been current or past contaminant releases to the environment based on their regulatory compliance history, or
  - a facility that has documented conditions of past contaminant release located at a distance greater than 0.25 mile from the proposed centerline and is not adjacent to the LOD.
    Example of a low-risk site: a Resource Conservation and Recovery Act generator with no history of contaminant releases.
- **Moderate**: Facility or area of concern that is located within 0.25 mile of the proposed centerline or is adjacent to the LOD:
  - with a documented past contaminant release that has been remediated, or
  - is actively participating in a regulatory program.
    Example of moderate-risk site: an LPST with final closure issued within 0.25 mile of the proposed centerline because some contaminants may still remain in the soil or groundwater.
- **High**: Facility or area of concern located in or immediately adjacent to the LOD:
  - with documented conditions of past/current contaminant release that is currently undergoing corrective action or remediation monitoring, or
  - exhibits obvious conditions that do not meet current regulatory standards based on field reconnaissance.
    Example of a high-risk site: an active LPST within the LOD with ongoing monitoring or remediation activities is an example of a high-risk site.

Based on the assigned risk category, recommendations were made to conduct further investigations such as Phase I and/or Phase II ESAs at several identified hazardous material sites. All high-risk sites would require further investigations because they are undergoing remediation/monitoring activities or because visual evidence of contamination was observed during field reconnaissance. Moderate-risk sites that are within or adjacent to the LOD would require further investigation because of their proximity to the project area. Moderate-risk sites that are not adjacent to the LOD would not require further investigation because it was determined that contamination migration to the project area is unlikely to occur based on sites locations relative to the project area. Low-risk sites would not require further investigation either because there is no evidence of past contaminant releases at these sites or because these sites are located at a distance from the project area and contamination migration is unlikely to occur.

3.5.3.2 Solid Waste

Solid waste facilities that may serve the Build Alternatives during the construction and operation periods were identified by reviewing TCEQ files. The amount of solid waste that would be generated during the construction and operation of the Build Alternatives was estimated and compared to the annual amounts disposed at these facilities.

The amount of solid waste that would be generated during construction was estimated based on the cut and fill, concrete waste and rebar waste amounts provided by TCRR (see **Appendix F, TCRR Conceptual Engineering Design Report**) and the amount of waste that would be generated from demolition of buildings. Cut and fill amounts were determined using engineering calculations. Concrete waste and rebar waste estimates were based on the assumption provided by TCRR that 0.5 percent of total concrete and 1.5 percent of reinforcement would be eventually disposed in landfills. Demolition waste was estimated by assuming that all buildings within/intersecting the LOD would be demolished. The square footage of these buildings was determined and then converted to tons of waste assuming that 155 pounds of waste would be generated per square foot of commercial/non-residential building demolished and that 25 percent of that amount would be recycled.[4]

Solid waste would also be generated during operations of the Build Alternatives from passenger and employee usage. The estimated HSR ridership is five million annual passengers and the estimated number of full-time employees at the stations, TMFs and MOW facilities is 1,576 (per **Appendix F, TCRR Conceptual Engineering Design Report**). A solid waste generation rate of 4.38 pounds per person per day[5] was used to estimate the amount of solid waste that would be generated by the employees. This generation rate was factored by 0.2 to estimate the amount of waste that would be generated by passengers to account for the amount of time a passenger would be in the station and/or on the train.

3.5.4 Affected Environment

3.5.4.1 Hazardous Materials

Within the Study Area, industrial and commercial developments, such as warehouses, petroleum handling and transportation facilities, and manufacturing facilities were dominant in Dallas and Harris counties. The database search based on the criteria listed in **Table 3.5-1** identified a total of 456 sites of potential risk of hazardous materials contamination within the Study Area. A matrix summarizing the findings of the database search is presented in **Table 3.5-2**. Along with a brief summary of each finding, the table includes the distance of the site from the proposed centerline of each Build Alternative and the assigned risk level. Each identified site was assigned a map identification number (MAP ID) and has been plotted for reference purposes in the **Potential Hazardous Materials Sources Mapbook** presented in **Appendix D.** A Hazardous Materials Initial Site Assessment Report was completed. The Initial Site Assessment Report and a photographic log documenting the field reconnaissance are presented in **Appendix E, Hazardous Materials Initial Site Assessment Report**.

A summary of past land uses based on review of historic USGS topographic maps, historic aerial maps and Sanborn Fire Insurance Rate maps is provided in the Initial Site Assessment Report. Four sites of concern (MAP ID 466 to 469) were identified based on the historic maps review and have been plotted for reference purposes in the **Potential Hazardous Materials Sources Mapbook** presented in **Appendix D.** The identified sites are discussed at the end of this section.

[4] Characterization of Building-Related Construction and Demolition Debris in the United States, U.S. EPA Report, June 1998, pages ES-3 and 2-7.
[5] U.S. EPA, "Municipal Solid Waste Generation, Recycling, and Disposal in the U.S.: Facts and Figures for 2012," February 2014.

Table 3.5-2 Hazardous Materials Database Search

Map ID	Distance From Alternative Centerline (mi)	Site's Relative Elevation to Rail	Facility Name and Address	County	Segment	In LOD	Risk	Further Investigation Required	Summary of Findings from Database Search
1	0.74 N	Higher	Hotel Adolphus 1321 Commerce St, Dallas, 75202	Dallas	1	N	L	N	**IHW:** Inactive corrective action. Completed workload in 2014. **PST:** Two USTs filled in place in 1979. One diesel AST in use.
2	0.81 N	Higher	Guaranty Federal Bank Property Dallas 1802 Jackson St, Dallas, 75201	Dallas	1	N	L	N	**IHW:** Inactive corrective action. Completed workload in 2003.
3	0.46 NW	Higher	Avis Rent A Car 607 S Houston St, Dallas, 75202	Dallas	1	N	L	N	**LPST:** Final concurrence issued, case closed in 1997. **PST**: one UST removed in 1990.
4	0.48 NE	Higher	No 4 Fire Station 816 S Akard St, Dallas, 75202	Dallas	1	N	L	N	**LPST:** Final concurrence issued, case closed in 1992. **PST:** Two USTs removed in 1992.
5	0.47 NE	Higher	Vogel Alcove Griffin Street Property Griffin Street west and south Akard Dallas, 75231	Dallas	1	N	L	N	**VCP:** Active 2009 VCP agreement for soils/groundwater affected by metals. Currently in remediation phase.
6	0.78 NE	Higher	Old City Park Yellow Cab Of Dallas 1717 Gano St, Dallas, 75215	Dallas	1	N	L	N	**IHW:** Inactive corrective action since 2001.
7	0.21 NE	Higher	Texas Delivery Service 840 S Lamar St, Dallas, 75202	Dallas	1	N	M	N	**LPST:** Two LPSTs reported. Final concurrence issued, cases closed in 1996 and 1998. **PST:** Eleven USTs removed in 1990. **VCP:** Completed VCP for soil and groundwater contamination. Final certificate issued in 2015.
8	0.60 NE	Higher	Conley Lott Nichols Machinery 1311 S Ervay St, Dallas, 75215	Dallas	1	N	L	N	**IHW:** Inactive corrective action. Completed workload in 2006.
9	0.43 NE	Higher	Peters St Soc T44209 1112 Peters St, Dallas, 75215	Dallas	1	N	L	N	**LPST:** Final concurrence issued, case closed in 2009. **PST:** One UST removed in 2007.
10	0.39 NW	Lower	Former Reunion Arena Site 777 Sports Street, Dallas, 75207	Dallas	1	N	L	N	**VCP:** 2012 VCP agreement for soil/groundwater affected by metals, chlorinated solvents, PAH, SVOC, TPH, VOC, arsenic, and lead. Currently in investigation phase.
11	0.18 NE	Higher	Former Good Luck Svc Station 904 Cadiz St, Dallas, 75215	Dallas	1	N	M	N	**LPST:** Final concurrence issued, case closed in 2008
12	0.31 NW	Lower	Cockrell Tract - Lot E 700 S Stemmons Fwy, Dallas, 75201	Dallas	1	Y	M	Y	**VCP:** Active 2012 VCP agreement. Currently in investigation phase.
13	0.13 NE	Lower	Austin Street 39 RM 777 S Austin St, Dallas, 75202	Dallas	1	N*	M	Y	**LPST:** Final concurrence issued, case closed in 1991. **PST:** Four USTs removed in 1991.

Table 3.5-2 Hazardous Materials Database Search

Map ID	Distance From Alternative Centerline (mi)	Site's Relative Elevation to Rail	Facility Name and Address	County	Segment	In LOD	Risk	Further Investigation Required	Summary of Findings from Database Search
14	0.18 NE	Higher	Greyhound Lines 1100 S Lamar St, Dallas, 75215	Dallas	1	N	M	N	**LPST:** Final concurrence issued, case closed in 2000. **PST:** Two USTs filled in place in 1987 and 1991. Four USTs removed from ground in 1987 and 1991.
15	0.49 NE	Higher	Former Dresser Industries 1501 S Akard St, Dallas, 75215	Dallas	1	N	L	N	**LPST:** Final concurrence issued, case closed in 2002.
16	0.49 W	Lower	Mikes Garage 530 S Riverfront Blvd, Dallas, 75207	Dallas	1	N	L	N	**IHW:** Inactive corrective action. Completed workload in 2006.
17	0.94 NE	Higher	Childress Properties 2600, 2604, 2608, and 2612 S Good-Latimer Expwy, Dallas	Dallas	1	N	L	N	**IHW:** Inactive corrective action. Completed workload in 2012.
18	0.11 SW	Lower	Trinity Drive Inn 70335 325 Cadiz St, Dallas, 75207	Dallas	1	N*	L	N	**PST:** Three USTs removed In 1997.
19	0.16 SW	Lower	Alford Refrigerated Warehouses 318 Cadiz St, Dallas, 75207	Dallas	1	N*	M	Y	**CERCLIS:** Not on the NPL. **LPST:** Final concurrence issued, case closed in 1995. PST: Five USTs removed in 1991. **VCP:** Completed VCP, with final certificate issued in 2012.
20	0.07 SW	Lower	Jacks Service Station 322 Cadiz St, Dallas, 75207	Dallas	1	Y	M	Y	**LPST:** Final concurrence issued in 2011, pending well plugging documentation. **PST:** Five USTs removed in 1990
21	0.16 SW	Equal	Bill Poston & Don Jenny 1208 S Riverfront Blvd, Dallas, 75207	Dallas	1	N	L	N	**PST:** Two USTs filled in place in 1987.
22	0.15 SW	Equal	Ace Brass And Aluminum Co 1203 S Industrial Blvd, Dallas	Dallas	1	N	L	N	**RCRA:** active SQG of lead.
23	0.27 NE	Higher	South Side Plaza 1700 S Lamar St, Dallas, 75215	Dallas	1	N	L	N	**IOP:** Completed IOP, with final certificate issued in 2008.
24	0.24 NE	Higher	Vacant Commercial Project 1701 S Lamar St, Dallas, 75215	Dallas	1	N	M	N	**LPST:** Final concurrence issued, case closed in 1993. **PST:** One UST removed in 1992.
25	0.26 NE	Higher	Off The Bone BBQ 1734 S Lamar St, Dallas, 75215	Dallas	1	N	L	N	**LPST:** Final concurrence issued, case closed in 2011.
26	0.12 SW	Equal	Refrigerated Transport 1400 S Riverfront Blvd, Dallas, 75207	Dallas	1	Y	M	Y	**LPST:** Final concurrence issued, case closed in 1993. **PST:** Two USTs removed in 1990.

Table 3.5-2 Hazardous Materials Database Search

Map ID	Distance From Alternative Centerline (mi)	Site's Relative Elevation to Rail	Facility Name and Address	County	Segment	In LOD	Risk	Further Investigation Required	Summary of Findings from Database Search
27	0.24 NE	Higher	Princeton Packaging 2236 Cockrell Ave, Dallas, 75215	Dallas	1	N	L	N	**LPST:** Final concurrence issued, case closed in 1989. **PST:** Five USTs filled in place and ten removed in 1988.
28	0.18 NE	Higher	Dallas ISD 2419 Cockrell Ave, Dallas, 75215	Dallas	1	N	M	N	**LPST:** Final concurrence issued, case closed in 1993. **PST:** Eleven USTs removed in 1990, 1991, and 1993.
29	0.02 SW	Lower	E H Teasley 503 Corinth St, Dallas, 75207	Dallas	1	Y	L	N	**PST:** One UST removed in 1990.
30	0.19 NE	Higher	ITEX Fabrication Facility 2510 Cockrell Ave, Dallas, 75215	Dallas	1	N	M	N	**LPST:** Final concurrence issued, case closed in 1992. **PST:** Two USTs removed in 1990.
31	0.13 SW	Equal	The Sherwin-Williams Company 1824 S Industrial Blvd, Dallas, 75207	Dallas	1	N	L	N	**RCRA:** Inactive waste generator of spent nonhalogenated solvents.
32	0.42 NE	Higher	Gulf Service Station 60105875 1620 Martin Luther King Jr Blvd Dallas, 75215	Dallas	1	N	L	N	**LPST:** Final concurrence issued, case closed in 1999. **PST:** Three USTs removed in 1990.
33	0.09 SW	Lower	Whitlock 401 Corinth St, Dallas, 75207	Dallas	1	N*	M	Y	**LPST:** Final concurrence issued, case closed in 2002. **PST:** Three USTs removed in 1995.
34	0.15 SW	Lower	Crescent Machinery Company 19119 S Industrial Blvd, Dallas, 75207	Dallas	1	N	L	N	**RCRA:** Inactive waste generator. No waste streams listed.
35	0.18 NE	Higher	Cockrell 2510 2710 S Lamar St, Dallas, 75215	Dallas	1	N	M	N	**LPST:** Final concurrence issued, case closed in 2003. **PST:** Three USTs removed in 1989.
36	0.09 SW	Equal	Kwik Stop 418 Corinth St, Dallas, 75207	Dallas	1	N*	M	Y	**LPST:** Final concurrence issued, case closed in 2009. **PST:** Three gasoline USTs in use.
37	0.12 SW	Equal	Metro Cost Plus 201 Corinth St, Dallas, 75207	Dallas	1	N*	H	Y	**LPST:** Active LPST reported in 1990. **PST:** Two gasoline USTs in use. Four USTs removed in 1992. Site had two closed enforcements and four compliance investigations events in 2010, 2011, and 2013 for failure to complete the required monitoring for the USTs.
38	0.24 SW	Equal	Buckley Oil 1809 Rock Island St, Dallas, 75207	Dallas	1	N	M	N	**IHW:** Active corrective action for soil affected by TPH. Ongoing workload. **LPST:** Final concurrence issued, case closed in 2010. **VCP:** Withdrawn VCP in 2000. Site had one closed emergency response in 2003.

Table 3.5-2 Hazardous Materials Database Search

Map ID	Distance From Alternative Centerline (mi)	Site's Relative Elevation to Rail	Facility Name and Address	County	Segment	In LOD	Risk	Further Investigation Required	Summary of Findings from Database Search
39	0.10 NE	Higher	Willow Distributors 2601 Cockrell Ave, Dallas, 75215	Dallas	1	N	M	N	**LPST:** Final concurrence issued, case closed in 2004. **PST:** Five USTs removed and one UST filled in place in 2003. One PST removed in 1999. **VCP:** Withdrawn VCP in 2003.
40	0.16 NE	Higher	Floyds Food Store 2900 S Lamar St, Dallas, 75215	Dallas	1	N	M	N	**LPST:** Final concurrence issued, case closed in 1999. **PST:** Two USTs removed in 1991.
41	0.31 NE	Higher	Star Drive and Gas 1502 Pennsylvania Ave, Dallas, 75215	Dallas	1	N	L	N	**TX Brownfields:** Brownfield site assessment application accepted in 2012. PST removal report indicated no leaks and case was closed in 2013.
42	0.20 SW	Equal	Bartholow Rental 2205 S Riverfront Blvd, Dallas, 75207	Dallas	1	N	M	N	**IHW:** Inactive corrective action. Completed workload in 2014.
43	0.20 SW	Equal	Atlas Scrap Iron and Metal 2209 S Riverfront Blvd, Dallas, 75207	Dallas	1	N	M	N	**IHW:** Inactive corrective action, transferred to VCP**. VCP:** Active VCP agreement for soil contamination. Conditional certificate of completion issued in 1999.
44	0.25 SW	Equal	James Bishop 106 Corinth St, Dallas, 75207	Dallas	1	N	M	N	**LPST:** Final concurrence issued, case closed in 1993. **PST:** Three USTs removed in 1987.
45	0.10 SW	Lower	Image Ready Mix Concrete 1005 Forest Avenue, Dallas, 75215	Dallas	1	N	L	N	**PST:** One active Diesel AST in use and one AST out of use.
46	0.07 SW	Lower	Praxair/Union Carbide Corp. Linde Div. 1001 Forest Ave, Dallas, 75215	Dallas	1	N*	M	Y	**IHW:** Inactive corrective action. Completed workload in 2012. **RCRA:** CORRACTS TSD site, cleanup completed. Inactive generator of corrosive and spent nonhalogenated wastes. **LPST:** Final concurrence issued, case closed in 1989. **PST:** Three USTs removed in 1988.
47	0.05 NE	Higher	Gold Auto Parts Recycling 3301 S Lamar St, Dallas, 75215	Dallas	1	N	M	N	**IHW:** Inactive corrective action. Completed workload in 2005. **LPST:** Final concurrence issued, case closed in 1999. **PST:** Six USTs removed in 1992. **RCRA:** Inactive generator.
48	0.08 SW	Lower	Faubion Associates Forest/Dresser Industries Inc. Guiberson Div. 1000 Forest Ave, Dallas, 75215	Dallas	1	N*	L	N	**PST:** Three USTs removed in 1987. **RCRA:** Active CESQG of ignitable and corrosive waste, lead, silver, spent halogenated solvents, and other waste.
49	0.10 SW	Higher	Matheson Tri-Gas Dallas 3301 National St, Dallas, 75215	Dallas	1	N*	M	Y	**LPST:** LPST reported in 1995, final concurrence issued in 2006, pending well plugging. **PST:** 2 USTs removed in 1995. **RCRA:** Inactive generator. **VCP:** Completed VCP for soil/groundwater contamination. Final certificate issued in 2006.

Table 3.5-2 Hazardous Materials Database Search									
Map ID	**Distance From Alternative Centerline (mi)**	**Site's Relative Elevation to Rail**	**Facility Name and Address**	**County**	**Segment**	**In LOD**	**Risk**	**Further Investigation Required**	**Summary of Findings from Database Search**
50	0.10 SW	Higher	Redi-Mix Dallas 3301 National St, Dallas, 75215	Dallas	1	N*	L	N	**PST:** One active diesel AST in use. Site had one closed emergency response event in 2002. 60 gallons of diesel were released to an impervious concrete parking area due to overfill of AST. Absorbent was applied and area was cleaned-up.
51	0.07 SW	Lower	Unnamed On E. side of Trinity River and S. side of Martin Luther King Blvd. at end of Lenway St Dallas	Dallas	1	N*	M	Y	**MSW:** Origin is unknown. Closure Confirmed in 1992 by City of Dallas. Contained household items. During mid-1980 city did remediation by constructing clay berm between site and river to stop seepage.
52	0.07 SW	Lower	Oxychem/Occidental Chemical Dallas Silicate Plant 1100 Lenway St, Dallas, 75215	Dallas	1	N*	H	Y	**IOP:** withdrawn in 2013. **PST:** Three active ASTs in use. **RCRA:** Active CESQG of ignitable and corrosive waste, mercury, benzene, and tetrachloroethylene.
53	0.09 NE	Higher	Procter And Gamble Manufacturing Co 3701 S Lamar St, Dallas	Dallas	1	N	M	N	**LPST:** Final concurrence issued, case closed in 1993. **PST:** One UST removed in 1993. **RCRA:** Inactive generator of ignitable wastes, corrosive wastes, chromium, and lead.
54	0.18 NE	Higher	Gold Metal Recyclers 4305 S Lamar St, Dallas, 75215	Dallas	1	N	M	N	**CERCLIS:** Not on the NPL. **LPST:** Final concurrence issued, case closed in 1992. **VCP:** Active 2009 VCP agreement for soils/groundwater affected by TPH, VOCs and metals. Conditional certificate of completion issued in 2012. Site had two closed emergency response events in 2008 And 2011.
55	0.45 E	Higher	Vacant Gas Station 5006 S Lamar St, Dallas, 75215	Dallas	1	N	L	N	**LPST:** Final concurrence issued in 2016, pending well plugging. **PST:** Four USTs removed in 2000.
56	0.42 E	Higher	Herman Gibbons 5003 S Lamar, Dallas	Dallas	1	N	L	N	**MSW:** Historical MSW facility closed in 1994, 11 acres in size. Contained household items, construction debris, tires, and brush.
57	0.71 SW	Higher	Dal Chrome 3044 Morrell Ave, Dallas, 75203	Dallas	1	N	L	N	**IHW:** Inactive corrective action. Completed workload in 2006. **RCRA:** CORRACTS TSD facility, cleanup completed in 2006, engineering & institutional controls in place.
58	0.60 SW	Higher	Dallas Plant/ Mainland Land & Equipment Co 1000 Sargent Rd, Dallas, 75203	Dallas	1	N	L	N	**IHW:** Active corrective Action since 2002 for soil affected by metals, lead, antimony, and arsenic. Ongoing workload.
59	0.58 SW	Higher	American Lone Star 1100 Sargent Rd, Dallas, 75203	Dallas	1	N	L	N	**LPST:** Final concurrence issued, case closed in 1996. **PST:** Two USTs removed and two USTs filled in place in 1991.

Table 3.5-2 Hazardous Materials Database Search

Map ID	Distance From Alternative Centerline (mi)	Site's Relative Elevation to Rail	Facility Name and Address	County	Segment	In LOD	Risk	Further Investigation Required	Summary of Findings from Database Search
60	0.42 E	Higher	Borden Dairy 5327 S Lamar St, Dallas, 75215	Dallas	1	N	L	N	**LPST:** Final concurrence issued, case closed in 2005. **PST:** Five USTs removed in 1990. One active diesel AST in use.
61	0.82 W	Higher	Dixie Metals Dallas 3030 Mcgowan St Dallas, 75203	Dallas	1	N	L	N	**IHW:** Active corrective action since 2012 for groundwater contamination. Ongoing workload. **RCRA:** CORRACTS TSD facility, ongoing cleanup.
62	0.75 W	Higher	Darling International 1240 Sargent Rd, Dallas, 75203	Dallas	1	N	L	N	**IHW:** Inactive corrective action for soil affected by metals and lead. Completed workload in 2012.
63	0.59 W	Higher	City Of Dallas Central WWTF 1020 Sargent Rd, Dallas, 75203	Dallas	1	N	L	N	**LPST:** Final concurrence issued, case closed in 1992. **PST:** One AST out of use in 1997 and two USTs filled in place in 1988. Facility had fish kill incidents in 2007, 2008, 2011, and 2013.
64	0.44E	Higher	Valley Steel Products Dallas 5901 S Lamar St, Dallas, 75215	Dallas	1	N	L	N	**IHW:** Inactive corrective action. Completed workload in 2014 for soil affected by metals and TPH.
65	0.15 E	Lower	ITEX Laboratory 4140 Overton Road, Dallas	Dallas	1	N	M	N	**VCP:** Withdrawal from the program in 1997. Cleanup activities were not completed.
66	0.05 W	Equal	Jan A Grant 3901 E Overton Rd, Dallas, 75216	Dallas	1	Y	L	N	**PST:** One UST removed in 1998.
67	0.02 W	Higher	Overton Texaco 3926 E Overton Rd, Dallas, 75216	Dallas	1	Y	L	N	**PST:** Two active gasoline USTs and one diesel UST in use.
68	0.03 W	Lower	Southwest Professional Vehicles Inc. 3910 E Overton Rd, Dallas, 75216	Dallas	1	N*	L	N	**RCRA:** Active SQG of ignitable wastes and spent halogenated and non-halogenated solvent wastes.
69	0.18 W	Higher	First Group America 3730 E Overton Rd, Dallas, 75216	Dallas	1	N	M	N	**LPST:** Final concurrence issued, case closed in 2005. **PST:** One UST removed In 2005.
70	0.20 W	Higher	Scheduled Truckways 3740 E Overton Rd, Dallas, 75216	Dallas	1	N	M	N	**LPST:** Final concurrence issued, case closed in 1995. **PST:** Three USTs removed In 1995.
71	0.21 E	Lower	Southern Pacific Railroad Dallas 7600 S Central Expwy, Dallas, 75216	Dallas	1	N	M	N	**IHW:** Inactive corrective action. Completed workload in 2006. **LPST:** Final concurrence issued, case closed in 2001. **PST:** Four USTs removed in 1990.
72	0.10 W	Higher	3818 Kolloch Dr 3818 Kolloch Dr, Dallas, 75216	Dallas	1	N	M	N	**LPST:** Final concurrence issued, case closed in 1994. **PST:** One UST removed in 1994.

Table 3.5-2 Hazardous Materials Database Search

Map ID	Distance From Alternative Centerline (mi)	Site's Relative Elevation to Rail	Facility Name and Address	County	Segment	In LOD	Risk	Further Investigation Required	Summary of Findings from Database Search
73	0.09 E	Lower	Gateway 24/Star Enterprise 3915 Linfield Rd, Dallas, 75216	Dallas	1	N	M	N	**LPST:** Two LPSTs reported. Final concurrence issued, cases closed in 1992 and 1997. **PST:** Four USTs removed in 2008 and two active USTs in use. **RCRA:** Inactive generator of ignitable wastes and benzene.
74	0.39 E	Lower	TAMKO Building Products Dallas 7910 S Central Expwy, Dallas, 75216	Dallas	1	N	L	N	**LPST:** Final concurrence issued, case closed in 1996. **PST:** Five USTs removed in 1977 and 1991. Site had one closed emergency response event in 2004.
75	0.27 E	Lower	TxDOT Maintenance Facility 7825 S Central Expwy, Dallas, 75216	Dallas	1	N	L	N	**LPST:** Final concurrence issued, case closed in 1995. **PST:** Four ASTs removed in 1990 and one Active AST in use.
76	0.37 NE	Lower	Union Pacific Railroad Miller Yard 8150 S Central Expwy, Dallas, 75241	Dallas	1	N	L	N	**IHW:** Inactive corrective action. Completed workload in 2015. **LPST:** Final concurrence issued, case closed in 1999. **PST:** One UST removed in 1998. Site had seven closed emergency response events
470	0.51 NE	Lower	Union Pacific Railroad 8130 S Central Expy, Dallas, 75241	Dallas	1	N	L	N	**IHW:** Active corrective action since 2016. Ongoing workload.
77	0.32 NE	Lower	Ashland EDC Facility 8201 South Central Expressway, Dallas, 75241	Dallas	1	N	L	N	**RCRA:** Active LQG of several waste streams. **VCP:** Completed VCP, with final certificate issued in 2013 for soils affected by metals, chlorinated solvents, VOC and TPH.
78	0.43 NE	Lower	Crane Plumbing 8290 S Central Expwy, Dallas, 75241	Dallas	1	N	L	N	**IHW:** Inactive corrective action. Completed workload in 2009.
79	0.43 NE	Lower	Verson All Steel Press 8290 S Central Expwy, Dallas, 75241	Dallas	1	N	L	N	**LPST:** Final concurrence issued, case closed in 1993. **PST:** Four USTs removed In 1979, 1984, and 1987.
80	0.35 NE	Lower	Continental Electronics 4212 Loop 12, Dallas, 75241	Dallas	1	N	L	N	**LPST:** Final concurrence issued, case closed in 1991.
81	0.32 NE	Lower	ATS Continental Equipment 8505 S Central Expwy, Dallas, 75241	Dallas	1	N	L	N	**LPST:** Final concurrence issued, case closed in 1992. **PST:** Two USTs removed in 1992 and one active AST in use.
82	0.43 NE	Lower	Lloyd Miller 7600 South Central Expressway (US-75) in Hutchins	Dallas	1	N	L	N	**MSW:** Historical MSW facility closed in 1986. It was 5 acres in size and contained construction debris.

Table 3.5-2 Hazardous Materials Database Search

Map ID	Distance From Alternative Centerline (mi)	Site's Relative Elevation to Rail	Facility Name and Address	County	Segment	In LOD	Risk	Further Investigation Required	Summary of Findings from Database Search
83	0.33 SW	Higher	Jessie Majors 8500 Julius Schepps Highway, Dallas	Dallas	1	N	L	N	**MSW:** Historical MSW facility closed in 1992. It contained household items, construction debris, tires, and brush.
84	0.62 NE	Lower	Occidental Chemical Dallas 8800 S Central Expwy, Dallas, 75241	Dallas	1	N	L	N	**IOP:** Withdrawn in 2013. **IHW:** Active corrective action. Ongoing workload for groundwater affected by phosphates. **RCRA:** CORRACTS TSD facility.
85	0.53 SW	Higher	James Currey 3200 Stag Road, Dallas	Dallas	1	N	L	N	**MSW:** Historical MSW facility closed in 1994. It was 15 acres in size and contained household items and construction debris.
86	0.04 E	Lower	Chevron Fac 105982 4467 Simpson Stuart Rd, Dallas, 75241	Dallas	1	N*	M	Y	**LPST:** Final concurrence issued, case closed in 2009. **PST:** Three USTs removed in 2013. Had two compliance investigations in 2011 And 2013. **RCRA:** Inactive generator of ignitable wastes and benzene.
87	0.38 NE	Lower	Sam Nabor 5101 Youngblood St, Dallas	Dallas	1	N	L	N	**MSW:** Historical MSW facility closed in 1985. It was 5 acres in size and contained construction debris.
88	0.37 SW	Higher	3331, 3417, 3423 & 3427 Wylie Dr. Dallas 3331, 3417, 3423 & 3427 Wylie Dr Dallas, 75235	Dallas	1	N	L	N	**VCP:** Completed VCP, with final certificate issued in 2013 for groundwater affected by VOCs and chlorinated solvents.
89	0.46 SW	Higher	SMU New Tennis Center 4526 Cedardale Dr, Dallas, 75241	Dallas	1	N	L	N	**IHW:** Inactive corrective action. Completed workload in 2014.
93	0.49 W	Lower	DLH Tract 162 Farm Headquarters - Hutchins 4720 Witt Rd, Hutchins, 75141	Dallas	1	N	L	N	**IHW:** Inactive corrective action. Completed workload in 2012.
471	0.13 W	Higher	ADESA Dallas 3501 Lancaster Hutchins Rd, Hutchins 75141	Dallas	1	N	L	N	**PST:** One active gasoline/diesel AST in use.
472	0.30 W	Lower	Aquatic/ Lasco Bathware 151 Industrial St, Lancaster 75134	Dallas	1	N	L	N	**LPST:** Minor soil contamination. Final concurrence issued, case closed in 1992. Five USTs removed between 1991 and 1997. One AST and two USTs in use.
473	0.18 W	Lower	Bilco Brick 2116 N Lancaster Hutchins Rd, Lancaster	Dallas	1	N	L	N	**PST:** One UST removed in 1993.

Table 3.5-2 Hazardous Materials Database Search

Map ID	Distance From Alternative Centerline (mi)	Site's Relative Elevation to Rail	Facility Name and Address	County	Segment	In LOD	Risk	Further Investigation Required	Summary of Findings from Database Search
474	0.37 W	Lower	Bentwood Kitchens 2007 N Lancaster Hutchins Rd, Lancaster 75134	Dallas	1	N	L	N	**VCP:** VCP application received in 2000 for soil contamination. Withdrawn from VCP in 2001.
475	0.14 W	Lower	Matl Distribution Center 1325 Cornell Rd, Lancaster 75134	Dallas	1	N*	L	N	**PST:** One UST removed in 1996.
476	0.30 W	Higher	Stericycle Environmental Solutions/ Effective Environmental 945 E Pleasant Run Rd, Lancaster 75146	Dallas	1	N*	H	Y	**IHW:** Active corrective action site since 2002. Ongoing workload.
477	0.35 W	Higher	NCH Power Systems 939 E Pleasant Run Rd, Lancaster 75146	Dallas	1	N*	M	N	**IHW:** Inactive corrective action. Completed workload in 2003.
478	0.49 W	Higher	VI Car 825 E Pleasant Run Rd, Lancaster 75146	Dallas	1	N*	L	N	**PST:** One UST removed in 1992.
97	0.22 SE	Lower	Palmer Approximately 2 miles west of Hwy 75 And FM 878 intersection north of FM 878	Ellis	2B	N	L	N	**MSW:** Historical MSW facility, Identified In 1968 by US Dept. of HEW Survey, one acre in size containing household items.
98	0.25 W	Higher	Royal Food & Beverage 4331 S Highway 287, Waxahachie, 75165	Ellis	2A	N	L	N	**PST:** Two active USTs in use.
99	0.07 SW	Higher	Pencco Bardwell Site 6555 W Highway 34, Ennis	Ellis	2A	N*	H	Y	**RCRA:** Active CESQG of chromium.
100	0.36 SW	Higher	Jack Herod Trucking 108 W Highway 22, Barry, 75102	Navarro	3C	N	L	N	**PST:** one UST removed in 2014.
101	0.28 NE	Higher	Melton L A Landfill 1 mile NW Dresden or 4 mile S Blooming Grove on FM 55	Navarro	3C	N	L	N	**MSW:** Closed MSW facility. Permit start date in 1975 and revoked in 1977.

Table 3.5-2 Hazardous Materials Database Search

Map ID	Distance From Alternative Centerline (mi)	Site's Relative Elevation to Rail	Facility Name and Address	County	Segment	In LOD	Risk	Further Investigation Required	Summary of Findings from Database Search
102	0.45 NE	Lower	Redden Glenn Landfill 0.25 mile W of Richland Creek on FM 709, Corsicana	Navarro	3C	N	L	N	**MSW:** Closed MSW facility. Permit start date in 1975 and revoked in 1977.
103	0.18 NE	Higher	Lone Star Aggregates 7329 SW County Road 30 Richland, 76681	Navarro	3B	N	L	N	**PST:** Two active ASTs in use.
104	0.69 SW	Higher	Wortham Station FM 27 E Mile East Of Wortham	Freestone	4	N	L	N	**RCRA:** Inactive generator with no waste streams listed. Owner is Chevron pipeline.
455	0.48 E	Lower	BP Pipelines North America Release Site 3 miles west of Teague off FM 1365	Freestone	4	N	L	N	**IHW:** Active corrective action since 2003. Ongoing workload.
105	0.25 SW	Lower	AT&T Cell Tower 325 W I 45, Fairfield, 75840	Freestone	3C	N	M	N	**LPST:** Final concurrence issued, case closed in 2015.
106	0.06 NE	Higher	Charlies Truck Stop 220 Interstate 45 N, Fairfield, 75840	Freestone	3C	N*	L	N	**PST:** One UST removed in 2006.
107	0.05 SW	Lower	Cooper Farms Country Store 301 Interstate 45 E, Fairfield, 75840	Freestone	3C	N*	L	N	**PST:** Three active USTs in use and three USTs removed in 1990. Site had one enforcement order in 2012 for failure to provide proper release detection for the pressurized piping associated with the USTs.
108	0.06 NE	Higher	I-45 Shell Truck Stop 466 W Interstate 45, Fairfield, 75840	Freestone	3C	N*	L	N	**PST:** Four active USTs in use. Site had one enforcement order in 2012 for failure to provide proper release detection for the pressurized piping associated with the USTs.
109	0.06 NE	Higher	Pool Texas 319 Interstate 45 E, Fairfield, 75840	Freestone	3C	N*	L	N	**PST:** One AST out of use.
110	0.02 SW	Lower	Professional Wireline Rentals Fairfield Facility 375 N I-45, Fairfield, 75840	Freestone	3C	Y	M	Y	**IHW:** Inactive corrective action. Completed workload in 2013.
111	0.29 SW	Lower	Dow Chemical 101 W Commerce St, Fairfield, 75840	Freestone	3C	N	L	N	**IHW:** Listed under Corrective Action database with no information provided on status.

Table 3.5-2 Hazardous Materials Database Search

Map ID	Distance From Alternative Centerline (mi)	Site's Relative Elevation to Rail	Facility Name and Address	County	Segment	In LOD	Risk	Further Investigation Required	Summary of Findings from Database Search
112	0.02 SW	Higher	Loves Country Store 288 299 Interstate 45 N, Fairfield, 75840	Freestone	3C	Y	L	N	**PST:** Four active USTs in use.
113	0.13 SW	Lower	Environmental Emergency Response Team 105 FM 27 W, Fairfield, 75840	Freestone	3C	N	L	N	**RCRA:** Active transporter with no waste streams listed.
114	0.20 NE	Higher	Coles One Stop 1022 W Commerce St, Fairfield, 75840	Freestone	3C	N	M	N	**LPST:** First LPST reported in 1992. Final concurrence issued, case closed in 1992. Second LPST reported in 2009. Designated major or minor aquifer impacted. Remediation was completed and final concurrence issued in 2016. **PST:** One UST in use and three removed in 2009.
479	0.71 E	Lower	West Texas LPG Fairfield MP 89.36 Fairfield	Freestone	3C	N	L	N	**IHW:** Inactive corrective action. Completed workload in 2017.
480	0.05 E	Lower	Fairfield Field Camp 440 Interstate 45W, Fairfield 758840	Freestone	3C	N	M	N	**IHW:** Inactive corrective action. Completed workload in 2017.
115	0.24 NE	Higher	McDonalds Restaurant No 042 1060 669 W US Highway 84, Fairfield, 75840	Freestone	3C	N	M	N	**IOP:** Active 2011 IOP for groundwater contamination from upgradient gas station LPST plume moving onto site. Currently in investigation phase.
116	0.18 NE	Higher	Daniels Exxon 685 W Us Highway 84, Fairfield, 75840	Freestone	3C	N	M	N	**LPST:** Final concurrence issued, case closed in 1998. **PST:** Three active USTs in use and one out of service since 1991.
117	0.13 NE	Higher	Exxon Mobil Corporation 685 W 84th, Fairfield, 75840	Freestone	3C	N	L	N	**RCRA:** Inactive generator of ignitable wastes and benzene.
118	0.08 SW	Higher	Halliburton Energy Services Inc. 466 Interstate 45 W, Fairfield, 75840	Freestone	3C	N	L	N	**RCRA:** Active CESQG with no waste streams listed.
119	0.11 SW	Higher	Jollys Shell 630 W Us Highway 84, Fairfield, 75840	Freestone	3C	N	L	N	**PST:** Three active USTs in use. Site had one enforcement event in 2012.
481	0.08 NE	Lower	Fairfield Truck Center I-45 & US 84 West, Fairfield	Freestone	3C	N	M	N	**LPST:** Final concurrence issued in 2016, pending well plugging.
120	0.28 E	Lower	Jet Travel Plaza 771 State Highway 179, Teague, 75860	Freestone	3C	N	L	N	**LPST:** Active LPST reported in 1991. **PST:** Four active USTs in use and two removed in 2001. Site had two closed enforcement orders in 2012 for failure to provide proper release detection for USTs and for not completing the required monitoring for the USTs.

Table 3.5-2 Hazardous Materials Database Search

Map ID	Distance From Alternative Centerline (mi)	Site's Relative Elevation to Rail	Facility Name and Address	County	Segment	In LOD	Risk	Further Investigation Required	Summary of Findings from Database Search
121	0.27 E	Lower	Dew Truck Stop One 790 Hwy 179, Teague, 75860	Freestone	3C	N	L	N	**LPST:** Three LPSTs reported. Final concurrence issued, and cases closed in 1990, 2000, and 2015. **PST:** Four active USTs in use and five USTs removed in 1990.
122	0.03 W	Higher	Lucky JS Travel Center 680 I-45 South, Teague, 75860	Freestone	3C	Y	L	N	**PST:** Four active USTs in use.
123	0.12 NE	Higher	Stallion Oilfield Services 577 S Interstate 45, Teague, 75860	Freestone	3C	N	L	N	**PST:** One active AST in use.
124	0.81 NE	Higher	Buffalo HF Investigation 303 Commerce Street, Buffalo, 75831	Leon	3C	N	L	N	**CERCLIS:** Not on NPL and had one emergency cleanup in 2000.
125	0.39 NE	Higher	Brookshire Brothers 54 1220 W Commerce St, Buffalo, 75831	Leon	3C	N	L	N	**LPST:** Final concurrence issued, case closed in 2010. **PST:** Two USTs in use.
126	0.27 NE	Lower	Glick Brothers Formerly Buffalo Exxon I-45 & Hwy 79 SE Corner	Leon	3C	N	L	N	**LPST:** Final concurrence issued, case closed in 2008
127	0.27 NE	Lower	Chevron of Buffalo 1608 W Commerce, Buffalo, 75831	Leon	3C	N	L	N	**LPST:** Final concurrence issued, case closed in 2005. Two USTs in use and four removed in 1991
129	0.16 SW	Lower	Triangle Petroleum 2605 W Commerce St, Buffalo, 75831	Leon	3C	N	M	N	**LPST:** Active LPST reported in 2015. In active remediation phase. **PST:** Five active USTs in use and five removed in 1998, 1999, and 2015.
130	0.22 E	Lower	Woodys Smokehouse 1 1021 W Saint Marys St, Centerville, 75833	Leon	3C	N*	L	N	**PST:** Four active USTs in use, three USTs removed in 1999, and one filled in place in 1985.
131	0.23 E	Lower	Exxon RS 63615 IH 45 & State Hwy 7, Centerville	Leon	3C	N*	M	Y	**LPST:** Final concurrence issued, case closed in 1992. **PST:** Four USTs removed in 1992.
132	0.23 E	Lower	Texan Food Mart 1008 W St Marys St, Centerville, 75833	Leon	3C	N*	L	N	**PST:** Four active USTs in use.
133	0.03 E	Lower	Ryder Oil 992 State Highway 7 W, Centerville, 75833	Leon	3C	Y	L	N	**PST:** Three active diesel and two gasoline ASTs in use.
134	0.09 SW	Lower	Centerville Asphalt Plant 9271 IH 45 S, Centerville, 75833	Leon	3C	Y	L	N	**PST:** Two active diesel ASTs in use.

Table 3.5-2 Hazardous Materials Database Search									
Map ID	**Distance From Alternative Centerline (mi)**	**Site's Relative Elevation to Rail**	**Facility Name and Address**	**County**	**Segment**	**In LOD**	**Risk**	**Further Investigation Required**	**Summary of Findings from Database Search**
136	0.11 SW	Lower	Yellow Rose Travel Plaza 23456 OSR, Normangee, 77871	Madison	3C	N*	L	N	**PST:** Four active USTs in use.
482	0.20 W	Lower	Madison County Precinct 1 Landfill	Madison	4	N	L	N	**MSW:** Permit application submitted in 1984 and was withdrawn in 1989. Status is not constructed.
483	0.41 E	Higher	Vacant Former Four Way Stop Hwy 30 & 90, Roans Prairie	Grimes	5	N	M	N	**LPST:** Active LPST reported in 2015. Potential groundwater impact with public/domestic water supply well within 0.25 mile. Currently in release determination stage.
137	0.44 NE	Higher	Valero Corner Store 0541 15513 Highway 30, Anderson, 77830	Grimes	5	N	L	N	**LPST:** Final concurrence issued, case closed in 2013. **PST:** Two active USTs in use and four USTs removed in 2010.
138	0.26 W	Higher	H C Chandler & Son Inc. Hwy 105 W, Plantersville, 77363	Grimes	5	Y	L	N	**RCRA:** Active CESQG. No waste streams listed.
139	0.20 W	Higher	Circle N Grocery 29503 FM 1488 Rd, Waller, 77484	Grimes	5	N	M	N	**LPST:** Final concurrence issued, case closed in 2011. **PST:** Three USTs removed in 1990.
140	1.20 W	Higher	Destara Chemical 18314 Mathis Rd, Waller, 77484	Waller	5	N	L	N	**IHW:** Active corrective action Since 2009. Ongoing workload. One complaint in 2006 for venting vapors directly to atmosphere and no emission controls.
141	0.45 SW	Lower	Romine Kevin D Recycling Facility 2 miles S of highway 290, 8 miles N of FM 529 on Katy Hockley Road	Waller	5	N	L	N	**MSW:** Active Type 5RC facility, with a start date in 1998
142	0.13 NE	Lower	Cypress Truck Stop 25802 Highway 290, Cypress, 77429	Harris	5	N	M	N	**LPST:** Final concurrence issued, case closed in 2002. **PST:** Five USTs removed in 1996.
143	0.04 NE	Higher	Exxon 863 20621 Northwest Frwy, Cypress, 77429	Harris	5	N	L	N	**PST:** Two active USTs in use.
144	0.26 NE	Higher	APD Holdings III Cypress 13303 Skinner Rd, Cypress, 77429	Harris	5	N	L	N	**IHW:** Inactive corrective action. Completed workload in 2011.
145	0.06 NE	Lower	Timewise Exxon 823 20600 Northwest Fwy, Cypress, 77429	Harris	5	N	M	N	**LPST:** Final concurrence issued, case closed in 2014. **PST:** Four active USTs in use. Site had two NOVs for failure to maintain records.

Table 3.5-2 Hazardous Materials Database Search

Map ID	Distance From Alternative Centerline (mi)	Site's Relative Elevation to Rail	Facility Name and Address	County	Segment	In LOD	Risk	Further Investigation Required	Summary of Findings from Database Search
146	0.10 NE	Higher	Hewlett-Packard Company 24500 Highway 290, Cypress, 77429	Harris	5	N	M	N	**IHW:** Inactive corrective action. Completed workload in 2011. **LPST:** Final concurrence issued, case closed in 1996. **PST:** one active AST in use. **RCRA:** Inactive generator of ignitable, corrosive, and reactive wastes and several metal wastes.
147	0.11 SW	Higher	Plant 11 11934 Barker Cypress Rd, Cypress, 77433	Harris	5	N	L	N	**PST:** Two ASTs out of use.
149	0.10 NE	Lower	Telge Transportation Center 11010 Telge Rd, Houston, 77040	Harris	5	N	M	N	**LPST:** Final concurrence issued, case closed in 1998. **PST:** Four USTs removed in 1995.Four active ASTs in use.
150	0.11 NE	Lower	Telge Shell 22250 Northwest Fwy, Cypress, 77429	Harris	5	N	L	N	**PST:** Three active USTs in use.
151	0.09 SW	Lower	Siemens Energy 10730 Telge Rd, Houston, 77095	Harris	5	N*	L	N	**PST:** One active AST in use.
152	0.26 SW	Lower	Wyman Gordon Forgings 10825 Telge Rd, Houston, 77095	Harris	5	N	L	N	**IHW:** Inactive corrective action. Completed workload in 2014. **LPST:** Final concurrence issued, case closed in 1996. **RCRA:** Active SQG. Site had seven emergency responses and ten NOVs that have all been resolved.
153	0.22 SW	Lower	Stewart & Stevenson - Engineered Products Division	Harris	5	N	L	N	**RCRA:** Active SQG of ignitable, corrosive, and flammable wastes, cadmium, selenium, and other waste streams.
154	0.17 NE	Lower	North Cypress Medical Center Pob II Garage & Pedestrian Bridge	Harris	5	N	L	N	**PST:** Two active ASTs in use.
155	0.04 NE	Higher	C & J Machine & Supply Co 20818 Hempstead Highway, Houston, 77040	Harris	5	N	L	N	**RCRA:** Inactive generator with no waste streams listed.
156	0.12 NE	Higher	Mckesson 20710 Hempstead Rd, Houston, 77065	Harris	5	N	L	N	**PST:** One active AST in use.
157	0.13 NE	Higher	Marco-Cabell Chrysler Plymouth 18700 Hempstead Rd, Houston, 77065	Harris	5	N	L	N	**PST:** Two USTs removed in 1990.

Table 3.5-2 Hazardous Materials Database Search

Map ID	Distance From Alternative Centerline (mi)	Site's Relative Elevation to Rail	Facility Name and Address	County	Segment	In LOD	Risk	Further Investigation Required	Summary of Findings from Database Search
158	0.04 NE	Lower	SPX Flow Control Houston 19191 Hempstead Rd, Jersey Village, 77065	Harris	5	N	M	N	**IHW:** Inactive corrective action. Completed workload in 2015. **PST:** Two USTs removed in 1991. **RCRA:** Active LQG of ignitable and corrosive waste, benzene, pyridine, and other waste streams. Site had two closed emergency response events in 2007 and 2008.
159	0.23 NE	Higher	TNL Shell 13250 FM 1960 Rd W, Houston, 77065	Harris	5	N	M	N	**LPST:** Final concurrence issued, case closed in 2010. **PST:** Three active USTs in use.
160	0.32 NE	Higher	Speedy Stop 303 13155 FM 1960 Rd W, Houston, 77065	Harris	5	N	L	N	**LPST:** Final concurrence issued, case closed in 2012.**PST:** Two active USTs in use and three USTs removed in 2005.
161	0.12 NE	Lower	Builders Square Inc. 13328 FM 1960 W, Houston, 77065	Harris	5	N	L	N	**RCRA:** Inactive generator of ignitable and corrosive waste.
162	0.04 SW	Lower	West End Lumber 9335 Highway 6 N, Houston, 77095	Harris	5	N*	M	Y	**LPST:** Final concurrence issued, case closed in 2000. **PST:** One UST removed in 1997 and three ASTs out of use.
456	0.18 SW	Higher	SpoolTech 9325 Hwy 6 N, Houston TX 77095	Harris	5	N	L	N	PST: Two diesel and gasoline ASTs out of use since 1992
484	0.51 SW	Higher	Weatherford Enterra Compression 8920 Point Six Circle Dr., Houston 77095	Harris	5	N	L	N	**IHW:** Inactive corrective action. Completed workload in 2016.
163	0.15 NE	Lower	Carmax 7203 19500 Northwest Fwy, Jersey Village, 77065	Harris	5	N	L	N	**PST:** One active AST in use. Site had three NOVs for failure to maintain records and inspections.
164	0.36 NE	Higher	Lot 18 12500 Castlebridge Dr, Jersey Village, 77065	Harris	5	N	L	N	**LPST:** Final concurrence issued, case closed in 1991. **PST:** Three USTs were removed in 1990.
165	0.12 NE	Higher	Budget Rent A Car Of Houston 19050 Northwest Fwy, Jersey Village, 77065	Harris	5	N	L	N	**PST:** Three USTs removed in 1993.
166	0.83 NE	Lower	Jones Road Ground Water Plume Houston, 77008	Harris	5	N	L	N	**CERCLIS:** Currently on the final NPL.

Table 3.5-2 Hazardous Materials Database Search

Map ID	Distance From Alternative Centerline (mi)	Site's Relative Elevation to Rail	Facility Name and Address	County	Segment	In LOD	Risk	Further Investigation Required	Summary of Findings from Database Search
167	0.19 NE	Lower	Lone Star Chevrolet 18900 Northwest Fwy, Houston, 77065	Harris	5	N	L	N	**PST:** One active AST in use.
168	0.08 NE	Lower	Northwest Harris County MUD 29 9603 N Eldridge Pkwy, Houston, 77065	Harris	5	N	L	N	**PST:** One active AST in use.
169	0.32 SW	Higher	Varn Products 14000 Westfair East Dr, Houston, 77041	Harris	5	N	L	N	**IHW:** Active corrective action since 2007. Ongoing workload. **RCRA:** Inactive generator.
170	0.45 SW	Higher	Chemlawn Brand 14150 Westfair East Dr, Houston, 77041	Harris	5	N	L	N	**LPST:** Final concurrence issued, case closed in 2002. **PST:** One UST removed in 1991.
171	0.15 SW	Higher	Bray Controls 13333 Westland East Blvd, Houston, 77041	Harris	5	N	L	N	**RCRA:** Active CESQG of ignitable, corrosive, and flammable wastes, chromium, and mercury.
172	0.04 NE	Lower	Marco Cabell Chrysler-Plymouth 18700 Northwest Freeway, Houston, 77065	Harris	5	N	L	N	**RCRA:** Inactive generator
173	0.06 SW	Higher	Silver Eagle Distributors 8660 N Eldridge Pkwy, Houston, 77041	Harris	5	N*	L	N	**PST:** Two active USTs in use.
174	0.06 NE	Higher	Eldridge Fast Stop Shell 18990 Northwest Fwy, Houston, 77065	Harris	5	N	M	N	**LPST:** Final concurrence issued in 2007, pending well plugging documentation. **PST:** Two USTs removed in 2003.
175	0.05 SW	Higher	John Eagle Honda 18787 Northwest Fwy, Houston, 77065	Harris	5	N*	L	N	**PST:** One active AST in use.
176	0.01 SW	Lower	Fabmark 7938 Wright Rd, Houston, 77041	Harris	5	Y	L	N	**PST:** Three USTs removed in 1988.
485	0.11 SW	Higher	Wright Road Mulch 7800 1/2 Wright Rd, Houston 77041	Harris	5	N	L	N	**MSW:** Type 5RR (recycling) facility with active disposal permit.

Table 3.5-2 Hazardous Materials Database Search

Map ID	Distance From Alternative Centerline (mi)	Site's Relative Elevation to Rail	Facility Name and Address	County	Segment	In LOD	Risk	Further Investigation Required	Summary of Findings from Database Search
177	0.10 NE	Higher	Shell Retail Facility 17504 Northwest Fwy, Houston, 77065	Harris	5	N	M	N	**LPST:** Final concurrence issued, case closed in 2004. **PST:** Three USTs removed in 2002.
178	0.10 NE	Higher	Jones Road Exxon 69395 17438 Northwest Fwy, Jersey Village, 77040	Harris	5	N	M	N	**LPST:** Final concurrence issued, case closed in 2014. **PST:** Three active USTs in use. **RCRA:** Inactive generator.
179	0.11 NE	Higher	Super K Food Store 17342 Northwest Fwy, Jersey Village, 77040	Harris	5	N	M	N	**LPST:** Final concurrence issued, case closed in 2005. **PST:** One active UST in use and three USTs removed in 2003. Site had three NOVs in 2011, all of which have been resolved.
180	0.04 NE	Higher	Tesoro Gas Marketing Digas Cypress 17311 Northwest Freeway, Houston, 77040	Harris	5	N	L	N	**RCRA:** Inactive generator with no waste streams listed.
181	0.08 NE	Higher	Concrete Batch Plant Houston 539/United Rentals 17138 Highway 290, Jersey Village, 77040	Harris	5	N	M	N	**LPST:** Final concurrence issued, case closed in 1994. **PST:** Three USTs removed in 1994.
182	0.43 SW	Higher	Champion Coatings 7403 Wright Rd, Houston, 77041	Harris	5	N	L	N	**IHW:** Inactive corrective action. Completed workload in 2012.
183	0.63 SW	Higher	NCI Building Systems 7301 Fairview St, Houston, 77041	Harris	5	N	L	N	**IHW:** Inactive corrective action. Completed workload in 2006. **LPST:** Final concurrence issued, case closed in 1992. **PST:** One UST removed in 1990. **RCRA:** Inactive generator. **VCP:** Completed VCP, with final certificate issued in 2000.
184	0.17 SW	Higher	Guardsman/ Cytex Industries 11502 Charles Rd, Jersey Village, 77041	Harris	5	N	M	N	**LPST:** Active LPST reported in 2015 with no further information. **VCP:** 2012 VCP agreement for soils/groundwater affected by VOCs. VCP in investigation phase. **RCRA:** Inactive generator
185	0.07 SW	Higher	Pinnacle Products 11330 Charles Road, Houston, 77041	Harris	5	N	L	N	**RCRA:** Inactive generator of cadmium, chromium, lead, and spent non-halogenated solvents.
186	0.37 SW	Higher	Fairview Gardens Developments WWTP 11800 Charles Rd, Jersey Village,	Harris	5	N	L	N	**IHW:** Inactive corrective action. Completed workload in 2011. **RCRA:** Active SQG of numerous waste streams.

Table 3.5-2 Hazardous Materials Database Search									
Map ID	Distance From Alternative Centerline (mi)	Site's Relative Elevation to Rail	Facility Name and Address	County	Segment	In LOD	Risk	Further Investigation Required	Summary of Findings from Database Search
			77041						
187	0.11 SW	Lower	Charles Rd SOC 11515 Charles Rd, Jersey Village, 77041	Harris	5	N	M	N	**LPST:** Final concurrence issued, case closed in 1992. **PST:** One UST removed in 1999.
188	0.40 SW	Higher	Grayloc Products 11835 Charles Rd, Jersey Village, 77041	Harris	5	N	L	N	**IHW:** Inactive corrective action. Transferred to VCP in 2004. **RCRA:** Active SQG. **VCP:** Active 2003 VCP agreement. In remediation phase
486	0.57 SW	Higher	BASF Houston EBN Site 7100 Wright Rd, Houston 77041	Harris	5	N	L	N	**IHW:** Inactive corrective action. Completed workload in 2016.
487	0.28 SW	Higher	Former Hubco Paving Facility 11714 Charles Rd, Jersey Village 77041	Harris	5	N	L	N	**LPST:** Active LPST reported in 2017. Currently in release determination stage. Assessment is still incomplete, no apparent receptors impacted.
189	0.12 NE	Higher	Joe Myers Ford 16634 Northwest Fwy, Jersey Village, 77040	Harris	5	N	M	N	**LPST:** Final concurrence issued, case closed in 1999. **PST:** One active AST in use and one AST out of use. Three USTs removed in 1992 and 1987.
190	0.16 NE	Lower	Joe Myers Mazda 16500 Northwest Fwy, Jersey Village, 77040	Harris	5	N	L	N	**PST:** One active AST in use.
191	0.36 SW	Lower	Elg Ireland Alloys, Inc. 11300 Spencer Road, Houston, 77041	Harris	5	N	L	N	**VCP:** Active 2000 VCP agreement for soil/groundwater affected by metals and chlorinated solvents. In investigation phase.
192	0.78 SW	Higher	Pathfinder Energy Services 11997 FM 529 Rd, Houston, 77041	Harris	5	N	L	N	**IHW:** Inactive corrective action. Completed workload in 2010.
193	0.88 SW	Higher	Quest Chemical 12255 FM 529 Rd, Bldg A Houston, 77041	Harris	5	N	L	N	**IHW:** Inactive corrective action. Completed workload in 2012.
488	0.81 SW	Higher	Elmar National Oilwell Varco 11993 FM 529 Rd, Houston 77041	Harris	5	N	L	N	**IHW:** Active corrective action site since 2017. Ongoing workload.
194	0.32 SW	Higher	Brookside Equipment Sales 11431 FM 529 Rd, Houston, 77041	Harris	5	N	L	N	**IOP:** Completed IOP, with final certificate issued in 2008.

Table 3.5-2 Hazardous Materials Database Search

Map ID	Distance From Alternative Centerline (mi)	Site's Relative Elevation to Rail	Facility Name and Address	County	Segment	In LOD	Risk	Further Investigation Required	Summary of Findings from Database Search
195	0.16 SW	Lower	Compression Systems Facility 16250 Port NW, Houston, 77041	Harris	5	N	M	N	**IHW:** Inactive corrective action. Completed workload in 2007. **RCRA:** Active SQG for numerous waste streams.
196	0.09 SW	Lower	Freshpak Corp 16240 Port NW, Houston, 77041	Harris	5	N	L	N	**RCRA:** Active CESQG with no waste streams listed.
197	0.09 SW	Lower	Dresser Roots Meters and Instruments 16240 Port NW, Houston, 77041	Harris	5	N	L	N	**RCRA:** Active CESQG of corrosive waste.
198	0.02 NE	Lower	Northwest Harris County MUD 25 7290 Brittmoore Rd, Houston, 77041	Harris	5	Y	L	N	**PST:** One UST removed in 1996.
199	0.05 NE	Higher	Texaco Service Station/Star Enterprise 16131 Northwest Fwy, Jersey Village, 77040	Harris	5	N	M	N	**LPST:** Final concurrence issued, case closed in 1997. **PST:** Four USTs removed in 2003.
200	0.19 NE	Higher	Speedy Stop 308 15830 Northwest Fwy, Jersey Village, 77040	Harris	5	N	M	N	**LPST:** Final concurrence issued, case closed in 2004. **PST:** Four USTs removed in 2013.
201	0.44 SW	Lower	Houston FM 529 Facility 11235 FM 529 Rd, Houston, 77041	Harris	5	N	L	N	**IHW:** Inactive corrective action. Completed workload in 2011. **IOP:** Completed IOP for soil affected by mercury, cadmium, lead, and silver, with final certificate issued in 2009.
202	0.10 NE	Higher	Shell Station 15835 Northwest Fwy, Jersey Village, 77040	Harris	5	N	M	N	**LPST:** Final concurrence issued, case closed in 2003. **PST:** Three USTs removed in 2002.
203	0.11 SW	Higher	TD Industries 6950 W Sam Houston Pkwy N, Houston, 77041	Harris	5	N	L	N	**PST:** Two USTs removed 1991.
204	0.022 SW	Higher	SPM Houston Mfg 7131 Perimeter Park, Houston, 77041	Harris	5	N*	M	Y	**IHW:** Inactive corrective action. Completed workload in 2016. **RCRA:** Inactive generator, mining machinery manufacturer with no listed waste streams.
205	0.12 SW	Higher	Houston 2 US Army Reserve Center 7077 Perimeter Park Dr, Houston, 77041	Harris	5	N	M	N	**IHW:** Active corrective action since 2011. Ongoing workload.

Table 3.5-2 Hazardous Materials Database Search

Map ID	Distance From Alternative Centerline (mi)	Site's Relative Elevation to Rail	Facility Name and Address	County	Segment	In LOD	Risk	Further Investigation Required	Summary of Findings from Database Search
206	0.08 SW	Lower	Van Leeuwen Pipe And Tube 15333 Hempstead Rd, Houston, 77040	Harris	5	N	L	N	**PST:** Two USTs removed in 2001.
207	0.73 SW	Higher	Norriseal Houston 11122 W Little York Rd, Houston, 77041	Harris	5	N	L	N	**IHW:** Inactive corrective action. Completed workload in 2002.
208	0.41 NE	Lower	Waller West Harris Area Office 14838 Northwest Fwy, Houston, 77040	Harris	5	N	L	N	**IHW:** Inactive corrective action. Completed workload in 2006. **LPST:** Final concurrence issued, case closed in 1999. **PST:** One active diesel AST and three USTs in use. One UST removed in 1990.
209	0.68 SW	Lower	Tyco Valves and Controls Tec Houston 11050 W Little York Rd Bldg L Houston, 77041	Harris	5	N	L	N	**IHW**: Inactive corrective action. Completed workload in 2012.
210	0.20 SW	Higher	AMSA 4 6903 Perimeter Park, Houston, 77041	Harris	5	N	M	N	**LPST:** Final concurrence issued, case closed in 1996. **PST:** Three USTs removed in 1994. Two active USTs in use. **RCRA:** Inactive generator of benzene, ignitable wastes, and tetrachloroethylene.
228	0.23 NE	Lower	Baker Hughes Center For Technology Innovation Cti 14990 Yorktown Plaza Dr, Houston, 77040	Harris	5	N	M	N	**IHW:** Inactive corrective action. Completed workload in 2014.
229	0.06 SW	Higher	SGI Integrated Graphic Systems 14902 Sommermeyer, Ste 120, Houston, 77041	Harris	5	N	L	N	**RCRA:** Inactive generator of ignitable, corrosive, and flammable wastes, chromium, benzene, cadmium, and mercury.
230	0.06 NE	Lower	Rex Auto Repair 14720 1/2 Hempstead Rd, Houston, 77040	Harris	5	N	L	N	**PST:** Three USTs removed in 1998.
231	0.21 SW	Lower	Foxx Moving & Storage 6450 Clara Rd, Houston, 77041	Harris	5	N	L	N	**PST:** One AST out of use.
232	0.03 NE	Lower	Hempstead Texaco 14632 Hempstead Rd, Houston, 77040	Harris	5	N*	L	N	**PST:** One active UST in use and two USTs removed in 1994. Site had two NOVs in 2011 for failure to maintain the vapor recovery system and not completing required tank testing. Site had six enforcement orders in 2011 and 2014 for several non-compliance, such as for failure to investigate and

Table 3.5-2 Hazardous Materials Database Search

Map ID	Distance From Alternative Centerline (mi)	Site's Relative Elevation to Rail	Facility Name and Address	County	Segment	In LOD	Risk	Further Investigation Required	Summary of Findings from Database Search
									report a release.
233	0.08 NE	Lower	Houston Specialty Products Co 14518 Hempstead 1G, Houston, 77040	Harris	5	N	L	N	**RCRA:** Inactive generator of spent halogenated solvents.
234	0.004 NE	Equal	Spring Branch Alternator & Starter 14620 Hempstead Highway, Houston, 77040	Harris	5	Y	L	N	**RCRA:** Inactive generator of ignitable wastes.
235	0.07 NE	Lower	City Of Houston Transfer Station Facility SW of Sommer Meyer Road, 200 Feet SW of US Highway 290, 300 Feet E Of Teague Road	Harris	5	N	M	N	**MSW:** Closed Type 5TS (transfer station) with 1977 start date and 2014 end date.
236	0.07 SW	Higher	Mathew-Price Industries 14545 Sommermeyer St, Houston, 77041	Harris	5	N*	M	Y	**LPST:** Final concurrence issued, case closed in 1996. **PST:** One UST removed in 1994.
237	0.07 NE	Lower	Bright Truck Leasing 13310 Hempstead Rd, Houston, 77040	Harris	5	N	L	N	**PST:** One AST out of use.
238	0.46 NE	Lower	West By Northwest Business Park 6300 Rothway St, Houston, 77040	Harris	5	N	L	N	**IOP:** 2014 IOP agreement for groundwater contamination. IOP in investigation phase. Site also had another completed IOP, with final certificate issued in 2011.
239	0.05 SW	Lower	Compressor Exchange 14507 Sommermeyer St, Houston, 77041	Harris	5	N	L	N	**PST:** One UST removed in 1992.
240	0.06 SW	Higher	NW Police Substation 6000 Teague Rd, Houston, 77041	Harris	5	N	M	N	**LPST:** Final concurrence issued, case closed in 1999. **PST:** One UST removed in 1994.
241	0.02 NE	Higher	CY Fair Tire 14402 Hempstead Rd, Houston,	Harris	5	N*	M	Y	**LPST:** Final concurrence issued, case closed in 1991. **PST:** Three USTs removed in 1991.

Table 3.5-2 Hazardous Materials Database Search

Map ID	Distance From Alternative Centerline (mi)	Site's Relative Elevation to Rail	Facility Name and Address	County	Segment	In LOD	Risk	Further Investigation Required	Summary of Findings from Database Search
			77040						
242	0.15 SW	Lower	Northwest Machine 10015 Grover Ln, Houston, 77041	Harris	5	N	M	N	**LPST:** Final concurrence issued, case closed in 1992. **PST:** Three USTs removed in 1992.
243	0.03 SW	Higher	City Of Houston Neighborhood Depository 14400 Sommermeyer St, Houston, 77041	Harris	5	N	L	N	**PST:** One UST removed in 2000. **RCRA:** Inactive generator of scrap.
244	0.13 SW	Higher	Houston Northwest Transfer Station Facility NW of Sommer Meyer Road, 200 Feet SW off US Highway 290	Harris	5	N	M	N	**MSW:** Active Type 5TS (transfer station) with 1997 start date.
245	0.04 NE	Higher	Hempstead Truck Stop 14304 Hempstead Rd, Houston, 77040	Harris	5	N*	L	N	**PST:** Four USTs in use.
246	0.21 SW	Lower	Teague Water Maintenance 5900 Teague Rd, Houston, 77041	Harris	5	N	M	N	**LPST:** Final concurrence issued in 2004, pending well plugging documentation. **PST:** 6 USTs in use and 4 removed in 1993.
247	0.12 SW	Lower	V&M Tube Alloy 14333 Sommermeyer St, Houston, 77041	Harris	5	N	L	N	**RCRA:** Active CESQG of chromium.
248	0.02 NE	Lower	Prosser Auto Repair 14230 Hempstead Rd, Houston, 77040	Harris	5	N*	L	N	**PST:** One used oil UST in use.
249	0.08 SW	Lower	TAPCO Intl 14309 Sommermeyer St, Houston, 77041	Harris	5	N	L	N	**PST:** One UST removed in 1990.
250	0.06 NE	Lower	AAA Feed Store 14138 Hempstead Rd, Houston, 77040	Harris	5	N	M	N	**LPST:** Final concurrence issued in 2015, pending well plugging documentation. **PST:** Two USTs removed in 2007.
251	0.02 NE	Lower	Sunmart 312 14222 Hempstead Rd, Houston, 77040	Harris	5	N*	L	N	**PST:** Four USTs in use. Site has one NOV for not maintaining the daily inspections.
252	0.06 SW	Higher	J P Hart Facility 14239 Sommermeyer St, Houston,	Harris	5	N	L	N	**PST:** Two USTs removed in 1999.

Table 3.5-2 Hazardous Materials Database Search									
Map ID	Distance From Alternative Centerline (mi)	Site's Relative Elevation to Rail	Facility Name and Address	County	Segment	In LOD	Risk	Further Investigation Required	Summary of Findings from Database Search
			77041						
253	0.05 NE	Lower	Fairbanks Central Office 14101 Aston St, Houston, 77040	Harris	5	N	L	N	**PST:** One UST removed in 2002 and one AST in use.
254	0.03 SW	Lower	Atlantic Industrial Services 5750A Campbell Rd, Houston, 77041	Harris	5	N*	L	N	**RCRA:** In the used oil program with no waste streams listed.
255	0.06 SW	Higher	Idealease Of Houston 14201 Hempstead Rd, Houston, 77040	Harris	5	N	L	N	**PST:** One UST in use and one UST filled in place 1987.
256	0.10 NE	Lower	AFCO 010503 8770 W Tidwell Rd, Houston, 77040	Harris	5	N	M	N	**LPST:** Final concurrence issued, case closed in 1997. **PST:** Five USTs removed in 2005.
257	0.09 SW	Lower	Crystal Clean South 5750 Campbell Rd Ste B, Houston, 77041	Harris	5	N	L	N	**RCRA:** Inactive generator, no generator status or waste streams listed.
258	0.03 NE	Lower	Midwest Paint & Body 14002 Hempstead Rd, Houston, 77040	Harris	5	N*	M	Y	**LPST:** Final concurrence issued in 1997, pending well plugging documentation. **PST:** Two USTs removed in 1991.
259	0.48 NE	Lower	Valero Corner Store 2345 8111 W Tidwell Rd, Houston, 77040	Harris	5	N	L	N	**LPST:** Final concurrence issued, case closed in 2008. **PST:** Three USTs removed in 2004.
260	0.30 SW	Lower	Preston L. Hall 10667 Tanner Rd, Houston	Harris	5	N	L	N	**MSW:** Historical MSW facility that was 5 acre in size. Industrial waste included discarded rubber and liquid waste based on a 1970 inspection.
261	0.48 SW	Higher	Western Landfill- BSIConstruction 10332 Tanner Road, Houston	Harris	5	N	L	N	**MSW:** Historical MSW facility. Received NOV in 1986 for emission of one or more air contamination.
262	0.04 SW	Lower	Tube Alloy Corp 9500 W Tidwell, Houston, 77041	Harris	5	N	L	N	**RCRA:** Inactive generator, metal coating facility with waste streams such as ignitable waste, barium, lead, chromium, and benzene.
263	0.05 SW	Lower	Los Gas & Diesel LPST 9501 W Tidwell Rd, Houston, 77041	Harris	5	N	M	N	**LPST:** Active LPST reported in 1997, in remediation phase. **PST:** Four USTs removed in 1997.
264	0.37 SW	Lower	Bells Dump 10374 Tanner Rd, Houston	Harris	5	N	L	N	**MSW:** Historical MSW facility, closure confirmed in 1969.
265	0.50 SW	Higher	Ms Wiley; Nelson Washington's Dump 10374 Tanner Rd, Houston	Harris	5	N	L	N	**MSW:** Historical MSW facility. Based on 1969 inspection, site was a fill area in abandoned sand pit with sewage odor and evidence of burning

Table 3.5-2 Hazardous Materials Database Search									
Map ID	**Distance From Alternative Centerline (mi)**	**Site's Relative Elevation to Rail**	**Facility Name and Address**	**County**	**Segment**	**In LOD**	**Risk**	**Further Investigation Required**	**Summary of Findings from Database Search**
									observed.
489	0.49 SW	Higher	Longhorn Machine 9915 Tanner Rd, Houston 77041	Harris	5	N	L	N	**IHW:** Active corrective action site since 2016. Ongoing workload.
266	0.05 SW	Lower	Atlantic North American 9505 W Tidwell Rd, Houston, 77041	Harris	5	N	L	N	**PST:** Two USTs removed in 1999.
267	0.07 SW	Higher	ICO Inc. 9400 Bamboo Rd, Houston, 77041	Harris	5	N	L	N	**RCRA:** Active CESQG of ignitable wastes, benzene, non-halogenated spent solvents, and tetrachloroethylene.
268	0.21 SW	Lower	Valeron Strength Film/Van Leer Flexibles, LP 9505 Bamboo Rd, Houston, 77041	Harris	5	N	M	N	**LPST:** Final concurrence issued, case closed in 1998. **PST:** Two USTs removed in 1990. **VCP:** Completed VCP, with final certificate issued in 2010.
269	0.025 NE	Equal	Circle D Auto Transm/ D&P Automotive 13709 Hempstead Rd, Houston, 77040	Harris	5	N	L	N	**PST:** One UST removed 1991. **RCRA:** Inactive generator
270	0.2 NE	Higher	Dril Quip 13550 Hempstead Highway, Houston, 77040	Harris	5	N	L	N	**RCRA:** Active CESQG of several waste streams such as ignitable waste, cadmium, chromium, lead, and benzene.
271	0.08 SW	Lower	PV Fluid Products 5150 Blalock Rd, Houston, 77041	Harris	5	N	L	N	**RCRA:** Active SQG of ignitable wastes, benzene, methyl ethyl ketone, and tetrachloroethylene.
272	0.07 NE	Higher	Miracle Paint & Paint 13504 Hempstead Hwy, Bldg A Houston, 77040	Harris	5	N	L	N	**RCRA:** Inactive generator, with no waste streams listed.
273	0.03 NE	Higher	Fairbanks Gulf 13438 Hempstead Rd, Houston, 77040	Harris	5	N*	M	N	**LPST:** Final concurrence issued, case closed in 1990. **PST:** Four USTs removed in 1989.
274	0.07 NE	Lower	Hanover Power Machinery 13424 Hempstead Highway, Houston, 77040	Harris	5	N	L	N	**PST:** One UST removed in 1997. **RCRA:** Inactive generator of spent non-halogenated solvents.

Table 3.5-2 Hazardous Materials Database Search									
Map ID	**Distance From Alternative Centerline (mi)**	**Site's Relative Elevation to Rail**	**Facility Name and Address**	**County**	**Segment**	**In LOD**	**Risk**	**Further Investigation Required**	**Summary of Findings from Database Search**
275	0.11 NE	Higher	Madden Galvanizing LLC 13420 Hempstead Rd, Houston, 77040	Harris	5	N	L	N	**RCRA:** LQG of corrosive waste, lead, chromium, barium, cadmium, selenium, and arsenic.
276	1.00 NE	Lower	Mustang Cat 12800 Northwest Fwy, Houston, 77040	Harris	5	N	L	N	**IHW:** Inactive corrective action. Completed workload in 2002. **LPST:** Final concurrence issued, case closed in 1993.
277	0.03 NE	Lower	Vacant 13328 Hempstead Rd, Houston, 77040	Harris	5	N*	L	N	**PST:** Two USTs removed in 1993.
278	0.51 SW	Higher	Tarrant Distributors Facility 9835 Genard Road, Houston, 77041	Harris	5	N	L	N	**LPST:** Final concurrence issued, case closed in 2001. **PST:** Four USTs removed in 1993. **VCP:** Completed VCP, with final certificate issued in 1999.
279	0.09 SW	Lower	Northwest Industrial Park 9230 Baythorne Dr, Houston, 77041	Harris	5	N	L	N	**PST:** One UST removed in 1992.
280	0.04 NE	Lower	Bright Truck Leasing 14500 Hempstead Rd, Houston, 77040	Harris	5	N*	L	N	**PST:** Three USTs removed in1989 and 1995.
281	0.15 SW	Higher	YNOT Better Papers 9349 Baythorne Dr, Houston, 77041	Harris	5	N	M	N	**LPST:** Final concurrence issued, case closed in 1992. **PST:** One UST removed in 1991.
282	0.35 NE	Lower	Pinemont Grocery 7700 Pinemont Dr, Houston, 77040	Harris	5	N	L	N	**LPST:** Final concurrence issued, case closed in 1997. **PST:** One UST removed in 2001 and two USTs in use.
490	0.18 NE	Lower	Med-Shred/ Stericycle Houston Processing Facility 5440 Guhn Rd, Houston 77040	Harris	5	N	L	N	**MSW:** Closed MSW Type 5 processing facility. Permit start date in 2005 and revoked in 2013.
283	0.18 NE	Lower	Bio Energy Landscape Maintenance 7930 Pinemont Dr, Houston, 77040	Harris	5	N	M	N	**LPST:** Final concurrence issued in 2007, pending well plugging documentation. **PST:** Two USTs removed in 1987.
284	0.42 SW	Lower	Integris Metals 9450 W Wingfoot Rd, Houston, 77041	Harris	5	N	L	N	**LPST:** Final concurrence issued, case closed in 1992. **PST:** Four USTs removed in 1991 and 2002.
285	0.29 NE	Lower	Barton Instrument Systems/ITT Hildebrandt 7707 Pinemont Drive, Houston, 77040	Harris	5	N	L	N	**VCP:** Completed VCP, with final certificate issued in 2007 for groundwater affected by dichlorethylene.
286	0.08 NE	Lower	Amtech Lighting Services 8101 Pinemont Dr, Houston, 77040	Harris	5	N	L	N	**PST:** One UST filled in place in 1994. **RCRA:** Inactive generator with no waste streams listed.

Table 3.5-2 Hazardous Materials Database Search										
Map ID	**Distance From Alternative Centerline (mi)**	**Site's Relative Elevation to Rail**	**Facility Name and Address**	**County**	**Segment**	**In LOD**	**Risk**	**Further Investigation Required**	**Summary of Findings from Database Search**
287	0.59 NE	Lower	UCR 7007 Pinemont Dr Houston, 77040	Harris	5	N	L	N	**IHW:** Active corrective action since 2011. Ongoing workload. **VCP:** 1997 VCP agreement was transferred to IHW corrective action in 2011.
288	0.11 SW	Lower	Altech Metals 4650 S Pinemont Ste 100, Houston, 77041	Harris	5	N	L	N	**RCRA:** Transporter of computer items. No waste streams listed.
289	0.12 NE	Higher	Drywall Supply 5092 Steadmont Dr, Houston, 77040	Harris	5	N	M	N	**LPST:** Final concurrence issued, case closed in 1994. **PST:** Two USTs removed in 1991.
290	0.66 SW	Higher	Krill Extraction Plant 4494 Campbell Rd, Houston, 77041	Harris	5	N	L	N	**IHW:** Inactive corrective action. Completed workload in 2014. **LPST:** Final concurrence issued, case closed in 1997. **RCRA:** Active SQG.
491	0.24 NE	Lower	Baker Hughes Process and Pipeline Services 7721 Pinemont Dr., Houston 77040	Harris	5	N	M	N	**IOP:** Active 2017 IOP agreement for groundwater impacted by chlorinated solvents. Currently in investigation phase.
291	0.06 NE	Higher	Furrow Building Materials 12922 Hempstead Rd, Houston, 77040	Harris	5	N*	L	N	**PST:** One UST permanently filled in place in 1988.
292	0.15 SW	Lower	RREEF West VI - Pineway Business Center, Inc. 4660 Pine Timbers, Houston	Harris	5	N	M	N	**VCP:** Completed VCP, with final certificate issued in 1997 for soil affected by PAHS, TPH, and chlorinated solvents.
293	0.15 SW	Lower	Baxter Healthcare Corporation 4660 Pine Timbers, Ste 100, Houston, 77041	Harris	5	N	L	N	**RCRA:** Inactive generator of ignitable, corrosive, and reactive wastes.
294	0.11 SW	Lower	Tenaris Coiled Tubes Subsea 8762 Clay Rd, Houston, 77080	Harris	5	N	M	N	**IOP:** Completed IOP, with final certificate issued in 2004.
295	0.42 NE	Lower	Vitran Express 4318 Northfield Ln, Houston, 77092	Harris	5	N	L	N	**LPST:** Two LPSTs reported. Final concurrence issued, first case closed in 1990 and second one in 2010. **PST:** Three USTs removed in 1990. One AST is out of use.
296	0.01 NE	Higher	Eagle Electronics Resources 12826 Hempstead Hwy, Suite B, Houston, 77092	Harris	5	N*	L	N	**RCRA:** Inactive generator of lead.

Table 3.5-2 Hazardous Materials Database Search

Map ID	Distance From Alternative Centerline (mi)	Site's Relative Elevation to Rail	Facility Name and Address	County	Segment	In LOD	Risk	Further Investigation Required	Summary of Findings from Database Search
297	0.20 SW	Lower	Sandvik Rock Tools Facility 8760 Clay Road, Houston, 77080	Harris	5	N	M	N	**VCP:** Active 1998 VCP agreement for soils/groundwater affected by metals, chlorinated solvents, and PCE. Currently in active remediation/underground injection phase. **RCRA:** Inactive generator with no waste streams listed.
298	0.02 NE	Higher	Exxon RS 6 7387 16638 Hempstead Hwy, Houston, 77040	Harris	5	N*	L	N	**PST:** Four USTs removed in 1987.
299	0.03 NE	Higher	Chamdal Food Mart 12720 Hempstead Rd, Houston, 77092	Harris	5	N*	M	Y	**LPST:** Final concurrence issued, case closed in 2003. **PST:** Three active USTs in use. Site had two resolved NOVs for failure to maintain records.
300	0.03 NE	Higher	Lube King 12720 Hempstead Rd, Houston, 77092	Harris	5	N*	L	N	**PST:** Four USTs removed in 1993 And 1998.
301	0.05 NE	Lower	Former Service Station 12708 Hempstead Rd, Houston, 77092	Harris	5	N*	M	Y	**LPST:** Final concurrence issued, case closed in 1998. **PST:** Four USTs removed in 1995.
302	0.89 SW	Lower	ITW Buildex 9510 Clay Rd, Houston, 77080	Harris	5	N	L	N	**IHW:** Inactive corrective action. Completed workload in 2007.
303	0.26 SW	Lower	Clay Road Texaco 8805 Clay Rd, Houston, 77080	Harris	5	N	L	N	**LPST:** Final concurrence issued, case closed in 2007. **PST:** Five USTs removed in 1999 and two temporarily out of service USTs.
304	0.36 SW	Lower	RSMC 4059 Hollister St, Houston, 77080	Harris	5	N	L	N	**IHW:** Inactive corrective action. Completed workload in 2007.
305	0.03 NE	Lower	Texas Oxygen 12430 Hempstead Rd, Houston, 77092	Harris	5	N*	L	N	**PST:** Two USTs removed in 1993.
306	0.07 SW	Lower	Ditch Witch Old Site 12407 Sowden Rd, Houston, 77080	Harris	5	N	L	N	**PST:** Two USTs removed in 1989.
307	0.16 SW	Lower	Stop N Bye 3760 Roma St, Houston, 77080	Harris	5	N	M	N	**LPST:** Final concurrence issued, case closed in 1998. **PST:** Two USTs temporarily out of service.
308	0.07 SW	Higher	Interbio Inc. 12405 Sowden Rd, Houston, 77080	Harris	5	N	L	N	**RCRA:** CESQG of ignitable, corrosive, and reactive waste.

Table 3.5-2 Hazardous Materials Database Search

Map ID	Distance From Alternative Centerline (mi)	Site's Relative Elevation to Rail	Facility Name and Address	County	Segment	In LOD	Risk	Further Investigation Required	Summary of Findings from Database Search
309	0.05 NE	Lower	Enterprise Rent A Truck 12230 Hempstead Rd, Houston, 77092	Harris	5	N	L	N	**PST:** One AST out of use.
310	0.09 SW	Higher	Cable-X 12333 Sowden Rd, Houston, 77080	Harris	5	N	L	N	**PST:** One UST removed in 1998.
311	0.05 SW	Higher	Bowman Tile Supply 12229 Sowden Rd, Houston, 77080	Harris	5	N	L	N	**PST:** Two USTs removed in 1993.
312	0.09 SW	Lower	Turn Key Coatings 8411 Rannie Rd, Houston, 77080	Harris	5	N	L	N	**RCRA:** SQG of ignitable and corrosive waste, chromium, silver, methyl ethyl ketone, non-halogenated solvents, and wastewater sludge.
313	0.03 NE	Lower	U-Save Fuel Express 12102 Hempstead Rd, Houston, 77092	Harris	5	N*	L	N	**PST:** Two gasoline and one diesel USTs in use. One AST out of use.
314	0.17 NE	Lower	Monarch Paint Company 3530 Lang Road, Houston, 77092	Harris	5	N	M	N	**VCP:** Completed VCP, with final certificate issued in 2005 for soils affected by metals, TPH, and VOCs. **PST:** Two USTs removed in 1991. **RCRA:** Active CESQG.
315	0.07 SW	Lower	Lone Star Truck Stop 3535 1/2 Bingle Rd, Houston, 77055	Harris	5	N	L	N	**PST:** Three USTs filled in place in 1999.
316	0.03 SW	Lower	Utility Operations Pipe Yard 12025 Sowden Rd, Houston, 77055	Harris	5	N	L	N	**PST:** Three USTs removed in 1994.
317	0.02 NE	Lower	JC All Seasons Market 11902 Hempstead Rd, Houston, 77092	Harris	5	N*	L	N	**PST:** Three active gasoline/diesel USTs in use. Site had one NOV for failing to maintain inspection records.
318	0.03 NE	Lower	Hearne Gulf Service 11898 Hempstead Rd, Houston, 77092	Harris	5	N*	M	Y	**LPST:** Final concurrence issued, case closed in 2008. **PST:** Four USTs removed in 1991.
319	0.13 SW	Higher	Rectorseal 2601 Spenwick Dr, Houston, 77055	Harris	5	N	M	N	**LPST:** Final concurrence issued, case closed in 1993. **PST:** One UST removed in 1992. **RCRA:** Active SQG of corrosives, lead, chromium, barium, cadmium, mercury, etc. **VCP:** Active 1997 VCP agreement for soil/groundwater affected by TPH, chlorinated solvents, and other contaminants. Currently in affidavit phase.
320	0.76 NE	Lower	Fin Tech Houston 5225 Milwee St, Houston, 77092	Harris	5	N	L	N	**IHW:** Inactive corrective action. Completed workload in 2005. **RCRA:** active LQG.

Table 3.5-2 Hazardous Materials Database Search

Map ID	Distance From Alternative Centerline (mi)	Site's Relative Elevation to Rail	Facility Name and Address	County	Segment	In LOD	Risk	Further Investigation Required	Summary of Findings from Database Search
321	0.42 SW	Higher	Bingle Warehouse 3003 Bingle Rd, Houston, 77055	Harris	5	N	L	N	**LPST:** Final concurrence issued, case closed in 1990. **PST:** One UST removed in 1990.
322	0.08 NE	Higher	P & C Texaco 11802 Hempstead Rd, Houston, 77092	Harris	5	N*	M	Y	**LPST:** Final concurrence issued, case closed in 2010. **PST:** Five USTs removed in 1989.
323	0.12 SW	Higher	Harkrider Supply Co 2550A Spenwick Dr, Houston, 77055	Harris	5	N	L	N	**RCRA:** Inactive generator with no waste streams listed.
324	0.08 SW	Lower	Chupik 7930 Blankenship Dr, Houston, 77055	Harris	5	N	L	N	**PST:** One UST removed in 1990.
325	0.40 SW	Higher	Walgreen Distribution Center 8110 Kempwood Dr, Houston, 77055	Harris	5	N	L	N	**LPST:** Final concurrence issued, case closed in 2005. **PST:** One UST removed in 1998 and one AST out of use in 2003.
326	0.04 SW	Lower	Ribelin Sales 7786 Blankenship Dr, Houston, 77055	Harris	5	N	L	N	**PST:** Two USTs removed in 1989.
327	0.39 NE	Lower	Coleman Jim 5842 W 34th St, Houston, 77092	Harris	5	N	L	N	**LPST:** Final concurrence issued, case closed in 1992. **PST:** Two USTs removed in 1991.
328	0.36 NE	Lower	Tom E Fairey 5902 W 34th St, Houston, 77092	Harris	5	N	L	N	**LPST:** Final concurrence issued, case closed in 1997. **PST:** Two USTs removed in 1996.
329	0.09 SW	Lower	Union Pacific Railroad Property South Of American Door Products Facility South of 7900 Block of Blankenship Drive Houston, 77055	Harris	5	N	M	N	**IOP:** Completed IOP, with final certificate issued in 2010.
330	0.13 NE	Lower	Hollywood Steel 6322 W 34Th St, Houston, 77092	Harris	5	N	M	N	**LPST:** Final concurrence issued, case closed in 1996. **PST:** Two USTs removed in 1993.
331	0.10 SW	Lower	AER Manufacturing Inc. 7777 Blankenship Dr, Houston, 77055	Harris	5	N	L	N	**PST:** One UST removed in 1999. **RCRA:** Inactive generator, motor vehicle body manufacturing facility with no waste streams listed.
332	0.18 SW	Lower	American Door Products 7967 Blankenship Drive, Houston	Harris	5	N	M	N	**VCP:** Active 2006 VCP agreement for soils/groundwater affected by pesticides, metals, and arsenic. Currently in affidavit phase.
333	0.04 SW	Lower	Hogan Hardwoods & Molding 7770 Blankenship Dr, Houston, 77055	Harris	5	N	L	N	**PST:** Two USTs removed in 1997.

Table 3.5-2 Hazardous Materials Database Search

Map ID	Distance From Alternative Centerline (mi)	Site's Relative Elevation to Rail	Facility Name and Address	County	Segment	In LOD	Risk	Further Investigation Required	Summary of Findings from Database Search
334	0.02 NE	Lower	Hempstead Food Mart 11650 Hempstead Rd, Houston, 77092	Harris	5	N*	M	Y	**LPST:** Final concurrence issued, case closed in 2009. **PST:** Two active USTs in use and four USTs removed in 2004.
335	0.06 SW	Lower	Camco Tejas Controls 7604 Kempwood Dr, Houston, 77055	Harris	5	N	L	N	**PST:** Two USTs removed in 1990.
336	0.03 SW	Lower	Now Cam Services 7604 Kempwood, Houston, 77055	Harris	5	N	L	N	**RCRA:** Inactive generator of ignitable waste.
337	0.03 NE	Lower	Penske Truck Leasing 11608 Hempstead Rd, Houston, 77092	Harris	5	N*	M	Y	**LPST:** Final concurrence issued in 2011, pending well plugging documentation. **PST:** Two USTs removed in 1991 and four USTs currently in use. **RCRA:** Inactive generator of ignitable waste, benzene, and tetrachloroethylene.
338	0.03 NE	Lower	Wonder Hostess Bakery 11612 Hempstead Hwy, Houston, 77040	Harris	5	N*	M	Y	**LPST:** Final concurrence issued, case closed in 1995.
339	0.49 SW	Higher	E I Du Pont De Nemours 8125 Kempwood Dr, Houston, 77055	Harris	5	N	L	N	**IHW:** Inactive corrective action. Completed workload in 2012.
340	0.59 SW	Higher	Ideal Printers 8219 Kempwood Dr, Houston, 77055	Harris	5	N	L	N	**IHW:** Inactive corrective action. Completed workload in 2014.
341	0.15 SW	Lower	Compucycle Inc. 7700 Kempwood Dr, Houston	Harris	5	N	L	N	**MSW:** Active type 5RR facility (recycling and recovery) with 2011 start date.
342	0.02 NE	Higher	A & M Food Mart 11530 Hempstead Rd, Houston, 77092	Harris	5	N*	L	N	**PST:** Four USTs removed in 1998.
343	0.40 NE	Lower	First Transit Northwest Bus Operating Facility 5555 Deauville Plaza Dr, Houston, 77092	Harris	5	N	L	N	**LPST:** Final concurrence issued, case closed in 2004. **PST:** Six USTs permanently filled in place in 1998.
344	0.20 NE	Lower	TX Lead & Supply 5800 Centralcrest St, Houston, 77092	Harris	5	N	M	N	**LPST:** Final concurrence issued, case closed in 1991. **PST:** One UST removed in 1991.
345	0.06 NE	Lower	Mary Sue Zuehlke 6016 Centralcrest St, Houston, 77092	Harris	5	N	M	N	**LPST:** Final concurrence issued, case closed in 2010. **PST:** One UST removed in 2005.

Table 3.5-2 Hazardous Materials Database Search

Map ID	Distance From Alternative Centerline (mi)	Site's Relative Elevation to Rail	Facility Name and Address	County	Segment	In LOD	Risk	Further Investigation Required	Summary of Findings from Database Search
346	0.04 NE	Lower	James Zuehlke 6102 Centralcrest St, Houston, 77092	Harris	5	N*	M	Y	**LPST:** Final concurrence issued, case closed in 2010. **PST:** One UST removed in 2005.
347	0.03 NE	Lower	N A 11442 1/2 Hempstead Rd, Houston, 77092	Harris	5	N*	L	N	**PST:** Two USTs removed in 1994.
348	0.06 SW	Lower	Liftmoore 11505 Todd, Houston, 77055	Harris	5	N	L	N	**RCRA:** Inactive generator, with no generator status or waste streams listed.
349	0.31 SW	Higher	Fiesta Mart 2323 Wirt Rd, Houston, 77055	Harris	5	N	L	N	**LPST:** Final concurrence issued, case closed in 2000. **PST:** Four USTs removed in 1994.
350	0.08 SW	Lower	Atlas Paint 2330 Wirtcrest, Houston, 77055	Harris	5	N	L	N	**RCRA:** Inactive generator with no generator status or waste streams listed.
351	0.06 SW	Lower	Former Western Fence 11445 Todd St, Houston, 77055	Harris	5	N*	M	Y	**LPST:** Final concurrence issued, case closed in 2012. **PST:** Registration pending.
352	0.27 SW	Higher	Handi Stop 50 2230 Wirt Rd, Houston, 77055	Harris	5	N	L	N	**LPST:** Final concurrence issued, case closed in 1999. **PST:** Three USTs removed in 1997.
353	0.07 NE	Lower	J H Walker Trucking 11404 Hempstead Rd, Houston, 77092	Harris	5	N	L	N	**PST:** One diesel UST and one gasoline UST in use. **RCRA:** Active transporter.
354	0.09 SW	Higher	Barton Instrument Systems LLC 11413 Todd St, Houston, 77055	Harris	5	N	L	N	**RCRA:** Inactive generator of cadmium.
355	0.24 SW	Higher	Mirror Industries 11510 Kilburn Rd, Houston, 77055	Harris	5	N	M	N	**IHW:** Active corrective action since 2008. Ongoing workload. **PST:** Seven USTs in use. **RCRA:** Active LQG of corrosive waste, chromium, lead, and wastewater sludge.
356	0.09 SW	Higher	Trademarks Co 11333 Todd St, Houston, 77055	Harris	5	N	L	N	**RCRA:** Inactive generator of several waste streams including ignitable waste, cadmium, chromium, lead, and benzene.
357	0.14 NE	Lower	Able Garage Door Manufacturing, Inc. 5707 Mitchelldale, Houston, 77092	Harris	5	N	M	N	Completed VCP, with final certificate issued in 2001 for soils affected by TPH and BTEX.
358	0.14 NE	Lower	Joe Myers Rental 5707 Mitchelldale St, Houston, 77092	Harris	5	N	M	N	**LPST:** Final concurrence issued, case closed in 1992. **PST:** Four USTs removed in 1991 and 1993.

Table 3.5-2 Hazardous Materials Database Search

Map ID	Distance From Alternative Centerline (mi)	Site's Relative Elevation to Rail	Facility Name and Address	County	Segment	In LOD	Risk	Further Investigation Required	Summary of Findings from Database Search
359	0.07 SW	Lower	CSW Supply 11329 Todd St, Houston, 77055	Harris	5	N	L	N	**PST:** Two USTs removed in 1995.
360	0.19 NE	Lower	Pelletizer Knives 5615 Mitchelldale St, Houston, 77092	Harris	5	N	M	N	**IHW:** Inactive corrective action. Completed workload in 2009.
361	0.08 SW	Higher	Diversified Business Forms Inc. 2127B Harland Drive, Houston, 77055	Harris	5	N	L	N	**RCRA:** Inactive generator of ignitable and corrosive wastes.
362	0.03 NE	Higher	Ryder Truck Rental 0138A 11200 Hempstead Highway, Houston, 77092	Harris	5	N*	M	Y	**LPST:** Two LPSTs reported. Final concurrence issued, first case closed in 1996 and second one in 2004. **PST:** Two USTs in use and six USTs removed in 1993 and 1995. **RCRA:** Inactive generator of ignitable wastes. Site had one closed emergency response event in 2014.
363	0.05 SW	Lower	Waste Management 10701 Todd St, Houston, 77055	Harris	5	N	L	N	**PST:** One UST removed in 2002. **RCRA:** Active transporter (hauling station).
364	0.48 NE	Lower	Milton E Lunde 4802 Ramus St, Houston, 77092	Harris	5	N	L	N	**LPST:** Final concurrence issued in 1997, pending well plugging documentation. **PST:** One UST removed in 1991.
365	0.49 NE	Lower	Karbach SOC 2602 Karbach St, Houston, 77092	Harris	5	N	L	N	**LPST:** Final concurrence issued, case closed in 1996. **PST:** One UST removed in 1994.
366	0.44 NE	Lower	Milton E Lunde 2617 Karbach St, Houston, 77092	Harris	5	N	L	N	**LPST:** Final concurrence issued, case closed in 1997. **PST:** One UST removed in 1991.
367	0.11 SW	Lower	Antoine Citgo Mini Mart 2099 Antoine Dr, Houston, 77055	Harris	5	N	M	N	**LPST:** Final concurrence issued, case closed in 2011.
368	0.10 SW	Higher	Air Liquide America Corporation 11101 Todd Road, Houston, 77055	Harris	5	N	M	N	**IHW:** Inactive corrective action, transferred to VCP. **VCP:** Completed VCP, with final certificate issued in 2000 for soils affected by metals. **RCRA:** Inactive generator with no waste streams listed.
369	0.10 SW	Higher	Big Three Industries 11101 Todd St, Houston, 77055	Harris	5	N	L	N	**PST:** One AST out of use and one UST removed in 1994.
370	0.47 NE	Lower	Brookhollow Exxon 63014 2416 Mangum Rd, Houston, 77092	Harris	5	N	L	N	**LPST:** Final concurrence issued, case closed in 1999. **PST:** Five USTs removed in 1998 and 2001.
492	0.08 SW	Lower	Envir. Equipment Transfer Station 2075 Afton St, Houston 77055	Harris	5	N	L	N	**MSW:** Closed MSW processing facility. Permit withdrawn in 1974.

Table 3.5-2 Hazardous Materials Database Search

Map ID	Distance From Alternative Centerline (mi)	Site's Relative Elevation to Rail	Facility Name and Address	County	Segment	In LOD	Risk	Further Investigation Required	Summary of Findings from Database Search
371	0.50 SW	Lower	W P Ballard 2041 Johanna Dr, Houston, 77055	Harris	5	N	L	N	**IHW:** Active corrective action since 2010. Ongoing workload. **LPST:** Active LPST reported in 2004.
372	0.21 NE	Lower	Ingersoll Rand Equipment 2210 Mcallister Rd, Houston, 77092	Harris	5	N	M	N	**LPST:** Final concurrence issued, case closed in 1991. **PST:** Three USTs removed in 1990.
373	0.21 NE	Lower	Diamond Shamrock 300 4830 Dacoma St, Houston, 77092	Harris	5	N	M	N	**LPST:** Final concurrence issued, case closed in 1991. **PST:** Three USTs removed in 1991.
374	0.15 NE	Lower	Valero Corner Store 903 4839 Dacoma St, Houston, 77092	Harris	5	N	M	N	**LPST:** Final concurrence issued, case closed in 1992. **PST:** Four USTs removed in 1982.
493	0.23 NE	Lower	Dacoma Gascard 260300 4747 Dacoma St, Houston 77092	Harris	5	N	M	N	**LPST:** Active LPST reported in 2016, groundwater impacted with no apparent threats or impacts to receptors. Currently in site assessment stage.
375	0.28 NE	Lower	Collision Craft Ore 2101 Magnum Rd, Houston, 77092	Harris	5	N	L	N	**LPST:** Final concurrence issued, case closed in 1994. **PST:** 4 USTs removed in 1992.
376	0.45 NE	Lower	Mobil SS 12 AWY 10155 Northwest Fwy, Houston, 77092	Harris	5	N	L	N	**LPST:** Final concurrence issued, case closed in 1996. **PST:** Three USTs removed in 1987.
377	0.55 NE	Lower	Autocator Controls D 4405 Directors Row, Houston, 77092	Harris	5	N	L	N	**IHW:** Inactive corrective action. Completed workload in 2007.
378	0.05 NE	Higher	Dacoma Inn 4949 Dacoma St, Houston, 77092	Harris	5	N	M	N	**IOP:** Completed IOP, with final certificate issued in 2006 for groundwater affected by BTEX and MTBE.
379	0.03 NE	Lower	Regency Car Wash 10454 Hempstead Rd, Houston, 77092	Harris	5	N*	M	Y	**LPST:** Final concurrence issued in 2005, case closed in 2012. **PST:** Three USTs removed in 2010.
380	0.35 NE	Lower	Del Mar Facility 2020 Mangum Rd, Houston, 77092	Harris	5	N	L	N	**LPST:** Two LPSTs reported. Final concurrence issued and cases closed in 1995 and 2015. **PST:** Two USTs permanently filled in place 1990.
381	0.29 SW	Lower	Best Pak Disposal Transfer Station 1903 Afton St, Houston, 77055	Harris	5	N	L	N	**MSW:** Closed type 5TS (transfer station), permit withdrawn in 1988.
382	0.07 NE	Lower	Rawson & Co 2010 Mcallister Rd, Houston, 77092	Harris	5	N	L	N	**PST:** One UST filled in place in 1992.

Table 3.5-2 Hazardous Materials Database Search									
Map ID	**Distance From Alternative Centerline (mi)**	**Site's Relative Elevation to Rail**	**Facility Name and Address**	**County**	**Segment**	**In LOD**	**Risk**	**Further Investigation Required**	**Summary of Findings from Database Search**
383	0.26 SW	Lower	WS Bellows Construction 1902 Afton St, Houston, 77055	Harris	5	N	L	N	**LPST:** Final concurrence issued, case closed in 1996. **PST:** Three USTs removed in 1990.
384	0.04 NE	Higher	Oreilly Auto Parts 403 10420 Hempstead Hwy, Houston, 77092	Harris	5	N	L	N	**RCRA:** Active CESQG of ignitable and reactive wastes.
385	0.13 NE	Lower	Audio Communications 2002 Karbach St, Houston, 77092	Harris	5	N	M	N	**LPST:** Final concurrence issued, case closed in 2000.
386	0.09 SW	Lower	IT Remarketing, Inc. DBA Technocycle 6600 Long Point, Ste 103, Houston 77055	Harris	5	N	L	N	**RCRA:** Active CESQG of lead And mercury.
387	0.08 SW	Higher	Weatherford Lamb Power Equipment Division 6550 Long Point Rd Ste 200 Houston, 77055	Harris	5	N	L	N	**RCRA:** Inactive generator with no generator status or waste streams listed.
388	0.37 SW	Lower	C R Schild 6918 Long Point Rd, Houston, 77055	Harris	5	N	L	N	**LPST:** Final concurrence issued, case closed in 1993. **PST:** Three USTs removed in 1993.
389	0.07 SW	Lower	Sherwin Williams 6450 Long Point, Houston, 77055	Harris	5	N*	L	N	**RCRA:** Inactive generator of methyl ethyl ketone, spent non-halogenated solvents, and ignitable wastes.
390	0.07 SW	Lower	Circle Sand 6401 Long Point Rd, Houston, 77055	Harris	5	Y	L	N	**PST:** One active diesel AST in use.
391	0.02 SW	Lower	Southern Pacific Transport 10205 Hempstead Rd, Houston, 77092	Harris	5	Y	M	Y	**LPST:** Final concurrence issued, case closed in 2000. **PST:** Four USTs removed in 1996.
392	0.31 SW	Lower	Personal Real Estate 6903 Long Point Rd, Houston, 77055	Harris	5	N	L	N	**LPST:** Final concurrence issued, case closed in 1991. **PST:** One UST removed in 1990.
393	0.38 SW	Higher	Prokop Devel 7019 Long Point Rd, Houston, 77055	Harris	5	N	L	N	**LPST:** Final concurrence issued, case closed in 1992. **PST:** Five USTs removed in 1992.
394	0.03 NE	Higher	Wilsons Texaco 10130 Hempstead Rd, Houston, 77092	Harris	5	N*	M	Y	**LPST:** Final concurrence issued, case closed in 1999. **PST:** Five USTs removed in 2000 and 2006.

Table 3.5-2 Hazardous Materials Database Search

Map ID	Distance From Alternative Centerline (mi)	Site's Relative Elevation to Rail	Facility Name and Address	County	Segment	In LOD	Risk	Further Investigation Required	Summary of Findings from Database Search
395	0.06 SW	Lower	P & S Rice Mills 10031 Hempstead Rd, Houston, 77092	Harris	5	Y	M	Y	**LPST:** Two LPSTs reported. Final concurrence issued, cases closed in 1993 and 2000. **PST:** Eight USTs removed in 1990.
396	0.18 SW	Lower	FCI Transports 6601 Long Point Rd, Houston, 77055	Harris	5	N	M	N	**LPST:** Final concurrence issued, case closed in 1995. **PST:** Three USTs removed in 1990.
397	0.22 NE	Lower	Handi Stop 107 4401 W 18th St, Houston, 77092	Harris	5	Y	M	Y	**LPST:** Final concurrence issued, case closed in 2010. **PST:** Seven USTs removed in 1989 and 2007. Three USTs in use.
398	0.38 SW	Lower	Mickey Service 6901 Raton St, Houston, 77055	Harris	5	N	L	N	**LPST:** Final concurrence issued, case closed in 2006. **PST:** Two USTs removed in 2001.
399	0.02 NE	Higher	Exxon RS 63250 9998 Hempstead, Houston, 77092	Harris	5	N*	M	Y	**LPST:** Final concurrence issued, case closed in 1999**. PST:** Four active USTs in use**. RCRA:** Inactive generator of ignitable waste and benzene.
400	0.08 NE	Higher	Firestone Master Care Center 660 Northwest Mall, Houston, 77092	Harris	5	Y	M	Y	**LPST:** Final concurrence issued, case closed in 1995.
401	0.03 SW	Lower	Electro Welding 9999 Hempstead Rd, Houston, 77092	Harris	5	Y	L	N	**PST:** One UST removed in 1989.
402	0.003 NE	Lower	Fermone Chemical Inc. 1523 N Post Oak Road, Houston, 77055	Harris	5	Y	L	N	**RCRA:** Inactive generator with no waste streams listed.
403	0.01 NE	Lower	Lunsford Estate Property / V&G 1525 North Post Oak Road, Houston	Harris	5	Y	H	Y	**VCP:** Active 1997 agreement for soil/groundwater affected by TPH, VOCs, SVOCs, pesticides, and herbicides. Currently in investigation phase
404	0.04 SE	Lower	Bill White Bit Co 1525 N Post Oak Road Ste A2, Houston, 77055	Harris	5	Y	L	N	**RCRA:** Inactive generator with no generator status or waste streams listed.
405	0.12 SW	Lower	Tex Tube 1503 N Post Oak Rd, Houston, 77055	Harris	5	Y	H	Y	**IHW:** Active corrective action site as of 2002. Ongoing workload (underground injection). **PST:** Three USTs removed in 1989, 2001, And 2010. **RCRA:** Active CESQG of several waste streams including ignitable and corrosive waste, arsenic, barium, lead, and mercury. Site had three emergency response events that have been closed.
406	0.01 NE	Lower	Wheel World 9645 Hempstead Rd, Houston, 77092	Harris	5	Y	M	Y	**LPST:** Final concurrence issued, case closed in 1994. **PST:** Three USTs removed in 1994.

Table 3.5-2 Hazardous Materials Database Search

Map ID	Distance From Alternative Centerline (mi)	Site's Relative Elevation to Rail	Facility Name and Address	County	Segment	In LOD	Risk	Further Investigation Required	Summary of Findings from Database Search
407	0.07 S	Lower	South Texas Equipment 1495 N Post Oak Rd, Houston, 77055	Harris	5	Y	M	Y	**IOP:** Active 2014 IOP agreement for groundwater affected by benzene, toluene, and tetrachloroethylene. Currently in affidavit phase.
408	0.08 SW	Lower	Bergen Brunswig Drug 1440 N Post Oak Rd, Houston, 77055	Harris	5	N*	M	Y	**LPST:** Final concurrence issued, case closed in 1989. **PST:** One UST removed in 1989.
409	0.30 E	Lower	Fleming Grocery Wholesalers 2525 Minimax St, Houston, 77008	Harris	5	N	L	N	**LPST:** Final concurrence issued, case closed in 1990. **PST:** Seven USTs removed in 1989, 1995, and 1997.
410	0.05 W	Lower	Celotex The Houston Plant 1400 N Post Oak Rd, Houston, 77055	Harris	5	N	L	N	**PST:** One UST filled in place in 1957 and two USTs removed in 1989.
411	0.21 SW	Lower	Rollins Leasing 6050 Westview Dr, Houston, 77055	Harris	5	N*	M	Y	**LPST:** Final concurrence issued, case closed in 1997. **PST:** Five USTs removed in 1994. **RCRA:** Inactive generator of ignitable waste and benzene.
412	0.14 W	Higher	Fant Childrens Trust Property 5900 Westview Dr, Houston, 77055	Harris	5	N	M	N	**IOP:** Completed IOP, with final certificate issued in 2012
413	0.14 W	Higher	N Post Oak Row North 5800 & 5900 Westview Dr Houston, 77055	Harris	5	N	M	N	**IOP:** Completed IOP, with final certificate issued in 2012
414	0.26 SW	Lower	Amber - Booth 1403 N Post Oak Rd, Houston, 77055	Harris	5	N*	M	Y	**LPST:** Final concurrence issued, case closed in 1992. **PST:** One UST removed in 1991.
415	0.07 W	Lower	New Process Steel 5800 Westview Drive, Houston, 77055	Harris	5	Y	L	N	**PST:** Four USTs removed in 1994 and 2013. **RCRA:** Inactive generator with no generator status or waste streams listed.
416	0.08 W	Higher	PRC Realty Systems 5821 Westivew Drive, Houston, 77055	Harris	5	N	L	N	**RCRA**: Inactive generator of silver.
417	0.78 E	Lower	Zep Manufacturing 6827 Wynnwood Ln, Houston, 77008	Harris	5	N	L	N	**IHW:** Inactive corrective action. Completed workload in 2011.
418	0.30 W	Higher	Roadrunner Moving & Storage 6005 Westview Dr, Houston, 77055	Harris	5	N*	L	N	**LPST:** Final concurrence issued, case closed in 1995. **PST:** Two USTs removed in 1998.

Table 3.5-2 Hazardous Materials Database Search

Map ID	Distance From Alternative Centerline (mi)	Site's Relative Elevation to Rail	Facility Name and Address	County	Segment	In LOD	Risk	Further Investigation Required	Summary of Findings from Database Search
419	0.11 W	Higher	McKinley Paper 1300 N Post Oak Rd, Houston, 77055	Harris	5	N*	M	Y	**IHW:** Inactive corrective action. Completed workload in 2012. **LPST:** Final concurrence issued, case closed in 2003. **PST:** One UST removed in 1993.**VCP:** Active 2012 VCP agreement for groundwater affected by vinyl chloride, trichloroethylene, and dichlorethylene. Currently in affidavit phase.
420	0.33 E	Higher	Weslaco Hills Apartments 8990 Hempstead Rd, Ste 110 Houston, 77008	Harris	5	N	L	N	**IOP:** Completed IOP, with final certificate issued in 2012.
421	0.52 E	Higher	Crane Valve Services 3602 W 12th St, Houston, 77008	Harris	5	N	L	N	**LPST:** Final concurrence issued, case closed in 1992. **PST:** One UST removed in 1992. **VCP:** Active 2004 VCP agreement for soils/groundwater affected by chlorinated solvents, TPH, metals, and VOCs. Currently in investigation phase.
422	0.76 E	Higher	GE Industrial Systems 3530 W 12th St, Houston, 77008	Harris	5	N	L	N	**IHW:** Inactive corrective action site. Completed workload in 2016. **RCRA:** Active CESQG of several waste streams including ignitable and corrosive waste, chromium, lead, and mercury.
423	0.25 E	Higher	Zenneca Former Stauffer Management 8901 Hempstead Rd, Houston, 77008	Harris	5	N	M	N	**IHW:** Active corrective action site as of 1998 for soil affected by pesticides and herbicides. Ongoing workload. **RCRA:** Active CESQG of several waste streams including ignitable waste, endrin, lindane, and carbon tetrachloride.
424	0.42 W	Higher	Post Oak Business Center 7 1293 N Post Oak Rd, Houston, 77055	Harris	5	N	L	N	**LPST:** Final concurrence issued, case closed in 1993. **PST:** Two USTs removed in 1993.
425	0.02 W	Lower	PTS Laboratories Inc. 4350 W 12th, Houston, 77055	Harris	5	N	L	N	**RCRA:** Inactive generator of ignitable waste and spent non-halogenated solvents.
426	0.71 E	Higher	Houston Cryogenics Division Alac 3543 W 12th St, Houston, 77008	Harris	5	N	L	N	**IHW:** Inactive corrective action. Completed workload in 2011. **VCP:** Active 2014 VCP agreement for groundwater affected by vinyl chloride, trichloroethylene, and dichloromethane. Currently in investigation phase.
427	0.88 E	Lower	Air Liquide America Houston 3511 W 12th St, Houston, 77008	Harris	5	N	L	N	**IHW:** Inactive corrective action. Completed workload in 2002.
428	0.05 W	Higher	Hughes MPD 4427 W 12th St, Houston, 77055	Harris	5	N	L	N	**PST:** Four USTs removed in 1990.

Table 3.5-2 Hazardous Materials Database Search

Map ID	Distance From Alternative Centerline (mi)	Site's Relative Elevation to Rail	Facility Name and Address	County	Segment	In LOD	Risk	Further Investigation Required	Summary of Findings from Database Search
429	0.66 W	Higher	Silber 3 Property Houston 1150 Silber Rd, Houston, 77055	Harris	5	N	L	N	**IHW:** Inactive corrective action. Completed workload in 2005.
430	0.26 E	Higher	Southline Metal Products 3777 W 12th St, Houston, 77055	Harris	5	N	L	N	**IHW:** Inactive corrective action. Completed workload in 2013. **IOP:** Active 2012 IOP agreement for groundwater affected by arsenic. Currently in investigation phase. **VCP:** Completed VCP, with final certificate issued in 2014 for soil/groundwater affected by chlorinated solvents.
431	0.10 W	Higher	Kennametal Firth Sterling 4435 W 12th St, Houston, 77055	Harris	5	N*	M	Y	**IHW:** Inactive corrective action. Completed workload in 2011. **RCRA:** TSD CORRACTS, CESQG generator of ignitable waste, lead, and benzene.
432	0.24 W	Higher	Kvaerner National 1255 North Post Oak Road Houston 77055	Harris	5	N*	M	Y	**VCP:** Completed VCP, with final certificate issued in 2011 for soil/groundwater affected by antimony, nickel, DCE, and vinyl chloride. A second completed VCP, with final certificate issued in 2016 for groundwater affected by chlorinated solvents.
433	0.84 E	Lower	Air Liquide Demolition 3602 W 11th St, Houston, 77008	Harris	5	N	L	N	**IHW:** Inactive corrective action. Completed workload in 2015.
434	0.004 W	Higher	West Loop 6 & 7 1213 West Loop N, Houston, 77055	Harris	5	Y	M	Y	**IOP:** Completed IOP, with final certificate issued in 2002.
435	0.39 E	Lower	The Premier 3834 W 11th, Houston, 77008	Harris	5	N	L	N	**LPST:** Final concurrence issued, case closed in 1992.
436	0.83 E	Lower	Engineers and Fabricators 11th St Houston 3501 W 11th St, Houston, 77008	Harris	5	N	L	N	**IHW:** Inactive corrective action. Completed workload in 2005 for groundwater affected by benzene and trichloroethylene. **LPST:** Final concurrence issued, case closed in 2005.
437	0.04 E	Higher	A Division Of Cummins Southern Plains 1155 West Loop N, Houston, 77055	Harris	5	Y	L	N	**PST:** One UST removed in 1991. Site had one closed emergency response event in 2008.
438	0.04 E	Higher	Graebel Houston Movers 1255 West Loop N, Houston, 77055	Harris	5	Y	M	Y	**LPST:** Two LPSTs reported. Final concurrence issued, cases closed in 1993 and 1996. **PST:** One UST removed in 1990.
439	0.04 E	Higher	Malibu Grand Prix 1105 West Loop N, Houston, 77055	Harris	5	Y	M	Y	**LPST:** Final concurrence issued, case closed in 2001. **PST:** One UST removed in 1997.
440	0.04 E	Higher	Patrick Media Group Of Houston 1313 West Loop N, Houston, 77055	Harris	5	Y	M	Y	**LPST:** Final concurrence issued, case closed in 1995. **PST:** Three USTs removed in 1992.

Table 3.5-2 Hazardous Materials Database Search

Map ID	Distance From Alternative Centerline (mi)	Site's Relative Elevation to Rail	Facility Name and Address	County	Segment	In LOD	Risk	Further Investigation Required	Summary of Findings from Database Search
441	0.10 W	Higher	Post Oak Memorial Office Park 1110 North Post Oak Road, Houston	Harris	5	Y	M	Y	**VCP:** Completed VCP, with final certificate issued in 2000 for soil affected by arsenic and metals.
442	0.44 E	Lower	Precision Flamecutting 7104 Old Katy Road, Houston	Harris	5	N	L	N	**VCP:** Completed VCP, with final certificate issued in 1996 for soil affected by metals, TPH, lead, and chromium.
443	0.03 E	Higher	Malibu Grand Prix 1111 West Loop N, Houston, 77055	Harris	5	Y	M	Y	**LPST:** Final concurrence issued, case closed in 2002. **PST:** One UST removed in 1997.
444	0.03 E	Higher	MTSO 1 1195 West Loop N, Houston, 77055	Harris	5	Y	L	N	**PST:** One UST removed in 1995. One active diesel AST in use and one AST out of use.
445	0.34 E	Lower	Austin Steel Company, Inc. 7110 Old Katy Road, Houston	Harris	5	N	L	N	**VCP:** Completed VCP, with final certificate issued in 1998 for soil affected by metals, VOC, chromium, TPH, arsenic, cadmium, mercury, selenium, BTEX, and others.
446	0.84 W	Higher	Helfman Dodge 1031 Silber Rd, Houston, 77055	Harris	5	N	L	N	**IHW:** Inactive corrective action. Completed workload in 2011.
447	0.09 W	Higher	Duratherm Inc./ Bird Environmental 1000 N Post Oak Ste 270 Houston, 77055	Harris	5	Y	L	N	**RCRA:** Inactive generator of ignitable wastes, sludge from oil refining industry, and oil emulsion solids.
448	0.80 W	Lower	Cameron Katy Rd 1100 Silber Rd, Houston, 77055	Harris	5	N	L	N	**IHW:** Inactive corrective action. Transferred to VCP in 2002. Active VCP agreement in remediation phase.
449	0.13 W	Higher	Business Park 10001 Old Katy Rd, Houston, 77055	Harris	5	Y	M	Y	**LPST:** Final concurrence issued in 1990, pending well plugging documentation. **PST:** Five USTs removed in 1989.
450	0.02 SE	Higher	Laroche Industries 7310 Katy Road, Houston, 77024	Harris	5	Y	M	Y	**IHW:** Inactive corrective action. Transferred to VCP in 2002. **VCP:** 1997 VCP agreement was terminated in 2007, for soil/groundwater affected by metals, pesticides, aldrin, arsenic, and others. **RCRA:** Inactive generator.
460	0.19 W	Higher	Post Oak Paint & Body Shop 1201 N Post Oak Rd, Houston TX, 77055	Harris	5	N	L	N	**PST:** Three USTs removed in 2002.
461	0.09 W	Higher	Carrier Building Systems and Service 1050 N Post Oak, Houston, 77055	Harris	5	Y	L	N	**RCRA:** Inactive generator of ignitable waste, arsenic, chromium, methane

Table 3.5-2 Hazardous Materials Database Search

Map ID	Distance From Alternative Centerline (mi)	Site's Relative Elevation to Rail	Facility Name and Address	County	Segment	In LOD	Risk	Further Investigation Required	Summary of Findings from Database Search
462	0.09 W	Higher	Laboratory Corporation of America 1050 N Post Oak, Houston, 77055	Harris	5	Y	L	N	**RCRA:** Inactive generator of spent nonhalogenated solvents
463	0.09 W	Higher	Laser Tech Color 1050 N Post Oak, Houston, 77055	Harris	5	Y	L	N	**RCRA:** Inactive generator of silver
464	0.70 SE	Lower	Barney Garver Mazda 7025 Old Katy Rd, Houston, 77024	Harris	5	N	L	N	**IHW:** Inactive corrective action. Completed workload in 2014.
465	0.85 SE	Lower	CTMS Building 6922 Old Katy Rd, Houston, TX 77024	Harris	5	N	L	N	**IHW:** Inactive corrective action. Completed workload in 1996.

Source: AECOM, 2017; TCEQ, 2017; EPA, 2017
Note:

- Sites are not sorted necessarily by numerical order. Sites are mainly sorted from north to south.
- Relative elevation indicates whether a site is at a higher or lower elevation relative to the proposed rail tracks at the ground surface level.
- Site names and addresses are written as they appeared in the database search.
- N* means that a site is adjacent to the LOD,
- Further investigation may include TCEQ files review, Phase I ESA, and/or Phase II ESA.
- Acronyms- **L**: Low, **M**: Moderate, **H**: High, **BTEX**: Benzene Toluene Ethylbenzene Xylene, **CERCLIS:** Comprehensive Environmental Response Compensation and Liability Information System, **CESQG**: Conditionally Exempt Small Quantity Generator, **CORRACTS:** Corrective Action Site, **IHW:** Industrial Hazardous Waste, **IOP**: Innocent Owner/Operator Program, **LPST:** Leaking Petroleum Storage Tank, **LQG**: Large Quantity Generator, **MSW**: Municipal Solid Waste, **MTBE:** Methyl Tertiary Butyl Ether, **NOV**: Notice of Violation, **PAH**: Polycyclic Aromatic Hydrocarbons, **PST:** Petroleum Storage Tank, **RCRA**: Resource Conservation and Recovery Act, **SQG**: Small Quantity Generator, **SVOC**: Semi Volatile Organic Compound, **TPH**: Total Petroleum Hydrocarbons, **TSD:** Treatment Storage and Disposal, **VCP**: Voluntary Cleanup Program, **VOC**: Volatile Organic Compound.
- Rows highlighted in red are high-risk sites.
- Rows highlighted in orange are moderate-risk sites that require further investigation.

Based on the database search, six sites were classified as high-risk sites (highlighted in red), 145 sites were classified as moderate-risk sites and the remaining 305 sites were classified as low-risk sites. Sites classified as presenting a high-risk of potential hazardous materials contamination are described in more detail below. Moderate risk sites that are within or adjacent to the LOD or currently undergoing corrective action or active remediation are also discussed. If field reconnaissance was conducted at a site, observations are discussed in the section below. All referenced photos are included in **Appendix E, Hazardous Materials Initial Site Assessment Report, Attachment 1**.

Based on historic maps review, three sites were classified as moderate-risk sites and one site was classified as low-risk site. The identified sites (MAP ID 466 to 469) are discussed below.

3.5.4.1.1 Dallas County (Segment 1)

- **MAP ID 12:** Cockrell Tract - Lot E is a moderate-risk site. The site is located 1,600 feet northwest of Segment 1 and is within the Dallas Terminal LOD. It has an active 2012 voluntary cleanup program agreement that is in the investigation phase for soil and groundwater affected by total petroleum hydrocarbons, semi-volatile organic compounds and metals. The site is a 6.6 acres parking lot and the listed responsible party is City of Dallas.

- **MAP ID 13**: Austin Street 39 RM is a moderate-risk site. The site is located 700 feet northeast of Segment 1 and is adjacent to the LOD. LPST was reported, final concurrence was issued and the case was closed in 1991. Four USTs were removed in 1991. The listed responsible party is TXI Operations LP.

- **MAP ID 19**: Alford Refrigerated Warehouses is a moderate-risk site. The site is located 800 feet southwest of Segment 1 and is adjacent to the LOD. It is a Comprehensive Environmental Response Compensation and Liability Information System site that is not on the NPL. It is a former voluntary cleanup program site that has been cleaned and received final certificate of completion in 2012. LPST was reported, final concurrence was issued and the case was closed in 1995. Five USTs were removed in 1991. Based on field reconnaissance, the site is a currently vacant tract of land with no visible concerns observed (**Appendix E, Hazardous Materials Initial Site Assessment Report, Attachment 1, Photo #3**).

- **MAP ID 20:** Jacks Service Station is a moderate-risk site. The site is located 300 feet west of Segment 1 and is within the LOD. LPST was reported, final concurrence was issued in 2011 and the case is pending well plugging documentation. Five USTs were removed in 1990. Based on field reconnaissance, this is currently a vacant property with signs of recent ground disturbance due to new road construction/grading. (**Appendix E, Hazardous Materials Initial Site Assessment Report, Attachment 1, Photo #2**).

- **MAP ID 466:** Based on historic aerial maps review, several industrial and warehouse type facilities were dominant in the Dallas Terminal area south of Cadiz Street from the 1960s until 2006. Currently that area is a lightly vegetated tract of land. This area is considered moderate-risk because it is within the LOD and is adjacent to sites (MAP ID 19 and 20) that had history of releases.

- **MAP ID 26:** Former Refrigerated Transport is a moderate-risk site. The site is located 700 feet southwest of Segment 1 and is within the Dallas Terminal Station LOD. LPST was reported, final concurrence was issued and the case was closed in 1993. Two USTs were removed in 1990. Based on field reconnaissance, the site is a currently vacant tract of land with no visible concerns observed (**Appendix E**, **Hazardous Materials Initial Site Assessment Report, Attachment 1, Photo #5**).

- **MAP ID 33:** Whitlock is a moderate-risk site. The site is located 500 feet southwest of Segment 1 and adjacent to the LOD. LPST was reported, final concurrence was issued and the case was closed in 2002. Three USTs were removed in 1995. Based on field reconnaissance, there is an active storage yard for demolition equipment (Keating Demolition) at this address (**Appendix E**, **Hazardous Materials Initial Site Assessment Report, Attachment 1, Photo #6)** and no visible concerns were observed.

- **MAP ID 36:** Kwik Stop is a moderate-risk site. The site is located 500 feet southwest of Segment 1 and adjacent to the LOD. It has three gasoline USTs in use. LPST was reported, final concurrence was issued and the case was closed in 2009. Based on the field reconnaissance, this site is currently in operation (**Appendix E**, **Hazardous Materials Initial Site Assessment Report, Attachment 1, Photo #7**) and no visible concerns were observed.

- **MAP ID 37:** Metro Cost Plus is considered a high-risk site. This facility is a gas station in operation located 600 feet southwest of Segment 1 and adjacent to the LOD. It currently has two gasoline USTs in use. The facility is an active LPST site since 1990, with impacted groundwater within 500 feet to 0.25 mile of surface water used by humans or endangered species. Listed responsible party is Chevron Environmental Management Company. Four USTs were removed in 1992.This facility is undergoing remediation and groundwater monitoring. Monitoring wells were observed during field reconnaissance (**Appendix E**, **Hazardous Materials Initial Site Assessment Report, Attachment 1, Photo #8**). Visual indicators of contamination were not observed. The facility had two closed enforcement orders for failure to complete the required monitoring for the USTs.

- **MAP ID 38:** Buckley Oil is a moderate-risk site. The site is located 1,300 feet southwest of Segment 1 and outside the LOD. This is an active industrial hazardous waste corrective action site with ongoing workload for soil affected by total petroleum hydrocarbons. LPST was reported, final concurrence was issued and the case was closed in 2010. Several ASTs were observed during field reconnaissance (**Appendix E**, **Hazardous Materials Initial Site Assessment Report, Attachment 1, Photo #9**).

- **MAP ID 43:** Atlas Scrap Iron and Metal is a moderate-risk site. The site is located 1,000 feet south of Segment 1 and outside the LOD. It has an active 1999 voluntary cleanup program agreement for soil affected by metals, total petroleum hydrocarbons and volatile organic compounds. The site received conditional certificate of completion in 1999. No visible concerns were observed during field reconnaissance (**Appendix E**, **Hazardous Materials Initial Site Assessment Report, Attachment 1, Photo #10**).

- **MAP ID 46:** Praxair/Union Carbide Corporation is a moderate-risk site. The site is located 400 feet southwest of Segment 1 and is adjacent to the LOD. This is a Resource Conservation and Recovery Act corrective action and a treatment, disposal and storage facility. It is an inactive TCEQ corrective action facility, with completed workload in 2012. LPST was reported, final concurrence was issued and case was closed in 1989. Three USTs were removed in 1988. Based on the field reconnaissance, there is an active facility (EZWall Stucco) at this address. Numerous storage totes, a pump house and a trash/tires dump were observed.

- **MAP ID 49:** Former Matheson Tri-Gas Dallas is a moderate-risk site. This site is located 500 feet southwest of Segment 1 and is adjacent to the LOD. LPST was reported in 1995 and two USTs were removed in 1995. The site was transferred to voluntary cleanup program because of presence of non-LPST type contaminants. Soil/groundwater was affected by total petroleum hydrocarbons, volatile organic compounds, acetone and methylene chloride. The site is reported to have been cleaned to non-residential standards, with receipt of final certificate from TCEQ in 2006. Based on the field reconnaissance, currently there is an active concrete mixing facility (Redi-Mix Dallas) at this address (**Appendix E**, **Hazardous Materials Initial Site Assessment Report, Attachment 1, Photo #14**).

- **MAP ID 51:** Unnamed historical municipal solid waste facility is a moderate-risk site. The site is located 400 feet southwest of Segment 1 and is adjacent to the LOD. Closure was confirmed in 1992 by City of Dallas. The site contained household items and could not be identified during field reconnaissance. Currently, Occidental Chemical (MAP ID 52) and Redi-Mix concrete facility (MAP ID 50) are located at or near this site.

- **MAP ID 52:** Occidental Chemical Dallas Silicate Plant is a high-risk site. This site is in operation and is located 350 feet southwest of Segment 1 and is immediately adjacent to the LOD. It had an innocent owner/operator program agreement that was withdrawn in 2013. It has three ASTs (diesel and distillate fuel oil) in use and is an active conditionally exempt small quantity generator of ignitable waste, corrosive waste, mercury, benzene and tetrachloroethylene (**Appendix E**, **Hazardous Materials Initial Site Assessment Report, Attachment 1, Photo #15a**). Based on the field reconnaissance, soil stained with oil product was observed at the southeastern side of the property (**Appendix E**, **Hazardous Materials Initial Site Assessment Report, Attachment 1, Photo #15b and #15c**). This may be the result of a recent spill or from contaminated stormwater drained from the ASTs secondary containment.

- **MAP ID 54:** Gold Metals Recyclers is a moderate-risk site. The site is located 1,000 feet east of Segment 1 and outside the LOD. It is a Comprehensive Environmental Response Compensation and Liability Information System site that is not on the NPL. It is an active voluntary cleanup program site for soil/groundwater affected by total petroleum hydrocarbons, volatile organic compounds and metals. It received conditional certificate of completion in 2012. LPST was reported at this site. TCEQ issued final concurrence and the case was closed in 1992. Based on the field reconnaissance, the site is a currently in operation (**Appendix E**, **Hazardous Materials Initial Site Assessment Report, Attachment 1, Photo #17**).

- **MAP ID 86:** Chevron Facility 105982 is a moderate-risk site. The site is located 200 feet east of Segment 1 and is adjacent to the LOD. LPST was reported, final concurrence was issued and the case was closed in 2009. Three USTs were removed in 2013. Based on the field reconnaissance, the site is currently a vacant fenced tract of land and no visible concerns were observed (**Appendix E**, **Hazardous Materials Initial Site Assessment Report, Attachment 1, Photo #21**).

- **MAP ID 476:** Stericycle Environmental Solutions/Effective Environmental is a high-risk site. The site is located 1,600 feet west of Segment 1 and is immediately adjacent to the LOD (a MOW facility would be located east of the site and a temporary construction area would be located south of the site). It is an active industrial hazardous waste corrective action site since 2002, with ongoing workload for soil affected by trichloroethylene. The property has a restrictive covenant. The facility installed an engineered cap to prevent exposure to contaminants. The facility submits an annual cap inspection report to TCEQ. Based on field reconnaissance, the site is currently in operation and Stericycle/Effective Environmental trucks were observed (**Appendix E**, **Hazardous Materials Initial Site Assessment Report, Attachment 1, Photo #108**). There is undeveloped land east of and south of this site.

3.5.4.1.2 Ellis County (Segments 2A, 2B)

- **MAP ID 99:** Pencco Bardwell is a high-risk site. The site is located 370 feet southwest of Segment 2A and is adjacent to the LOD. It is an active conditionally exempt small quantity generator of chromium. Based on field reconnaissance, the site is currently in operation (**Appendix E**, **Hazardous Materials Initial Site Assessment Report, Attachment 1, Photo #28a**). Significant soil staining/discoloration was observed, which is indicative of a spill or release (**Appendix E**, **Hazardous Materials Initial Site Assessment Report, Attachment 1, Photo #28b**).

3.5.4.1.3 Navarro County (Segments 3A, 3B, 3C)

No high or moderate-risk sites were identified within or adjacent to the LOD in Navarro County.

3.5.4.1.4 Freestone County (Segments 3C, 4)

- **MAP ID 110:** Professional Wireline Rentals is a moderate-risk site. The site is located 100 feet west of Segment 3C and is partially within the LOD. It is an inactive IHW corrective action site, with completed workload in 2013. From field reconnaissance, this site seemed abandoned (**Appendix E**, **Hazardous Materials Initial Site Assessment Report, Attachment 1, Photo #34**).

- **MAP ID 114:** Coles One Stop is a moderate-risk site. The site is located 1,000 feet east of Segment 3C and outside the LOD. Two LPSTs were reported at this site. The first LPST reported in 1992, on which TCEQ issued final concurrence and the case was closed in 1992. The second LPST was reported in 2009. A designated major or minor aquifer was impacted. Remediation was completed and TCEQ issued final concurrence in 2016. There is one UST in use and three removed in 2009. This site is in operation and no visible concerns were observed during field reconnaissance (**Appendix E**, **Hazardous Materials Initial Site Assessment Report, Attachment 1, Photo #36**).

- **MAP ID 120:** Jet Travel Plaza is a moderate-risk site. The site is located 1,400 feet east of Segment 3C and outside the LOD. LPST was reported in 1991 and status is listed as active with ongoing remediation. This site is in operation, but fuel pumps were not working and excavation activities near fuel tanks were observed during field reconnaissance (**Appendix E**, **Hazardous Materials Initial Site Assessment Report, Attachment 1, Photo #37**).

3.5.4.1.5 Limestone County (Segment 4)

No high or moderate-risk sites were identified within or adjacent to the LOD in Limestone County.

3.5.4.1.6 Leon County (Segments 3C, 4)

- **MAP ID 129:** Triangle Petroleum is a moderate-risk site. The site is located 800 feet southwest of Segment 3C and outside the LOD. Five active USTs are in use and five USTs have been removed in 1998, 1999 and 2015. It also has an active LPST that was reported in 2015 and is currently in remediation phase. This site is in operation and no visible concerns were observed during field reconnaissance (**Appendix E**, **Hazardous Materials Initial Site Assessment Report, Attachment 1, Photo #40**).

- **MAP ID 131:** Exxon RS 63615 is a moderate-risk site. The site is located 1200 feet east of Segment 3C and is adjacent to the LOD. LPST was reported in 1992 for minor soil contamination. There was no remedial action required. Final concurrence was issued and case was closed in 1992. There were four USTs removed in 1992. Currently, this site is in operation (**Appendix E**, **Hazardous Materials Initial Site Assessment Report, Attachment 1, Photo #42**) and there are four active USTs in use. There were no visible concerns observed during field reconnaissance.

3.5.4.1.7 Madison County (Segment 3C, 4)

No high or moderate-risk sites were identified within or adjacent to the LOD in Madison County.

3.5.4.1.8 Grimes County (Segments 3C, 4, 5)

No high or moderate-risk sites were identified within or adjacent to the LOD in Grimes County.

3.5.4.1.9 Waller County (Segment 5)

No high or moderate-risk sites were identified within or adjacent to the LOD in Waller County.

3.5.4.1.10 Harris County (Segment 5)

- **MAP ID 145:** Timewise Exxon is a moderate-risk site. The site is located 300 feet east of Segment 5 and outside the LOD. There are four active USTs in use. LPST was reported, final concurrence was issued and case was closed in 2014. This site is in operation (**Appendix E**, **Hazardous Materials Initial Site Assessment Report, Attachment 1, Photo #47**) and plugged and abandoned monitoring wells were observed during field reconnaissance.

- **MAP ID 158:** SPX Flow Control is a moderate-risk site. The site is located 200 feet east of Segment 5 and outside the LOD. It is an inactive industrial hazardous waste corrective action site, with completed workload in 2015. Site is an active large quantity generator of ignitable and corrosive waste, benzene and other waste streams. This site is in operation and one AST and five exhaust stacks were observed during field reconnaissance (**Appendix E**, **Hazardous Materials Initial Site Assessment Report, Attachment 1, Photo #51**).

- **MAP ID 162:** West End Lumber is a moderate-risk site. The site is located 200 feet west of Segment 5 and is immediately adjacent to the LOD. LPST was reported, final concurrence was issued and the case was closed in 2000. Groundwater was impacted with no apparent threats or impacts to receptors. The site had one UST removed in 1997 and three ASTs out of use. This site is in operation and one out-of-service AST was observed during field reconnaissance (**Appendix E**, **Hazardous Materials Initial Site Assessment Report, Attachment 1, Photo #52**).

- **MAP ID 467:** Based on historic aerial maps review, a tank farm existed in this area from the 1940s to 2004 along Segment 5. There were approximately 20 ASTs in a 100 acre area that were likely used for oil storage and an impoundment/water body. Currently the area is developed into industrial facilities, but that water body is still visible in the 2016 aerials. This area is considered a moderate-risk site because it is immediately adjacent to the LOD.

- **MAP ID 184**: Guardsman/Cytex Industries is a moderate-risk site. The site is located 900 feet south of Segment 5 and outside the LOD. Active LPST was reported in 2015 with no further information. This site has been an active voluntary cleanup program site since 2012 for soil/groundwater affected by volatile organic compounds. Voluntary cleanup program is currently in investigation phase. From field reconnaissance, CSE-W Industries is currently located at this address (**Appendix E**, **Hazardous Materials Initial Site Assessment Report, Attachment 1, Photo #58**).

- **MAP ID 191**: Elg Ireland Alloys is a moderate-risk site. The site is located 2,000 feet southwest of Segment 5 and outside the LOD. This site has been an active voluntary cleanup program site since 2000 for soil/groundwater affected by metals and chlorinated solvents. A voluntary cleanup program is currently in investigation phase. Based on field reconnaissance, Versa Tech is currently located at this address (**Appendix E**, **Hazardous Materials Initial Site Assessment Report, Attachment 1, Photo #59**).

- **MAP ID 199:** Texaco Service Station/Star Enterprise is a moderate-risk site. The site is located 280 feet north of Segment 5 and outside the LOD. LPST reported at this site, with final concurrence issued and the case closed in 1997. There were four USTs removed in 2003. Based on field reconnaissance, this is currently a vacant lot and no visible concerns were observed (**Appendix E**, **Hazardous Materials Initial Site Assessment Report, Attachment 1, Photo #60**).

- **MAP ID 204**: SPM Houston Manufacturing is a moderate-risk site. The site is located 100 feet south of Segment 5 and is adjacent to the LOD. It is an inactive IHW corrective action site, with completed workload in 2016. Currently this is a vacant property and no visible remediation activities were observed during field reconnaissance (**Appendix E**, **Hazardous Materials Initial Site Assessment Report, Attachment 1, Photo #62**).

- **MAP ID 205**: Houston 2 U.S. Army Reserve Center is a moderate-risk site. The site is located 600 feet south of Segment 5 and outside the LOD. This site has been an active IHW corrective action site since 2011 with ongoing workload. No visible concerns or remediation activities were observed during field reconnaissance (**Appendix E**, **Hazardous Materials Initial Site Assessment Report, Attachment 1, Photo #63**).

- **MAP ID 236**: Mathew-Price Industries is a moderate-risk site. The site is located 380 feet west of Segment 5 and is adjacent to the LOD. It had one UST removed in 1994. LPST was reported, final concurrence was issued and the case was closed in 1996. Currently Allesco Process Specialty is located at this address and no visible concerns were observed (**Appendix E**, **Hazardous Materials Initial Site Assessment Report, Attachment 1, Photo #71**).

- **MAP ID 241**: CY Fair Tire is a moderate-risk site. The site is located 100 feet northeast of Segment 5 and is adjacent the LOD. LPST was reported, final concurrence was issued and the case was closed in 1991. Three USTs were removed in 1991. Currently Location One Tires is located at this address and no visible concerns were observed (**Appendix E**, **Hazardous Materials Initial Site Assessment Report, Attachment 1, Photo #72**).

- **MAP ID 258:** Midwest Paint and Body is a moderate-risk site. The site is located 150 feet north Segment 5 and is adjacent to the LOD. LPST was reported, final concurrence was issued in 1997 and the case is pending well plugging documentation. Groundwater was impacted, with no apparent threats or impacts to receptors. Two USTs were removed in 1991. Currently Coastal Metal Recycling is located at this address and no visible concerns were observed (**Appendix E**, **Hazardous Materials Initial Site Assessment Report, Attachment 1, Photo #74**).

- **MAP ID 263**: Los Gas and Diesel is a moderate-risk site. The site is located 270 feet south of Segment 5 and outside the LOD. It had four USTs removed in 1997. LPST was reported in 1997 and it is currently in active remediation/monitoring phase. At the time of the field reconnaissance, this was a vacant property and no remediation or monitoring activities were observed (**Appendix E**, **Hazardous Materials Initial Site Assessment Report, Attachment 1, Photo #75**).

- **MAP ID 273:** Fairbanks Gulf is a moderate-risk site. The site is located 150 feet north of Segment 5 and is adjacent to LOD. LPST was reported, final concurrence was issued and the case was closed in 1990. Four USTs were removed in 1989.

- **MAP ID 297:** Sandvik Rock Tools Facility is a moderate-risk site. The site is located 1,000 feet south of Segment 5 and outside the LOD. This is an active voluntary cleanup program site since 1998 for soils/groundwater affected by metals and chlorinated solvents. According to the TCEQ database, the site is in active remediation phase. American Tile and Stone is currently located at this address and no remediation activities were observed (**Appendix E**, **Hazardous Materials Initial Site Assessment Report, Attachment 1, Photo #77**).

- **MAP ID 468:** Based on historic maps review (Hedwig Village 1970 and 1982 USGS topographic maps), a sewage disposal pond was located at this area along Segment 5. Currently this area is developed into a business park with multiple office buildings. This area is considered a low-risk site.

- **MAP ID 299:** Chamdal Food Mart is a moderate-risk site. The site is located 150 feet east of Segment 5 and is adjacent to the LOD. It has three active USTs in use. LPST was reported, final concurrence was issued and the case was closed in 2003. The site is in operation (**Appendix E**, **Hazardous Materials Initial Site Assessment Report, Attachment 1, Photo #78**). Plugged and abandoned monitoring wells were observed during field reconnaissance.

- **MAP ID 301**: Former Service Station is a moderate-risk site. The site is located 200 feet east of Segment 5 and is adjacent to the LOD. LPST was reported, final concurrence was issued and the case was closed in 1998. Four USTs were removed in 1995. Budget Host-Hempstead Inn is currently located at this address.

- **MAP ID 318**: Hearne Gulf Service is a moderate-risk site. The site is located 150 feet east of Segment 5 and is adjacent to the LOD. LPST was reported, final concurrence was issued and the case was closed in 2008. Four USTs were removed in 1991. A&K Complete Auto Service is currently located at this address.

- **MAP ID 319**: Rectorseal is a moderate-risk site. The site is located 670 feet west of Segment 5 and outside the LOD. This site has an active 1997 voluntary cleanup program agreement for soil/groundwater affected by total petroleum hydrocarbons, chlorinated solvents and other contaminants. Remediation has been completed. A final certificate of completion has not been issued and is pending a signed affidavit. LPST was reported, final concurrence was issued and the case was closed in 1993. One UST was removed in 1992. This site is in operation (**Appendix E**, **Hazardous Materials Initial Site Assessment Report, Attachment 1, Photo #79**). At the time of the field reconnaissance, numerous ASTs and plugged and abandoned monitoring wells were observed.

- **MAP ID 332**: American Door Products is a moderate-risk site. The site is located 1,000 feet west of Segment 5 and outside the LOD. This site has an active 2006 voluntary cleanup program agreement for soil/groundwater affected by pesticides, metals and arsenic. Remediation has been completed. A final certificate of completion has not been issued and is pending a signed affidavit. This site is in operation (**Appendix E**, **Hazardous Materials Initial Site Assessment Report, Attachment 1, Photo #80**) and no remediation activities were observed during the field reconnaissance.

- **MAP ID 334**: Hempstead Food Mart is a moderate-risk site. The site is located 100 feet east of Segment 5 and is adjacent to the LOD. LPST was reported, final concurrence was issued and the case was closed in 2009. It has two USTs in use and four USTs were removed in 2004. This site is in operation.

- **MAP ID 337:** Penske Truck Leasing is a moderate-risk site. The site is located 175 feet east of Segment 5 and is adjacent to the LOD. Site has four USTs in use and two USTs were removed in 1991. LPST was reported, final concurrence was issued in 2011 and the case is pending well plugging documentation. This site is in operation and has an active fueling area (**Appendix E**, **Hazardous Materials Initial Site Assessment Report, Attachment 1, Photo #81**).

- **MAP ID 338:** Wonder Hostess Bakery is a moderate-risk site. The site is located 150 feet northeast of Segment 5 and is adjacent to the LOD. LPST was reported, final concurrence was issued and the case was closed in 1995.

- **MAP ID 351:** Former Western Fence is a moderate-risk site. The site is located 300 feet west of Segment 5 and is adjacent to the LOD. LPST was reported, final concurrence was issued and the case was closed in 2012.

- **MAP ID 362:** Ryder Truck Rental is a moderate-risk site. The site is located 170 feet east of Segment 5 and is adjacent the LOD. The site had two LPSTs reported, final concurrence was issued and the cases were closed in 1996 and 2004. There are two USTs in use and six USTs were removed in 1993 and 1995. This site is in operation and had one closed emergency response event in 2014.

- **MAP ID 379:** Regency Car Wash is a moderate-risk site. The site is located 150 feet east of Segment 5 and is adjacent to the LOD. LPST was reported, final concurrence was issued and the case was closed in 2012. Three USTs were removed in 2010 at this site.

- **MAP ID 391**: Southern Pacific Transport (former Bay Oil Company) is a moderate-risk site. The site is located 50 feet southwest of Segment 5 and is within the Houston Industrial Site Terminal Station option LOD. LPST was reported in 1996, groundwater impacted with no apparent threats or impacts to receptor. Final concurrence was issued and the case was closed in 2000. Four USTs were removed in 1996 at this site. Currently, this is a vacant property (**Appendix E**, **Hazardous Materials Initial Site Assessment Report, Attachment 1, Photo #82**). Plugged and abandoned monitoring wells and trash/tires dump were observed during field reconnaissance.

- **MAP ID 394:** Wilsons Texaco is a moderate-risk site. The site is located 140 feet east of Segment 5 and is adjacent to the LOD. LPST was reported, final concurrence was issued and the case was closed in 1999. Five USTs were removed in 2000 and 2006 at this site.

- **MAP ID 395:** P&S Rice Mills is a moderate-risk site. The site is located 300 feet west of Segment 5 and is within the Houston Industrial Site Terminal Station option LOD. Two LPSTs were reported, final concurrence was issued and the cases were closed in 1993 and 2000. There were eight USTs removed in 1990.

- **MAP ID 397:** Handi Stop 107 is a moderate-risk site. The site is within the Northwest Mall Terminal Station option LOD. LPST was reported, final concurrence was issued and the case was closed in 2010. Seven USTs were removed in 1989 and 2007 at this site. This site is currently in operation and there are three USTs in use.

- **MAP ID 399:** Exxon RS 63250 is a moderate-risk site. The site is located 130 feet east of Segment 5 adjacent to the LOD. It has four active USTs in use. LPST was reported, final concurrence was issued and the case was closed in 1999. This site is currently in operation.

- **MAP ID 400:** Firestone Master Care Center is a moderate-risk site. The site is within the Northwest Mall Terminal Station option LOD. LPST was reported, final concurrence was issued and the case was closed in 1995. Currently, Northwest Mall is located at this address (**Appendix E**, **Hazardous Materials Initial Site Assessment Report, Attachment 1, Photo #83**).

- **MAP ID 403:** Lunsford Estate Property is a high-risk site. The site is within the Houston Industrial Site Terminal Station option LOD. This is an active voluntary cleanup program site with a 1997 agreement for soil/groundwater affected by total petroleum hydrocarbons, volatile organic compounds, pesticides and herbicides. The site is currently in the investigation phase. Custom Car Cool Body Shop is currently located at this address (**Appendix E**, **Hazardous Materials Initial Site Assessment Report, Attachment 1, Photo #85**). A monitoring well was observed during field reconnaissance.

- **MAP ID 405:** Tex Tube is a high-risk site. The site is within the Houston Industrial Site Terminal Station option LOD. This is an active industrial hazardous waste corrective action since 2002, with ongoing workload. This site is in operation (**Appendix E**, **Hazardous Materials Initial Site**

Assessment Report, Attachment 1, Photo #86). A remediation system (underground injection) and monitoring wells were observed during field reconnaissance.

- **MAP ID 469:** Based on historic aerial maps reviews, industrial facilities were located at this area from 1950s to 2013. Currently this area is a vegetated tract of land with a small body of water. This area is considered a moderate-risk site because it is within the LOD of Segment 5.

- **MAP ID 419:** Former McKinley Paper is a moderate-risk site. The site is located 600 feet west of Segment 5 adjacent to the LOD. This is an inactive industrial hazardous waste corrective action site, with completed workload in 2012. LPST was reported, final concurrence was issued and the case was closed in 2003. Also, this is an active voluntary cleanup program site with a 2012 agreement for groundwater affected by vinyl chloride, trichloroethylene and dichloroethylene. Remediation was completed and TCEQ received a signed affidavit in June 2017. TCEQ is in the process of issuing a final certificate of completion. Currently, there is a new condominium development at this address. (**Appendix E**, **Hazardous Materials Initial Site Assessment Report, Attachment 1, Photo #93**).

- **MAP ID 431:** Kennametal Firth Sterling is a moderate-risk site. The site is adjacent to the Northwest Transit Center Terminal Station option LOD. This is an inactive IHW corrective action site, with completed workload in 2011. It is a Resource Conservation and Recovery Act treatment, storage and disposal corrective action facility, with completed workload. This site is in operation (**Appendix E**, **Hazardous Materials Initial Site Assessment Report, Attachment 1, Photo #97**) and no visible concerns were observed during field reconnaissance.

- **MAP ID 438:** Former Graebel Houston Movers is a moderate-risk site. The site is partially within the Northwest Transit Center Terminal Station option LOD. Two LPSTs were reported, final concurrence was issued and the cases were closed in 1993 and 1996. One UST was removed in 1990. Currently the property is vacant and overgrown (**Appendix E**, **Hazardous Materials Initial Site Assessment Report, Attachment 1, Photo #101**).

- **MAP ID 439:** Former Malibu Grand Prix is a moderate-risk site. The site is partially within the Northwest Transit Center Terminal Station option LOD. LPST was reported, final concurrence was issued and the case was closed in 2001. One UST was removed in 1997. Currently the property is vacant and overgrown (**Appendix E**, **Hazardous Materials Initial Site Assessment Report, Attachment 1, Photo #100**).
- **MAP ID 440:** Former Patrick Media Group of Houston is a moderate-risk site. The site is partially within the Northwest Transit Center Terminal Station option LOD. LPST was reported, final concurrence was issued and the case was closed in 1995. Three USTs were removed in 1992. Currently a new condominium development is being constructed at the site **(Appendix E**, **Hazardous Materials Initial Site Assessment Report, Attachment 1, Photo #93**). The site is covered by construction materials and three monitoring wells were observed.

- **MAP ID 443:** Former Malibu Grand Prix is a moderate-risk site. The site is within the Northwest Transit Center Terminal Station option LOD. LPST was reported, final concurrence was issued and the case was closed in 2002. One UST was removed in 1997. Currently there is a TxDOT concrete plant with several tanks at this address (**Appendix E**, **Hazardous Materials Initial Site Assessment Report, Attachment 1, Photo #105**).

- **MAP ID 450:** Former Laroche Industries is a moderate-risk site. The site is within the Northwest Transit Center Terminal Station option LOD. This was a voluntary cleanup program site with a 1997 agreement for soil/groundwater affected by metals, pesticides, arsenic and other contaminants. Agreement was terminated in 2007 with no cleanup information provided. Landry's Distribution Center is currently located at this address (**Appendix E**, **Hazardous Materials Initial Site Assessment Report, Attachment 1, Photo #107**) and no visible concerns were observed during field reconnaissance.

3.5.4.2 Solid Waste Facilities

Several municipal solid waste landfills and historic landfills were identified within the Study Area and were presented in **Table 3.5-2**. Solid waste facilities that would be near the Build Alternatives and may receive solid waste generated during the construction and operation are provided in **Table 3.5-3**. The table also lists the type of the facility, the total tons of waste landfilled in 2014 and the remaining capacity in years and tons.

Table 3.5-3: Solid Waste Capacity

County	Name	Type	2014 Tons	Remaining Capacity (years)	Remaining Capacity (tons)
Dallas	City of Dallas McCommas Bluff Landfill	1	1,872,789	45	65,176,330
Ellis	Waste Management Skyline Landfill	1	1,207,134	18	21,173,156
Navarro	City of Corsicana Landfill	1	102,126	107	11,851,537
Limestone	BFI Mexia Landfill	1	28,753	162	4,666,443
Grimes	Twin Oaks Landfill	1	309,870	77	23,090,233
Harris	McCarty Road Landfill	1	1,809,396	14	26,990,722
	Atascocita Recycling And Disposal Facility	1	1,111,277	35	38,639,436
	Greenhouse Road Landfill	4	88,028	19	4,620,738
	Hawthorn Park Landfill	4	218,530	3	646,196
	Tall Pines Landfill	4	312,273	8	2,369,089
	Lone Star Recycling & Disposal	4	228,650	32	6,399,758
		Total	**7,288,826**		

Source: TCEQ 2015. Municipal Solid Waste in Texas: A Year in Review. FY 2014 Data Summary and Analysis. http://www.tceq.state.tx.us/assets/public/comm_exec/pubs/as/187-15.pdf. October.

Notes:

- Type 1 is the standard landfill for the disposal of municipal solid waste.
- Type 4 landfills only accept brush, construction and demolition waste and other similar waste that does not putrefy.

3.5.5 Environmental Consequences

3.5.5.1 No Build Alternative

Under the No Build Alternative, the HST system would not be constructed. Existing hazardous materials sites would not be disturbed because no construction activities would occur. Therefore, there would be no greater risk to the Study Area than that which is already present. Additional solid waste would not be generated because no construction or operation of the HST system would occur under the No Build Alternative. Potential impacts could still occur under the No Build Alternative as new developments would continue due to natural growth in the area that would generate construction and operational waste and use remaining existing landfill capacity. However, the No Build Alternative would not contribute to this impact. Additionally, existing hazardous materials sites may be remediated in accordance with federal, state and local requirements under the No Build Alternative.

3.5.5.2 Build Alternatives

3.5.5.2.1 Construction Impacts

Hazardous Materials
All of the Build Alternatives would involve excavation and construction activities that could have the potential to uncover or disturb existing hazardous materials. Known hazardous materials sites within or near the Build Alternatives are presented by Segment in **Table 3.5-2** and summarized by Build Alternative in **Table 3.5-4**.

Table 3.5-4: Hazardous Material Sites by Build Alternative

	ALT A	ALT B	ALT C	ALT D	ALT E	ALT F
Low-Risk Sites	276	277	300	276	277	300
Moderate-Risk Sites	136	136	145	136	136	145
High-Risk Sites	6	6	6	5	5	5
Total Impacts	**418**	**419**	**451**	**417**	**418**	**450**

Source: AECOM, 2016

MAP IDs 37, 403, 405, and 476 which would be located within Segments 1 and 5 (Dallas and Harris counties, respectively), are high-risk sites and would pose the greatest concern because they are undergoing remediation/monitoring activities and would be within and adjacent to the LOD. Additionally, MAP IDs 52 and 99, which would be located within Segments 1 and 2A, respectively, are high-risk sites due to visual evidence of soil staining that was observed during field reconnaissance. Five of the six high-risk sites are common to all Build Alternatives. Alternative C and F would have slightly higher impacts than the other Build Alternatives because of the presence of additional low- and moderate-risk sites within proximity to Segment 3C. There would be an additional 24 low-risk sites and 9 moderate-risk sites within Alternatives C and F when compared to the other Build Alternatives. Environmental site assessments (Phase I and/or Phase II) would need to be conducted at the high-risk and moderate-risk sites identified in **Table 3.5.2** and at the moderate-risk sites identified based on historic maps review (MAP ID 466, 467 and 469) prior to the start of construction to determine the potential for contamination encountered during construction and operation, and to define site-specific remediation, as detailed in Section 3.5.6.2.

The hazardous materials sites within the LOD of the Houston Terminal Station options are summarized in **Table 3.5-5**. Out of the three station options, the Northwest Mall Terminal Option has the least hazardous materials site impacts.

Table 3.5-5: Hazardous Material Sites by Houston Terminal Station Option

	Industrial Site	Northwest Mall	Northwest Transit Center
Low-Risk Sites	4	0	6
Moderate-Risk Sites	3	3	8
High-Risk Sites	2	0	0
Total Impacts	**9**	**3**	**14**

Source: AECOM, 2017

Construction of the Build Alternatives would involve transporting, using, storing and disposing of hazardous materials, such as petroleum and oil products used for fueling and maintenance of construction equipment. Therefore, construction activities would have the potential to result in hazardous materials spills or releases that might impact human health or the environment. Safe handling, use, storage and disposal of these materials would be required during construction to avoid a potentially adverse effect, as detailed in **Section 3.5.6.2**.

In addition, numerous oil and gas wells and pipelines were identified within the LOD, as described in **Section 3.9.4.1, Utilities and Energy**. Relocation of existing wells and pipelines may be necessary during construction of any of the Build Alternatives. Oil/gas wells that would be abandoned or plugged incorrectly could release oil, gas, condensate or brine into surrounding soil that would affect nearby vegetation and contaminate water sources. In the abandonment of any well, there could be a danger of sudden pressure release, ignition of leached petroleum and/or fall hazards into large diameter openings. Decisions to plug or relocate wells would be addressed during the parcel acquisition process, which is discussed in more detail in **Section 3.13, Land Use**. If any oil and gas related contamination were to occur during construction of the Build Alternatives due to accidental damage, remediation would be conducted prior to continuation of construction activities as detailed in **Section 3.5.6.2**.

Demolition activities, associated with structure displacements (see **Section 3.13, Land Use**), may require the testing and removal of lead-based paint, asbestos-containing building materials or PCB-containing equipment. TCRR or its contractor would be responsible for removing these materials prior to demolition and transported to a proper disposal facility in accordance with Texas Department of State Health Services regulations.

Gas stations in or adjacent to the LOD could present a significant source of contamination from past underground fuel releases that could be encountered during construction. Regulatory closure does not mean all contamination has been removed. Closure means that contamination levels have met risk based criteria developed from likely future exposure scenarios and that the contaminant plume appears to have stopped migrating. Sites that have achieved regulatory closure may have residual contamination that extends onto the LOD and could be encountered during construction. Former or current gas station releases would be addressed by TCRR before or during construction activities. Gasoline contamination in soil or groundwater from service stations may affect specific design criteria, but would not be severe enough to affect the preferred alternative.

Solid Waste

Construction of the Build Alternatives would generate a substantial amount of waste from clearing of vegetation, removal of existing asphalt and gravel and demolition of existing structures. TCRR estimates that construction of the Build Alternatives would generate 7.5 million cubic yards of cut material from excavation activities, and would require 25.4 million cubic yards of fill material for embankment and undercut replacement. The generated cut material would be used as fill material and there would be no unused cut material to dispose. TCRR estimates that construction of the Build Alternatives would generate 59 thousand cubic yards of concrete waste and 32.5 million pounds of rebar waste that would be eventually disposed in a landfill. This would be an estimated 60.5 thousand tons of waste. The construction contractor would divert construction and demolition waste from landfills by reusing or recycling the material, where practicable, as discussed in **Section 3.5.6.2**.

The amount of waste that would be generated from buildings demolition is presented by Segment in **Table 3.5-6** and summarized by Build Alternative in **Table 3.5-7**. The amount of waste that would be generated from the Houston Terminal Station Options is also presented in **Table 3.5-6.** Out of the three station options, the Northwest Mall Terminal Option has the least solid waste impacts. Alternative F, along with the Northwest Transit Center Terminal Option, would generate the highest amount of demolition waste. This would be an estimated 300,315 tons of waste. Based on a 25 percent recycling rate as discussed in **Section 3.5.3.2**, the amount of demolition waste that would be disposed at landfills would be 225,235 tons.

Table 3.5-6: Building Demolition Analysis

Segment	Number of Buildings	Area in Square Feet	Demolition Waste (tons)
1	93	734,985	56,961
2A	50	84,939	6,583
2B	68	129,176	10,011
3A	36	95,238	7,381
3B	63	161,322	12,502
3C	142	616,280	47,762
4	120	180,794	14,012
5	274	1,544,407	119,692
Segment 5: Industrial Site Terminal Option	16	574,533	44,526
Segment 5: Northwest Mall Terminal Option	5	618,944	47,968
Segment 5: Northwest Transit Center Terminal Option	27	850,182	65,889

Source: AECOM, 2017.

The total estimate of solid waste that would be generated from construction and demolition activities would be approximately 285,735 tons. Based on the proposed 4-year construction schedule, this would represent 1 percent of the total annual amount disposed in 2014 at the solid waste facilities listed in **Table 3.5-3**. Based on these estimates, there would be sufficient existing landfill capacity to accommodate the projected solid waste generated by the Build Alternatives. Therefore, the impact of the construction of any of the Build Alternatives on landfill capacity would be not significant.

Table 3.5-7: Demolition Waste by Build Alternative (in tons)

ALT A	204,628
ALT B	209,750
ALT C	230,997
ALT D	208,056
ALT E	213,178
ALT F	234,426

Source: AECOM, 2017

3.5.5.2.2 Operational Impacts

Hazardous Materials

The operation and maintenance of the Build Alternatives would involve using and storing hazardous materials and would generate hazardous waste. Hazardous materials could include lubricants, hydraulic fluids and cleaning products used during the routine maintenance of rail vehicles and stations. Wastes that would require disposal could include used oil, used cleaning products, solvents and paint. Most of these hazardous materials and wastes would be used or generated at the TMFs and MOW facilities during maintenance, repair, washing and fueling activities. Therefore, operation and maintenance of the HSR system would involve handling, transporting, generating and disposing of hazardous and solid waste. Based on the type of waste, the waste would be transferred to a landfill or recycling facility and would be disposed of appropriately according to federal, state and local requirements.

Solid Waste

Solid waste would be generated during operations of the Build Alternatives from passenger and employee usage including administrative, security and food service, and would be primarily composed of municipal solid waste type everyday items and food waste. The Build Alternatives would generate approximately 3,450 tons of solid waste per year. This includes waste generated by passengers in the stations and on the train, and by employees at the stations, TMFs, and MOW facilities. The estimated solid waste generated during operation of the Build Alternatives would be approximately 0.05 percent of the total annual amount disposed at the landfills listed in **Table 3.5-3**. Therefore, the operational impacts of the Build Alternatives on existing remaining landfill capacity would be not significant.

3.5.6 Avoidance, Minimization and Mitigation

3.5.6.1 Compliance Measures

The following Compliance Measures (CM) would be required for Build Alternatives A through F:

HM-CM#1: Demolition of Structures. During construction, TCRR or its construction contractor shall be responsible for testing and the removal of lead-based paint, asbestos-containing building materials or PCB-containing equipment prior to demolition, and the transportation to a proper disposal facility in accordance with the regulations in the National Emission Standards for Hazardous Air Pollutants, Occupational Health and Safety Act and Title 25 of Texas Administrative Code. Asbestos regulations are enforced by the Texas Department of State Health Services.

HM-CM#2: Best Management Practices. During construction, TCRR or its construction contractor shall implement best management practices during construction and operation activities to avoid potential impacts to nearby receptors such as dust control, construction safety procedures, equipment stockpiling methods, personal protective equipment and employee training on safe handling of hazardous materials.

3.5.6.2 Mitigation Measures

The following Mitigation Measures (MM) would be required for Build Alternatives A through F:

HM-MM#1: Environmental Site Assessments. Prior to construction, TCRR or its construction contractor shall review available TCEQ files for moderate or high risk sites identified in **Table 3.5.2**. Based on review of soil and groundwater contamination data in TCEQ files TCRR or its construction contractor shall investigate sites using industry standard site assessment processes (Phase I and/or Phase II ESAs) at high- and moderate-risk sites identified in **Table 3.5-2.** Investigation activities shall be targeted at the specific location of planned transportation improvements. Phase I and II assessment can be conducted prior to purchase of the property, but typically owners do not allow pre-purchase inspections, consequently assessment may be performed after the property is purchased. If the results of a Phase I ESA reveal recognized environmental conditions at locations where substantial excavation would occur as part of construction, a Phase II assessment including soil and groundwater sampling shall be performed as necessary at specific locations to identify risk at the location of proposed subsurface excavation (unless sufficient information was obtained from TCEQ files). If the assessments indicate the presence of contaminated soil and/or groundwater that cannot be avoided, the impacted material shall be removed prior to construction or a site-specific waste management plan (H-MM#4) shall be developed. The plan shall be implemented during construction. Waste management shall be implemented in a manner to minimize construction delays while complying with all applicable environmental laws and rules. Where conditions warrant a Phase II ESA, TCRR or its construction contractor shall include the following in the ESAs:

- A work plan that includes the numbers and locations of proposed soil borings/monitoring wells, drilling and sampling methods, analytical methods, sampling rationale and site geohydrology sited in a manner to determine impacts to construction.
- A site-specific health and safety plan.
- Documentation to include field procedures and evaluation of the levels and extent of contaminants found and conclusions and recommendations regarding the condition of the site and the necessary remediation or waste management activities necessary to complete construction.

If the results of a Phase II ESA reveal the need for remediation measures that have high costs or time constraints associated with them, then avoidance of the hazardous materials site might be necessary. Avoidance would be accomplished by modifying the preferred Alternative or selecting a different Alternative.

HM-MM#2: Hazardous Materials Management. Prior to construction, TCRR or its construction contractor shall prepare a Hazardous Materials Management Plan to address the safe handling, use, storage and disposal of hazardous materials used during construction and operation activities. TCRR shall require its construction contractor and any other entities handling hazardous materials during construction and operation activities to adhere to the Hazardous Materials Management Plan. All required local and state permits for installation and operation of fuel/oil storage tanks shall be obtained before installing them. Fuel/oil storage tanks are likely to be installed initially during the construction period and then during the operation period for fueling and maintenance activities at the TMFs and MOW facilities. A Spill Prevention Control and Countermeasure (SPCC) Plan shall be developed for fuel storage tanks that have capacity in excess of 1,320 gallons and that could discharge oil into waters of the U.S., should a spill occur. The PST requirements are enforced by TCEQ.

HM-MM#3: Previously Unidentified Hazardous Materials. Prior to construction, TCRR or its construction contractor shall prepare a hazardous materials contingency plan to address the potential for discovery of unidentified hazardous materials, USTs or hazardous or solid waste. The contingency plan shall also address remediation of accidental damage that might occur during oil/gas wells and pipelines relocation and require that such remediation be conducted prior to continuation of construction activities. TCRR shall require its construction contractor and any other entities handling hazardous materials during construction and operation activities to adhere to the hazardous materials contingency plan. Hazardous materials and solid/hazardous waste regulations are enforced by TCEQ

HM-MM#4: Waste Management. During construction, TCRR or its construction contractor shall handle and dispose of hazardous waste, solid waste and debris encountered or generated during construction and operation activities according to applicable federal, state and local regulations. TCRR or its construction contractor shall prepare a Waste Management Plan to address handling, transporting and disposing of hazardous waste and construction and demolition waste generated during construction and operation activities. The Waste Management Plan shall specify that where practicable, uncontaminated construction and demolition waste would be diverted from landfills by reuse or recycling. Reuse of material may include reuse on the construction project when fill is needed. TCRR shall require its construction contractor and any other entities handling hazardous materials during construction and operation activities to adhere to the Waste Management Plan. Solid and hazardous waste regulations are enforced by TCEQ. Asbestos regulations are enforced by the Texas Department of State Health Services.

HM-MM#5: Removal of PSTs. During construction, TCRR or its construction contractor shall handle the decommissioning of PSTs that will be impacted, in accordance with federal and local regulations including the Resource Conservation and Recovery Act and Title 30 of Texas Administrative Code. The PST regulations are enforced by TCEQ.

3.5.7 Build Alternatives Comparison

Based on this analysis, each of the Build Alternatives could result in ground disturbance at or near a contaminated site that could potentially expose workers or the public to hazardous materials. The distribution of hazardous materials sites among Alternatives A through F and the Houston Terminal Station Options is presented in **Table 3.5-8**. The high-risk sites would be located in Segments 1 and 5, which are common to all Build Alternatives. Alternative C and F would have slightly higher impacts than the other Build Alternatives because of the presence of additional low- and moderate-risk sites within proximity to Segment 3C.

Table 3.5-8: Hazardous Material Sites by Build Alternative and Houston Terminal Station Options

	ALT A	ALT B	ALT C	ALT D	ALT E	ALT F	Industrial Site	Northwest Mall	Northwest Transit Center
Low-Risk Sites	276	277	300	276	277	300	4	0	6
Moderate-Risk Sites	136	136	145	136	136	145	3	3	8
High-Risk Sites	6	6	6	5	5	5	2	0	0
Total Impacts	**418**	**419**	**451**	**417**	**418**	**450**	**9**	**3**	**14**

Source: AECOM, 2017

The hazardous materials sites within the LOD of the Houston Terminal Station options are summarized in **Table 3.5-8**. Two high-risk sites and three moderate-risk sites would be located within the Industrial Site Terminal Station option. Eight moderate-risk sites would be located within the Northwest Transit

Center Terminal Station option. Out of the three station options, the Northwest Mall Terminal Station option has the least hazardous materials site impacts.

This page intentionally left blank.

3.6 Natural Ecological Systems and Protected Species

3.6.1 Introduction

Natural ecological systems include plant and animal species, frequently referred to as natural resources, and the habitats where they occur. This section provides an overview of the natural ecological systems and protected species within the Study Area, which is limited to the LOD for most resources. Some species have an extended Study Area, as defined in **Section 3.6.3, Methodology**. Plants and their associations are referred to as vegetation and animal species are referred to as wildlife. Habitat can be defined as the resources and conditions present in an area that supports the existence of a plant or animal.[1] Although ecological resources are intrinsically valuable, these resources also provide aesthetic, recreational and socioeconomic values to society. This analysis will evaluate potential impacts on ecological resources that are protected under federal or state law or statute including threatened and endangered species. Species may be listed or proposed for listing by the USFWS as threatened or endangered under the Endangered Species Act or as candidate species for listing under the Endangered Species Act. In the State of Texas, the TPWD may designate species of conservation concern as threatened or endangered.

Wetlands and other regulated waters important to many species are discussed in a regulatory context in **Section 3.7.2, Waters of the U.S.**

3.6.2 Regulatory Context

Regulatory compliance requirements vary based on the authorities under which the species has received designation. The regulatory framework pertaining to natural habitats and wildlife includes the following key federal and state laws, regulations and orders.

Federal

Endangered Species Act

Protected species are those plants or animals that, because of their scarcity or documented declining population numbers in the state or nation, have been designated by a federal, state or local governmental agency for protection and/or management. Under the Endangered Species Act (16 U.S.C. § 1531 *et seq.*), the USFWS has the authority to list and monitor the status of species whose populations are threatened or endangered. Endangered species are those species in danger of extinction throughout all or a significant portion of its range. Threatened species are any species likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.[2] USFWS maintains published lists of threatened and endangered wildlife and plant species at 50 C.F.R. § 17.11 and 17.12, respectively. In addition, USFWS has the authority to designate critical habitat.[3] Critical habitats are specific geographic areas that contain features essential for the conservation of a threatened or endangered species and that may require special management and protection. Critical habitat may include areas that are not currently occupied by the species but are needed for its recovery.

[1] Hall, L. S., P. R. Krausman, and M. L. Morrison. "The habitat concept and a plea for standard." *Wildlife Society Bulletin 25*, 1997: 173-182.
[2] 16 U.S.C. § 1532
[3] 16 U.S.C. § 1533(b)(2)

USFWS also maintains a list of candidate species. Candidate species are plant or animal species for which USFWS has sufficient information on file regarding biological vulnerability (or threats) to support a proposal that would list them as endangered or threatened under the Endangered Species Act, but have yet to be listed.[4] Candidate species are provided no statutory protection under the Endangered Species Act.

Endangered Species Act Prohibitions
Section 9 of the Endangered Species Act prohibits the take of any plant or animal species listed as endangered or threatened. Take, as defined by the Endangered Species Act, means "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct."[5] Harm is defined in regulations implementing the Act as "any act that kills or injures the species, including significant habitat modification."[6] This protection also includes a prohibition of indirect take, such as destruction of habitat. Additionally, Section 9 prohibits removing, cutting and maliciously damaging or destroying federally listed plants on sites under federal jurisdiction. The Endangered Species Act and accompanying regulations provide the necessary authority and incentive for individual states to establish their own regulatory vehicle for the management and protection of threatened and endangered species.

Endangered Species Act Authorization Process for Federal Actions
Section 7 of the Endangered Species Act requires that federal agencies consult with the USFWS to ensure that projects they authorize, fund, or carry out would not jeopardize the continued existence of an endangered or threatened species or destroy or adversely modify designated critical habitat.[7] In effect, Section 7 provides a means for the USFWS to authorize the take of threatened and endangered species and their habitat by federal agencies.

Section 7(a)(2) requires that federal agencies review any action they are authorizing, funding or conducting and determine if the action may affect federally listed and proposed species, or proposed or designated critical habitat. If the protected species are present and are likely to be adversely affected the federal agency must complete a Biological Assessment (BA) that identifies the threatened or endangered species that are likely to be affected by the action and consult with the USFWS.

Once formal consultation is concluded, the USFWS then formulates a Biological Opinion (BO) that identifies reasonable and prudent alternatives to the proposed action (if the action may jeopardize the continued existence of a species) or an incidental take statement (if the action would not jeopardize the continued existence of a species). Implementation of the project must comply with the BO.

Critical Habitat
The Endangered Species Act defines critical habitat as specific areas within the geographic area occupied by the species on which are found those physical or biological features essential to the conservation of the species and which may require specific management considerations or protection.[8] Critical habitats are also defined as specific areas outside the geographical area occupied by the species at the time it is listed but a determination has been made that such areas are essential for the conservation of the

[4] Hall, L. S., P. R. Krausman, and M. L. Morrison. "The habitat concept and a plea for standard." *Wildlife Society Bulletin 25*, 1997: 173-182.
[5] 16 U.S.C. § 1532(19)
[6] 50 C.F.R. § 17.3
[7] USFWS. "Consultation Handbook: Procedures for Conducting Consultation and Conference Activities Under Section 7 of the Endangered Species Act." *U.S. Fish and Wildlife Service and National Marine Fisheries Service*, 1998.
[8] 16 U.S.C. § 1532(5)

species. The designation of critical habitat for a listed species helps focus conservation activities by identifying areas that contain essential habitat features regardless of whether or not they are currently occupied by the listed species.

Migratory Bird Treaty Act

The Migratory Bird Treaty Act (MBTA) (16 U.S.C. §§ 703-712), is the domestic law that affirms, or implements, the U.S.' commitment to four international conventions (with Canada, Japan, Mexico and Russia) for the protection of a shared migratory bird resource. Each of the conventions protects selected species of birds that occur in more than one of the countries at some point during their annual life cycle. The MBTA protects migratory birds and their nests, eggs, young and parts from possession, sale, purchase, barter, transport, import, export and take. For purposes of the MBTA, take is defined as "to pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to pursue, hunt, shoot, wound, kill, trap, capture, or collect" (50 CFR § 10.12). The MBTA applies to migratory birds identified in regulation. The MBTA protects all birds occurring in the U.S. except for several nonnative species (e.g., house sparrow, European starlings and rock pigeons) and non-migratory upland game birds. The USFWS implements and enforces the MBTA; is the lead federal agency for managing and conserving migratory birds in the United States; regulates the take of migratory birds for educational, scientific and recreational purposes; and requires that harvests be limited to levels that prevent overutilization. Special Purpose Permits issued under 50 CFR § 2I.27 are required in the event that an action would take, possess or involve the sale or transport of birds protected by the MBTA.

Bald and Golden Eagle Protection Act

The Bald and Golden Eagle Protection Act of 1940, and as amended (16 U.S.C. 668–668d), prohibits anyone without a permit issued by USFWS from "taking" bald or golden eagles including their parts, nests or eggs. The Bald and Golden Eagle Protection Act defines "take" to include "pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest or disturb."[9] Regulations implementing the Bald and Golden Eagle Protection Act define "disturb" to mean "to agitate or bother a bald or golden eagle to a degree that causes, or is likely to cause, based on the best scientific information available, 1) injury to an eagle, 2) a decrease in its productivity, by substantially interfering with normal breeding, feeding or sheltering behavior or 3) nest abandonment, by substantially interfering with normal breeding, feeding or sheltering behavior."[10] The USFWS has a permitting process for activities which may disturb golden eagles or take an eagle nest where their location poses a risk to human or eagle safety. There are two established permit routes regarding Bald and Golden Eagles, a programmatic take permit and an individual take permit. USFWS defines programmatic take as ''take that (1) is recurring, but not caused solely by indirect effects, and (2) occurs over the long term and/or in a location or locations that cannot be specifically identified.'' A programmatic permit covers other take in addition to programmatic take but can be a much longer permitting process compared to individual take permits. An individual take permit would be required for removal of a nest, active or inactive.

Executive Order 13112

EO 13112 on Invasive Species (64 Fed. Reg. 6183) (3 February 1999) requires federal agencies to identify actions that may affect invasive species, use relevant programs to prevent introduction of invasive species; detect, respond and control such species; monitor invasive species populations; provide for

[9] 16 U.S.C. § 668c
[10] 50 C.F.R. § 22.3

restoration of native species; conduct research on invasive species; and promote public education.

Fish and Wildlife Coordination Act

The Fish and Wildlife Coordination Act of 1934 and subsequent amendments, as codified in 16 U.S.C. 661-666(c), protect wildlife when federal actions result in the control or modification of a natural stream or body of water. The act requires federal agencies to consider the effect that water-related projects have on fish and wildlife resources; act to prevent loss or damage to these resources; and provide for the development and improvement of these resources.

Executive Memorandum on Environmentally and Economically Beneficial Landscaping

The Executive Memorandum on Environmentally and Economically Beneficial Landscaping, effective April 26, 1994, encourages environmentally and economically beneficial landscaping practices to be considered at federal facilities and for federally funded projects.

State

TPWD Code - Chapters 67, 68 and 88

Endangered species legislation was passed in Texas in 1973. Subsequently, revisions to the TPWD Code in 1975, 1981 and 1985 established a state regulatory vehicle for the management and protection of threatened and endangered species. Chapters 67 and 68 (1975 revisions) of the TPWD Code authorize the TPWD to formulate lists of threatened and endangered fish and wildlife species and to regulate the taking or possession of those species. A 1981 revision (and 1985 amendment) to this code provides authority for the TPWD to designate and protect plant species as threatened or endangered and to prohibit commercial collection or sale of these species without permits. TPWD is the state enforcing agency for the management and protection of state listed threatened and endangered species. However, as the federal enforcing agency, USFWS has the final authority. The Texas Natural Diversity Database (TXNDD) catalogs, monitors and provides information on rare species and communities of concern.

Texas Administrative Code

The ensuing regulations are Sections 65.171-177 and 69.1-9 of the TAC (Chapters 67, 68 and 88 of the TPWD Code). These sections regulate the taking, possessing, transporting, exporting, processing, selling/offering for sale or shipping of endangered or threatened species of fish, wildlife and plants. Neither specific criteria for the listing of plant and animal species nor protection from indirect take (i.e., destruction of habitat or unfavorable management practices) is found in either of the above-mentioned statutes or regulations. Based on this information, unlike the federally listed species, there is no protection of habitat afforded to species that are only listed by the state. Furthermore, the State of Texas does not have a program in place to permit incidental take of listed or non-listed species; therefore, no state permits are applicable.

3.6.3 Methodology

To assess existing conditions of and potential impacts to natural ecological resources, a Study Area for these resources was developed. For most vegetation, wildlife and protected species, the Study Area is the LOD. However, the Study Area is broader than the LOD for two species: the bald eagle (*Haliaeetus leucocephalus*) and the Houston toad (*Bufo houstonensis*). The Study Area for the bald eagle is 660 feet beyond the LOD, which is based on the sensitivity of bald eagles to nest disturbance and recommendations put forth by the USFWS.[11]

The Study Area for the Houston toad is the LOD for each Build Alternative. However, once precise impacts to water resources are known, the impact calculations may be adjusted. Adjustments would include consideration of any habitat outside the LOD associated with a water source with the potential to be impacted to the extent that it is no longer capable of supporting breeding populations of the toad. This is due to potential upland habitat being associated with distance from water source.[12] Based on recent research, high to medium probability habitat is considered to be 0-330 feet from a water source.[13] Should the water source no longer be viable, then all surrounding potential habitat would be removed, and this can include areas outside the LOD.

Data collection and analysis efforts were completed for vegetation, wildlife and protected species. The methodology applied was generally the same across the three categories; therefore vegetation, wildlife and protected species methodology are addressed together (see **Natural Resources Mapbook, Appendix D**).

A desktop analysis was conducted using publically available data sources to review vegetation types and protected species information within the Study Area. Data sources include:

- USFWS – Environmental Conservation Online System (ECOS), Information for Planning and Conservation (IPaC)
- TPWD – Texas Natural Diversity Database (TXNDD), Rare, Threatened and Endangered Species of Texas by County (RTEST), Ecological Mapping Systems of Texas (EMST)

To evaluate vegetation, wildlife and potential protected species occurrence within the Study Area, GIS data were used to evaluate the Build Alternatives from a landscape perspective by overlaying the LOD with the collected natural resource data.[14, 15] Information such as ecoregions and vegetation communities that preserve natural habitat and protected species were included. Element of Occurrence Records (EORs) as documented in the TXNDD were reviewed.

The TPWD EMST was used to determine vegetation types within the Study Area.[16] The EMST was created to provide an expansive set of land cover classes to allow for better ecological interpretation of the landscape. It is important to note the classification by EMST is a framework and multiple factors influence habitat diversity. This system is meant for generalized guidance and actual conditions and acreages may differ. The mapped EMST vegetation types are also useful in identifying areas that may require further investigation for the potential presence of protected species. These results, based on the stated limitations of the TXNDD, do not mean that there is an absence of other endangered, threatened or rare species and should not be used for presence/absence determinations.

---

[11] USFWS, "National Bald Eagle Management Guidelines." May 2007a. http://www.fws.gov/migratorybirds/CurrentBirdIssues/Management/BaldEagle/NationalBaldEagleManagementGuidelines.pdf (accessed January 28, 2015).
[12] USFWS. Houston toad (*Bufo houstonensis*) 5-year Review: Summary and Evaluation. 2011.
[13] Vandewege et al. Breeding site fidelity and terrestrial movement of an endangered amphibian, the Houston toad (*Bufo houstonensis*). Herpetological Conservation and Biology: 435-446. 2013.
[14] USFWS. *Critical Habitat Portal.* 2015b. http://criticalhabitat.fws.gov/crithab (accessed December 15, 2015).
[15] TPWD. "TPWD County Lists of Protected Species and Species of Greatest Conservation Need." *Wildlife Division, Diversity and Habitat Assessment.* January 15, 2016. http://tpwd.texas.gov/gis/rtest/ (accessed January 15, 2016).
[16] Elliott, Lee F., et al. *Ecological Mapping Systems of Texas: Summary Report.* Austin: Texas Parks and Wildlife Department, 2014.

Habitat fragmentation may occur outside the LOD where existing vegetation remains between parallel developed corridors that becomes isolated from larger blocks. The amount of habitat fragmentation as a result of the Build Alternatives was assessed through a combination of EMST data and aerial imagery in locations where the Build Alternatives parallels developed corridors (See **Table 3.6-19** and **Table 3.6-20**). Perimeter/area ratios also referred to as edge density, defined as the length of all borders between different habitat patch types in an area divided by the total area of the unit, was calculated. Perimeter/area ratios take into account the shape and complexity of habitat patches and is an expression of the spatial heterogeneity of a landscape. As field surveys continue, these corridors of fragmented habitat will be further identified and refined for mapping. These efforts will be completed in conjunction with USFWS and TPWD coordination.

Initial data reviews revealed the potential presence of the federally-listed Houston toad, large-fruited sand verbena (*Abronia macrocarpa*), Navasota ladies'-tresses (*Spiranthes parksii*) and Texas prairie dawn (*Hymenoxys texana*) within the Study Area. GIS was then utilized to create a habitat suitability model to delineate potential habitat for all four species based on the EMST. In addition to EMST, using NRCS data, sandy soils to a depth of 24 inches or greater were included in the model for Houston toads and sandy soils over sandy clay loam soils from the Carrizo Sand, Sparta Sand and Queen City Sand geologic formations were included for large-fruited sand-verbena. The results of the habitat suitability model were then reviewed and compared to recent aerial imagery to eliminate developed areas. Visual surveys for the large-fruited sand verbena were conducted in accordance with the USFWS large-fruited sand verbena protocol using pedestrian methods within areas delineated by the habitat suitability model within the LOD and during peak flowering season, which is March to April.

Furthermore, canopy cover was analyzed for the Houston toad using a custom python script in ArcGIS 10.1 to delineate areas of 70 percent or greater canopy cover. Areas with suitable soils and canopy cover were then ranked from high to very low probability habitat based on distances to water sources using National Hydrography Dataset (NHD) and National Wetlands Inventory (NWI). The data generated by the modeling was then reviewed with aerial imagery and areas of unlikely presence (i.e., large areas with no canopy cover for the Houston toad) were removed from the dataset. Nocturnal surveys have been conducted at 120 points located near ponds and wetlands (85 in Leon County and 35 in Grimes County) located within or directly adjacent to modeled Houston toad habitat up to 3.1 miles from the LOD, as recommended by the USFWS. These surveys were conducted during times when weather parameters were considered optimal, which meant temperatures above 55°F, winds below 15 mph, humidity above 50 percent and a predicted barometric pressure drop. Pressure drops are considered the best predictor of Houston toad activity[17] and likely holds the most weight in combination with temperature and low wind for optimal hearing conditions. However, surveys may be conducted if humidity and pressure are not optimal. The goal of surveying was to record a minimum of 12 optimal nights (all four parameters met). Based on the USFWS verbal recommendations, a total of 20 surveys per observation point were conducted during the toad's active season. Surveys have been completed for the year 2017 and additional surveys are planned for 2018 and 2019.

A GIS model was created for Navasota ladies'-tresses using soils data. For the habitat suitability model, the physical attributes of soil (percent clay versus sand), soil pH, elevation and vegetation type were used to delineate the suitable habitat. With vegetation data acquired from the EMST, areas containing post oak woodlands were extracted and converted to a single raster file. After the creation of all raster

[17] Personal Communication with Mike Forstner

layers, a habitat suitability analysis (HSA) was completed using the weighted sum tool in ArcMap 10.1. The results of the habitat suitability model were then reviewed and compared to recent aerial imagery to eliminate developed areas. Visual surveys for the Navasota ladies'-tresses were conducted in accordance with the USFWS Navasota ladies'-tresses protocol using pedestrian methods within areas delineated by the habitat suitability model within the LOD and during peak flowering season, which is October to November.

Creating a habitat suitability model is difficult for the Texas prairie dawn due to the lack of research regarding the species' habitat requirements.[18] To determine areas of concern for the species, two habitat parameters: soil and vegetation, were considered. With vegetation data acquired from the EMST, areas of urban development were removed from the analysis. Using the NRCS soil data viewer, areas consisting of the Gessner Complex or Katy fine sandy loam soil associations were delineated.[19] Using Arcmap 10.1, the two layers were intersected to delineate areas with a high probability for occurrence. Texas prairie dawn have been known to occur on low sloping portions at the base of mima mounds, which are circular domes or mounds with flat tops, composed of sandy loam soils distinct from surrounding clay soils.[20,21,22] Due to the association between Texas prairie dawn and mima mounds, the LOD was further investigated for the occurrence of these mounds using historical aerial imagery and field investigations.

Consultation with the USFWS by FRA will continue throughout the EIS process. FRA will conduct three years of protected species presence/absence surveys as necessary in accordance with USFWS approved methods. Surveys have been and will be limited to potential listed target species habitat and properties for which right-of-entry has been obtained. If FRA surveys confirm that protected species are not present, formal coordination and the development of a BA would not be required. FRA would continue to informally coordinate with USFWS on appropriate mitigation measures to avoid or minimize impacts to protected species habitat. If FRA confirms the presence of any of the protected species, FRA would initiate formal Section 7 coordination with USFWS, which would include the development of a BA.

3.6.4 Affected Environment

The Study Area encompasses multiple habitat types in 10 counties, covering a linear distance of approximately 240 miles. Habitat conditions vary throughout the Study Area, with some landscapes in mostly natural condition, while others have been highly modified for urban and agricultural purposes.

3.6.4.1 Ecoregions

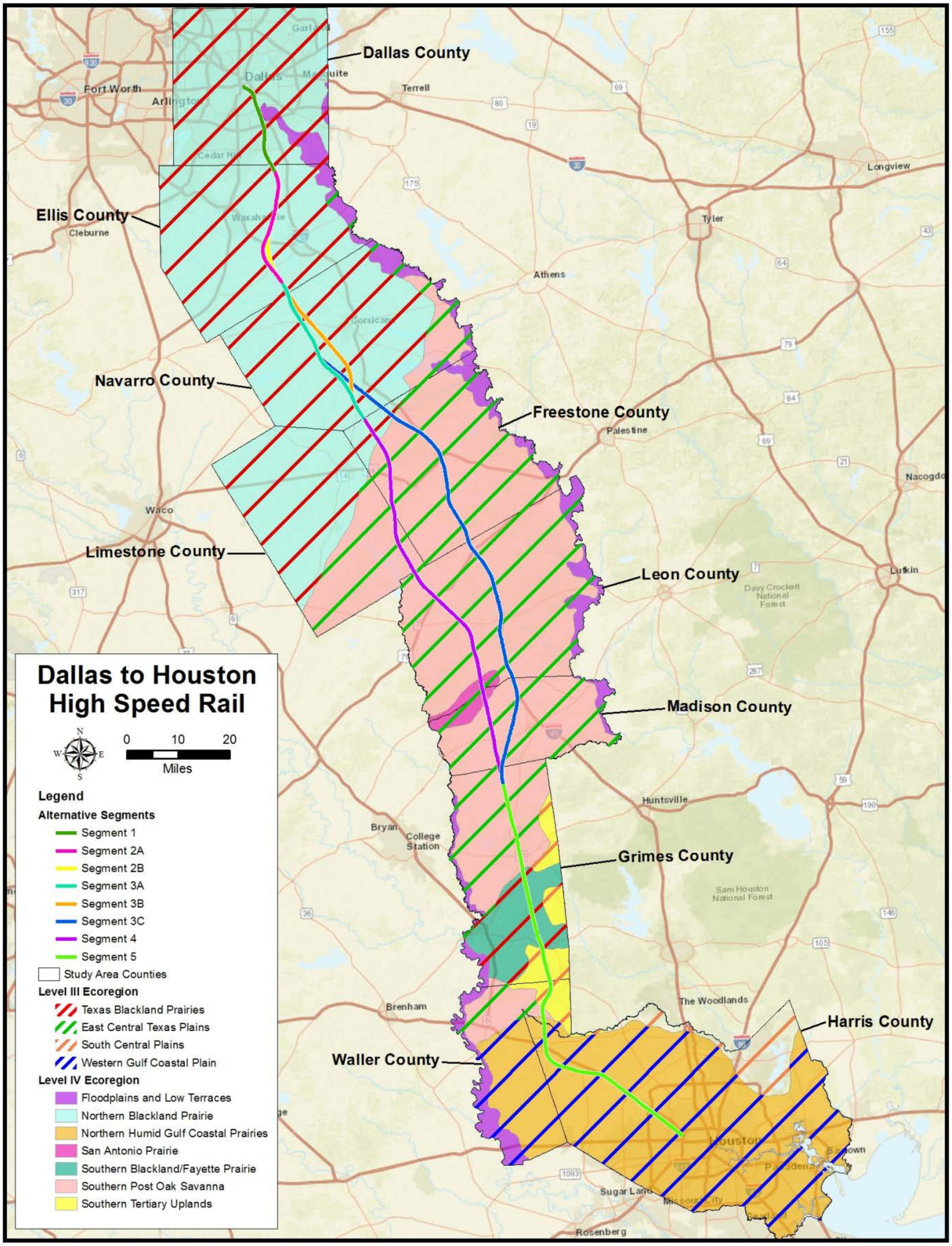
The geographic location of Texas puts it at the convergence of eastern and western habitats, southern subtropical habitats and northern temperate ones.[23] Ecoregions define areas of general similarity in ecosystems and in the type, quality and quantity of environmental resources. They are used to develop biological criteria and were created in a cooperative project between federal and state agencies. The Level I Ecoregion is the coarsest level of definition and divides North America into 15 regions. North

[18] USFWS. Texas prairie dawn (*Hymenoxys texana*) 5-year review. 2015.
[19] Ibid.
[20] Poole, Jackie M., William R Carr, Dana M. Price and Jason R. Singhurst. 2007. *Rare Plants of Texas*. College Station, Texas: Texas A&M University Press.
[21] USFWS. *Hymonoxys texana* Recovery Plan." Albuquerque, New Mexico: U.S. Fish and Wildlife Service, 1990.
[22] USFWS. Texas prairie dawn (*Hymenoxys texana*) 5-year review. 2015.
[23] TPWD. 2016. https://tpwd.texas.gov/education/hunter-education/online-course/wildlife-conservation/texas-ecoregions (accessed January 25, 2016)

America is then refined to Level II resulting in 50 ecoregions. Additional refinement to Level III results in 104 ecoregions, 12 of which are defined in Texas. Many states, including Texas, found the Level III resolution did not meet their needs and this resulted in a collaborative effort for further refinement with 56 Level IV ecoregions being mapped for Texas. The Study Area falls within 4 of the 12 Level III ecoregions and 7 of the 56 Level IV ecoregions (see **Figure 3.6-1**). Vegetation descriptions provided for ecoregion levels apply regionally;[24] therefore, the descriptions provided may also apply to locations outside the Study Area boundary. Multiple ecoregions may be present in each county and pertain to different segments of the Build Alternatives (**Table 3.6-1**).

[24] Griffith, Glenn E., Sandra A. Bryce, James M. Omerik, and Anne C. Rogers. *Ecoregions of Texas.* Austin: Texas Commission on Environmental Quality, 2007.

Figure 3.6-1: Ecoregions within the Study Area



Source: AECOM, 2017

Table 3.6-1: Ecoregions within the Study Area			
County	**Segment**	**Level III Ecoregion**	**Level IV Ecoregion**
Dallas	1	Texas Blackland Prairies	Floodplains and Low Terraces
			Northern Blackland Prairie
Ellis	1	Texas Blackland Prairies	Northern Blackland Prairie
	2A	Texas Blackland Prairies	Northern Blackland Prairie
	2B	Texas Blackland Prairies	Northern Blackland Prairie
	3A	Texas Blackland Prairies	Northern Blackland Prairie
	3B	Texas Blackland Prairies	Northern Blackland Prairie
	3C	Texas Blackland Prairies	Northern Blackland Prairie
Navarro	3A	Texas Blackland Prairies	Northern Blackland Prairie
	3B	Texas Blackland Prairies	Northern Blackland Prairie
	3C	Texas Blackland Prairies	Northern Blackland Prairie
Freestone	3A	Texas Blackland Prairies	Northern Blackland Prairie
	3B	Texas Blackland Prairies	Northern Blackland Prairie
	3C	East Central Texas Plains	Southern Post Oak Savanna
		Texas Blackland Prairies	Northern Blackland Prairie
	4	East Central Texas Plains	Southern Post Oak Savanna
		Texas Blackland Prairies	Northern Blackland Prairie
Limestone	4	East Central Texas Plains	Southern Post Oak Savanna
Leon	3C	East Central Texas Plains	Southern Post Oak Savanna
	4	East Central Texas Plains	San Antonio Prairie
			Southern Post Oak Savanna
Madison	3C	East Central Texas Plains	Southern Post Oak Savanna
	4	East Central Texas Plains	San Antonio Prairie
			Southern Post Oak Savanna
Grimes	3C	East Central Texas Plains	Southern Post Oak Savanna
	4	East Central Texas Plains	Southern Post Oak Savanna
	5	East Central Texas Plains	Southern Post Oak Savanna
		South Central Plains	Southern Tertiary Uplands
		Texas Blackland Prairies	Southern Blackland/Fayette Prairie
Waller	5	East Central Texas Plains	Southern Post Oak Savanna
		South Central Plains	Southern Tertiary Uplands
		Western Gulf Coastal Plain	Northern Humid Gulf Coastal Prairie
Harris	5	Western Gulf Coastal Plain	Northern Humid Gulf Coastal Prairie

Source: Griffith et al, 2007

The Level III and Level IV ecoregions are described below.

3.6.4.1.1 Eastern Central Texas Plains Level III Ecoregion

Historically, vegetative cover of the East Central Texas Plains Level III Ecoregion was predominantly post oak (*Quercus stellata*) savanna when compared to the open prairie regions to the north, south and west and the pine forests in the east. Much of the underlying region has a thick clay pan which alters water movement and moisture for plant growth. Today, the majority of the region is utilized for pasture and range.[25]

Within the Study Area, there are two Level IV ecoregions within the East Central Texas Plains Level III Ecoregion: San Antonio Prairie and Southern Post Oak Savanna.

[25] Griffith, Glenn E., Sandra A. Bryce, James M. Omerik, and Anne C. Rogers. *Ecoregions of Texas.* Austin: Texas Commission on Environmental Quality, 2007.

San Antonio Prairie Level IV Ecoregion - The San Antonio Prairie Level IV Ecoregion is named for the belt of blackland prairie running northeast to southwest along both sides of State Highway – Old San Antonio Road (SH OSR). It is described as treeless grassland within a post oak savanna. This area attracted settlement and crops such as cotton (*Gossypium* sp.), corn (*Zea mays*) and small grains were frequently grown in this ecoregion. Today, it is a mosaic of woodland, improved pasture, rangeland and some cropland. Typical vegetation includes little bluestem (*Schizachyrium scoparium*), yellow Indiangrass (*Sorghastrum nutans)*, switchgrass (*Panicum virgatum*), purpletop (*Tridens flavus*), sunflowers (*Helianthus* spp.), coreopsis (*Coreopsis* spp.), goldenrods (*Solidago* spp.) and phloxes (*Phlox* spp.).[26]

Southern Post Oak Savanna Level IV Ecoregion - The landscape of the Southern Post Oak Savanna Level IV Ecoregion is comprised of woods and forest primarily consisting of hardwoods. Post oak savannas historically occurred as the dominant land cover in this ecoregion. Today, post oak woods, pasture and rangeland make up the region, as well as some invasive mesquite (*Prosopis* sp.) regions to the south. Other areas also consist of yaupon (*Ilex* sp.) and eastern redcedar (*Juniperus virginiana*). Soils are mostly acidic with sand and sandy loam surface textures. However, clay and clay loams are found in low areas. A thick clay pan underlies all soils in the region. Characteristic vegetation of the region includes oak savannas or oak-hickory forest consisting of post oak, blackjack oak (*Q. marilandica*), black hickory (*Carya texana*) interspersed with grasses like little bluestem, purpletop, curly threeawn (*Aristida desmantha*) and yellow Indiangrass. Yaupon, eastern red cedar, winged elm (*Ulmus alata*), American beautyberry (*Callicarpa americana*) and farkleberry (*Vaccinium arboreum*) are the dominant understory species.[27]

3.6.4.1.2 South Central Plains Level III Ecoregion

The South Central Plains Level III Ecoregion, also known as the piney woods, occurs at the western boundary of the southern coniferous forest belt. Today, it consists of mostly loblolly pine (*Pinus taeda*) and shortleaf pine (*P. echinata*) plantations. Historically, it was a mix of pine and hardwood forest. The soils of this region are typically acidic sands and sandy loams. Within the Study Area, there is one Level IV ecoregion within the South Central Plains Level III Ecoregion: Southern Tertiary Uplands.

Southern Tertiary Uplands Level IV - The Southern Tertiary Uplands Level IV Ecoregion within this Level III Ecoregion represents the remaining longleaf pine range north of the Flatwoods. Historical vegetation types consisted of longleaf pine-bluestem woodlands as the dominate type with a variety of other forest types present. Today, it is comprised mostly of pine forest and pasture land instead of oak-pine forest. This ecoregion is also known for bogs with pitcher plants and orchids (*Orchis* spp.).[28]

3.6.4.1.3 Texas Blackland Prairies Level III Ecoregion

The Texas Blackland Prairies Level III Ecoregion is distinguished from surrounding regions by predominantly prairie vegetation and is named for the deep, fertile black soils that characterize the area. The prairie soils support grasses including little bluestem, big bluestem (*Andropogon gerardii*), yellow Indiangrass and switchgrass. This region now contains a higher percentage of cropland than

[26] Griffith, Glenn E., Sandra A. Bryce, James M. Omerik, and Anne C. Rogers. *Ecoregions of Texas.* Austin: Texas Commission on Environmental Quality, 2007.
[27] Ibid.
[28] Ibid.

adjacent regions; pasture and forage production for livestock is common. Large areas of the region have been converted to urban and industrial uses.[29]

Within the Study Area, there are three Level IV ecoregions within the Texas Blackland Prairies Level III Ecoregion: Northern Blackland Prairie, Southern Blackland Prairie and Floodplains and Low Terraces.

Northern Blackland Prairie Level IV Ecoregion - The Northern Blackland Prairie Level IV Ecoregion was historically a vast expanse of tallgrass prairie. Frequent fire and grazing suppressed woody species. The region was dominated by little bluestem, big bluestem, yellow Indiangrass and tall dropseed (*Sporobolus compositus*). While a few small remnants of grassland remain, virtually all of the native Blackland Prairie communities are gone.[30]

Southern Blackland Prairie Level IV Ecoregion - The Southern Blackland Prairie Level IV Ecoregion, also known as the Fayette Prairie, hosts less extensive areas of cropland than surrounding regions and land cover is a more complex mosaic with more post oak woods and pasture. Historically, this is tall grass prairie with big bluestem, brownseed paspalum, little bluestem, yellow Indiangrass and tall dropseed. Forbs present include prairie bluet (*Coenagrion angulatum*) and black-eyed susan (*Rudbeckia hirta*) and riparian forests contain bur oak (*Q. macrocarpa*), Shumard oak (*Q. shumardii*), sugar hackberry (*Celtis laevigata*), elm (*Ulmus spp*.), ash (*Fraxinus spp*.), eastern cottonwood (*Populus deltoides*) and pecan (*Carya illinoinensis*). Small knolls and shallow depressions present as a result of the clay soils can influence the composition of plant communities.[31]

Floodplains and Low Terraces Level IV Ecoregion - The Floodplains and Low Terraces Level IV Ecoregion of the Texas Blackland Prairies includes only the broadest floodplains, i.e., those of the Trinity, Brazos and Colorado rivers. As these main stem rivers cross the Level III ecoregions, however, the surrounding characteristics can be quite different from region to region. The bottomland forests contained bur oak, Shumard oak, sugar hackberry, elm, ash, eastern cottonwood and pecan, but most have been converted to cropland and pasture. The remaining fragments of riverine forest provide some habitat for deer (various species), squirrels (*Sciurus* spp.), common raccoon (*Procyon lotor*), common gray fox (*Urocyon cinereoargenteus*), red fox (*Vulpes vulpes*), Virginia opossum (*Didelphis virginiana*) and a variety of birds.[32]

3.6.4.1.4 Western Gulf Coastal Plain Level III Ecoregion

The Western Gulf Coastal Plain Level III Ecoregion is relatively flat, generally 50 to 90 miles wide and adjacent to the Gulf of Mexico. The principal distinguishing characteristics of this ecoregion are its relatively flat topography and natural vegetation of mainly grassland. Inland from this region the plains are older, more irregular and have mostly forest or savanna-type vegetation. Largely because of these characteristics, a higher percentage of the land is in cropland than in bordering ecological regions. Rice (*Oryza sativa*), grain sorghum (*Sorghum* spp.), cotton and soybeans (*Glycine max*) are the principal crops. Urban and industrial land uses have expanded greatly in recent decades, and oil and gas

[29] Griffith, Glenn E., Sandra A. Bryce, James M. Omerik, and Anne C. Rogers. *Ecoregions of Texas.* Austin: Texas Commission on Environmental Quality, 2007..
[30] Ibid.
[31] Ibid.
[32] Ibid.

production is common.[33] Within the Study Area, there is one Level IV ecoregion: Northern Humid Gulf Coastal Prairie.

> **Northern Humid Gulf Coastal Prairie Level IV Ecoregion -** Within the prairies on the gently sloping, mostly flat, coastal plains, the Northern Humid Gulf Coastal Prairie Level IV Ecoregion exhibits generally poor drainage and soils that remain wet for parts of the year. The historical vegetation was mostly tallgrass grasslands with a few clusters of oaks, known as oak mottes or maritime woodlands. Little bluestem, yellow Indiangrass, brownseed paspalum, gulf muhly (*Muhlenbergia capillaris*) and switchgrass were the dominant grassland species in a mixture with hundreds of other herbaceous species across these prairies. These coastal prairies had some similarities to the grasslands of the Texas Blackland Prairies. Some post oak savannas occurred along the boundary where coastal prairie and inland savannas intergrade. Some loblolly pine occurs in the northern part of the region. Riparian area vegetation begins a change from the north part of the region, where it is generally similar to the floodplain forests to the northeast. To the south, fewer bottomland oaks and hickories are present and pecan, sugar hackberry, ash, southern live oak (*Q. virginiana*) and cedar elm (*U. crassifolia*) become the important overstory species. Cane brakes (*Arundinaria gigantea*) may also have occurred along some creeks and rivers in this region.[34]

3.6.4.2 Vegetation

The vegetation types of the Study Area as defined by the EMST were evaluated over the entirety of the LOD including all counties and segments. Of the 47 vegetation types present, four types comprise 70 percent or the total LOD acreage. The four main vegetation types are as follows:

- Blackland Prairie: Disturbance or Tame Grassland – these grasslands are assumed to consist primarily of disturbance or non-native grasses as very little intact Blackland prairie remains. Non-native grasses such as bermudagrass (*Cynodon dactylon*) and Johnsongrass (*Sorghum halepense*) are common. Native grasses present may include little bluestem, Indiangrass and hairy grama (*Bouteloua hirsuta*). Other species generally present include common broomweed (*Amphiachyris dracunculoides*), honey mesquite (*P. glandulosa)* and huisache (*Vachellia farnesiana*). Blackland Prairie: Disturbance or Tame Grassland comprises approximately 18 percent of the Study Area.

- Post Oak Savanna: Post Oak Motte and Woodland – This vegetation type generally represents a deciduous woodland component. The typical occurrence is dominated by post oak, with blackjack oak. Black hickory may be a significant component of the overstory, particularly on deep sands. The shrub layer includes species such as American beautyberry, possumhaw (*Ilex decidua*), yaupon (*Ilex vomitoria*), gum bumelia (*Sideroxylon lanuginosum*), saw greenbrier (*Smilax bona-nox*), coral berry (*Symphoricarpos orbiculatus*), farkleberry and Hercules' club (*Zanthoxylum clava-herculis*). Herbaceous components are often represented by components of the surrounding prairies. Post Oak Savanna: Post Oak Motte and Woodland comprises approximately 12 percent of the Study Area.

[33] Griffith, Glenn E., Sandra A. Bryce, James M. Omerik, and Anne C. Rogers. *Ecoregions of Texas.* Austin: Texas Commission on Environmental Quality, 2007..
[34] Ibid.

- Post Oak Savanna: Savanna Grassland – This vegetation type represents the herbaceous expression of the overall system, which is a mosaic of woody and herbaceous cover types as suggested by reference to a savanna. These grasslands are often dominated by mid- and tallgrass species often present in the understory. Dominant species include little bluestem, Indiangrass and switchgrass. Post Oak Savanna: Savanna Grassland comprises approximately 24 percent of the Study Area.

- Row Crops – this includes all cropland where fields are fallow for some portion of the year. Crops that are present year-round are generally mapped as grassland. Row crops comprise approximately 16 percent of the Study Area.

Table 3.6-2, below, presents the EMST vegetation types found within the Study Area by county and segment. The EMST Code, presented with each specific vegetation type in the table, is the unique number assigned by TPWD.

Table 3.6-2: Vegetation Types within the Study Area (acres)

Vegetation Types (EMST Code)	Dallas	Ellis						Navarro			Freestone				Limestone	Leon		Madison		Grimes			Waller	Harris			
Segment	**1**	**1**	**2A**	**2B**	**3A**	**3B**	**3C**	**3A**	**3B**	**3C**	**3A**	**3B**	**3C**	**4**	**4**	**3C**	**4**	**3C**	**4**	**3C**	**4**	**5**	**5**	**5**	**Industrial Site Terminal**	**NW Mall Terminal**	**NW Transit Center Terminal**
Blackland Prairie: Disturbance or Tame Grassland (207)	133	11	361	296	3	8	3	575	660	605	1	1	35	202	--	17	11	--	--	--	--	238	1	--	--	--	--
Post Oak Savanna: Live Oak Motte and Woodland (602)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	12	--	--	--
Post Oak Savanna: Post Oak - Redcedar Motte and Woodland (603)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--	1	--	--	--
Post Oak Savanna: Post Oak Motte and Woodland (604)	5	--	--	--	--	--	--	54	79	55	--	--	344	205	82	396	431	55	104	28	16	254	45	3	--	--	--
Post Oak Savanna: Savanna Grassland (607)	--	--	--	--	--	--	--	17	44	9	--	--	498	366	235	678	604	438	563	51	36	566	5	--	--	--	--
Post Oak Savanna: Post Oak - Yaupon Motte and Woodland (613)	--	--	--	--	--	--	--	4	--	3	--	--	10	14	1	3	1	1	4	--	--	10	--	--	--	--	--
Post Oak Savanna:	--	--	--	--	--	--	--	--	--	--	--	--	1	15	--	8	17	--	--	--	--	--	--	--	--	--	--

Table 3.6-2: Vegetation Types within the Study Area (acres)

Vegetation Types (EMST Code)	Dallas	Ellis						Navarro			Freestone				Limestone	Leon		Madison		Grimes			Waller	Harris			
Segment	**1**	**1**	**2A**	**2B**	**3A**	**3B**	**3C**	**3A**	**3B**	**3C**	**3A**	**3B**	**3C**	**4**	**4**	**3C**	**4**	**3C**	**4**	**3C**	**4**	**5**	**5**	**5**	**Industrial Site Terminal**	**NW Mall Terminal**	**NW Transit Center Terminal**
Sandyland Woodland and Shrubland (706)																											
Post Oak Savanna: Sandyland Grassland (707)	--	--	--	--	--	--	--	--	--	--	--	--	1	1	--	14	13	--	--	--	--	--	--	--	--	--	--
Edwards Plateau: Oak / Hardwood Slope Forest (904)	--	--	1	--	--	--	--	1	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Edwards Plateau: Live Oak Motte and Woodland (1102)	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Edwards Plateau: Deciduous Oak / Evergreen Motte and Woodland (1103)	11	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Edwards Plateau: Oak / Hardwood Motte and Woodland - (1104)	34	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Edwards Plateau:	24	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Table 3.6-2: Vegetation Types within the Study Area (acres)

Vegetation Types (EMST Code)	Dallas	Ellis						Navarro			Freestone				Limestone	Leon		Madison		Grimes			Waller	Harris			
Segment	**1**	**1**	**2A**	**2B**	**3A**	**3B**	**3C**	**3A**	**3B**	**3C**	**3A**	**3B**	**3C**	**4**	**4**	**3C**	**4**	**3C**	**4**	**3C**	**4**	**5**	**5**	**5**	**Industrial Site Terminal**	**NW Mall Terminal**	**NW Transit Center Terminal**
Savanna Grassland (1107)																											
Central Texas: Floodplain Live Oak Forest (1802)	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Central Texas: Floodplain Hardwood / Evergreen Forest (1803)	3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Central Texas: Floodplain Hardwood Forest (1804)	71	1	21	25	--	--	--	13	19	36	--	--	74	49	16	28	21	--	--	--	--	15	--	--	--	--	--
Central Texas: Floodplain Deciduous Shrubland (1806)	1	--	--	--	--	--	--	2	2	1	--	--	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--
Central Texas: Floodplain Herbaceous Vegetation (1807)	9	--	7	9	--	--	--	60	46	70	--	--	32	77	12	44	15	--	--	--	--	10	--	--	--	--	--
Central Texas: Floodplain Seasonally	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Table 3.6-2: Vegetation Types within the Study Area (acres)

Vegetation Types (EMST Code)	**Dallas**	**Ellis**						**Navarro**			**Freestone**				**Limestone**	**Leon**		**Madison**		**Grimes**			**Waller**	**Harris**			
Segment	**1**	**1**	**2A**	**2B**	**3A**	**3B**	**3C**	**3A**	**3B**	**3C**	**3A**	**3B**	**3C**	**4**	**4**	**3C**	**4**	**3C**	**4**	**3C**	**4**	**5**	**5**	**5**	**Industrial Site Terminal**	**NW Mall Terminal**	**NW Transit Center Terminal**
Flooded Hardwood Forest (1814)																											
Central Texas: Riparian Hardwood / Evergreen Forest (1903)	--	--	--	--	--	--	--	1	--	1	--	--	1	--	--	--	--	--	--	--	--	2	--	--	--	--	--
Central Texas: Riparian Hardwood Forest (1904)	3	--	9	10	1	1	1	4	5	4	--	--	1	5	6	--	7	--	--	--	--	4	--	--	--	--	--
Central Texas: Riparian Deciduous Shrubland (1906)	--	--	1	--	--	--	--	--	--	--	--	--	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--
Central Texas: Riparian Herbaceous Vegetation (1907)	1	--	7	9	--	--	--	6	13	6	--	--	4	7	2	2	5	--	--	--	--	10	--	--	--	--	--
Pineywoods : Pine Forest or Plantation (3001)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	7	--	--	--	--	--	101	48	--	--	--	--
Pineywoods : Pine - Hardwood	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	35	12	--	--	--	--

Table 3.6-2: Vegetation Types within the Study Area (acres)

Vegetation Types (EMST Code)	Dallas	Ellis						Navarro			Freestone				Limestone	Leon		Madison		Grimes			Waller	Harris			
Segment	**1**	**1**	**2A**	**2B**	**3A**	**3B**	**3C**	**3A**	**3B**	**3C**	**3A**	**3B**	**3C**	**4**	**4**	**3C**	**4**	**3C**	**4**	**3C**	**4**	**5**	**5**	**5**	**Industrial Site Terminal**	**NW Mall Terminal**	**NW Transit Center Terminal**
Forest or Plantation (3003)																											
Pineywoods: Upland Hardwood Forest (3004)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	164	58	--	--	--	--
Pineywoods: Small Stream and Riparian Temporarily Flooded Mixed Forest (4803)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2	--	--	--	--	--
Pineywoods: Small Stream and Riparian Temporarily Flooded Hardwood Forest (4804)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3	42	41	4	19	31	9	2	--	--	--
Pineywoods: Small Stream and Riparian Seasonally Flooded Hardwood Forest (4814)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--
Pineywoods: Small Stream and	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	26	8	7	9	39	2	--	--	--	--

Table 3.6-2: Vegetation Types within the Study Area (acres)

Vegetation Types (EMST Code)	Dallas	Ellis						Navarro			Freestone				Limestone	Leon		Madison		Grimes			Waller	Harris			
Segment	**1**	**1**	**2A**	**2B**	**3A**	**3B**	**3C**	**3A**	**3B**	**3C**	**3A**	**3B**	**3C**	**4**	**4**	**3C**	**4**	**3C**	**4**	**3C**	**4**	**5**	**5**	**5**	**Industrial Site Terminal**	**NW Mall Terminal**	**NW Transit Center Terminal**
Riparian Wet Prairie (4817)																											
Gulf Coast: Coastal Prairie (5207)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	103	851	--	--	--
Gulf Coast: Coastal Prairie Pondshore (5307)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	9	--	--	--
Barren (9000)	--	--	--	--	--	--	--	--	--	--	--	--	6	--	3	1	5	--	--	--	--	--	--	1	<0.01	3	6
Swamp (9004)	1	--	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Marsh (9007)	--	--	--	--	--	--	--	1	--	1	--	--	--	--	--	1	--	1	--	--	--	1	--	1	--	--	--
Native Invasive: Juniper Woodland (9101)	1	--	--	--	--	--	--	3	--	2	--	--	25	23	--	2	--	--	5	--	--	--	--	--	--	--	--
Native Invasive: Deciduous Woodland (9104)	107	2	45	68	3	3	3	84	31	66	--	--	4	3	--	--	4	--	--	--	--	19	1	25	--	--	--
Native Invasive: Juniper Shrubland (9105)	4	--	--	1	--	--	--	--	--	--	--	--	--	--	--	10	--	--	--	--	--	--	--	--	--	--	--
Native Invasive: Mesquite Shrubland (9106)	13	--	5	1	--	--	--	20	15	24	--	--	11	9	--	--	--	--	--	--	--	2	--	1	--	--	--
Native	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	30	--	--	--

Table 3.6-2: Vegetation Types within the Study Area (acres)

Vegetation Types (EMST Code)	Dallas	Ellis						Navarro			Freestone				Limestone	Leon		Madison		Grimes			Waller	Harris			
Segment	1	1	2A	2B	3A	3B	3C	3A	3B	3C	3A	3B	3C	4	4	3C	4	3C	4	3C	4	5	5	5	Industrial Site Terminal	NW Mall Terminal	NW Transit Center Terminal
Invasive: Huisache Woodland or Shrubland (9124)																											
Native Invasive: Deciduous Shrubland (9126)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	2	--	--	--	--
Pineywoods: Disturbance or Tame (9197)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	342	20	--	1	--	--
Pine Plantation > 3 meters tall (9301)*	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	6	--	--	--
Row Crops (9307)*	309	8	511	531	112	110	112	290	287	260	--	--	--	--	--	--	1	--	--	--	--	--	1	241	--	--	--
Grass Farm (9317)*	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Urban High Intensity (9410)	117	--	--	--	--	--	--	--	5	--	--	--	190	--	1	76	2	36	--	--	--	3	--	114	88	77	80
Urban Low Intensity (9411)	150	2	7	8	--	--	--	11	28	11	--	--	129	16	1	85	6	3	2	--	--	13	1	103	9	1	1
Open Water (9600)	6	--	2	1	--	--	--	1	2	--	--	--	1	--	1	1	2	1	--	--	--	1	--	1	--	--	--

Source: TPWD, 2014
"—" Vegetation type not present, * Are considered agricultural types

3.6.4.2.1 <u>Commercially or Recreationally Important Plant Species</u>

Commercially or recreationally important plant species are defined as those that (a) are commercially or recreationally valuable; (b) are endangered or threatened; (c) affect the well-being of some important species within criterion (a) or (b); and (d) are critical to the structure and function of the ecological system or are biological indicators. According to the soil surveys for each county in the Study Area, commercially important vegetation species within the Study Area include corn, oats (*Avena sp*.), grain sorghum, soybeans, wheat (*Triticum sp*.), cotton, peanuts (*Arachis hypogaea*), sweet potatoes (*Ipomoea batatas*) and watermelons (*Citrullus lanatus*). Other commercially important species potentially in the Study Area include loblolly pine and slash pine (*P. elliottii*) grown at pine plantations for lumber and other pines such as Afghan pine (*P. brutia* var. *eldarica*), as well as Virginia pine (*P. virginiana*) and eastern red cedar, grown at Christmas tree farms.

Within the Study Area, three of the identified vegetation types are considered agricultural within the EMST: grass farm (9317), pine plantation greater than 9 feet (9301) and row crops (9307). While there are other vegetation types within the EMST system that contain “plantation” in the name, the classification does not differentiate between managed forests, unmanaged forests or plantations in more mature stands.[35] **Tables 3.6-2** detailed the acreages of these vegetation types within the Study Area. Approximately 15 percent of the Study Area is comprised of commercially or recreationally important plant species.

3.6.4.3 Wildlife

Wildlife includes all vertebrate animal species, with the exception of those identified as protected species. As many of these species are common and likely to exist throughout the Study Area (i.e., are not confined by political boundaries), this discussion encompasses all Study Areas and is divided into the following wildlife categories: amphibians and reptiles, fish, mammals and birds. **Tables 3.6-3** thru **3.6-6** present the most common species within each category and their potential occurrence within the Study Area counties and segments. It is important to note that these tables are not all-inclusive for wildlife species that may potentially occur in the Study Area.

3.6.4.3.1 <u>Amphibians and Reptiles</u>

The Study Area primarily lies within the Texan Biotic Province, straddling the border with the Austroriparian Biotic Province in the southern portion.[36] Less than 2 percent of the Study Area occurs within the Austroriparian Biotic Province, primarily in the Houston area which is likely no longer representative of the biotic province due to high urbanization. Therefore only the Texan Biotic Province is referred to for this assessment.

Blair, 1957, recognized 16 lizard species, 39 snake species, 18 anuran species (frogs and toads), two land turtles, five species of salamanders and newts and 49 species of mammals within the Texan Biotic Province; however, these numbers have likely considerably changed due to taxonomic revisions over the last half-century. Common vertebrate species with the potential to inhabit the Study Area (based on ranges that intersect the Study Area and their potential occurrence in relation to dominant EMST vegetation types) are discussed below. **Table 3.6-3** lists some of the most common species, organized by family. Most of the lizards and snakes in the Study Area are likely to occur in all five of the most common

---

[35] TPWD, Elliott, Lee F., et al. *Ecological Mapping Systems of Texas: Summary Report.* Austin: Texas Parks and Wildlife Department, 2014.
[36] Blair, W. Frank. "The Biotic Provinces of Texas." *Texas Journal of Science*, 1957: 93-117.

vegetation types within the Study Area.[37] However, water snakes (*Nerodia* spp.) and the cottonmouth (*Agkistrodon piscivorus*) tend to occur in habitats near water,[38] and are more commonly found in the Central Texas: Floodplain Hardwood Forest, Central Texas: Floodplain Herbaceous Vegetation and Pineywoods: Small Stream and Riparian Temporarily Flooded Hardwood Forest, as well as any other vegetation type that occurs near a water source. The salamanders, frogs and toads, alligator and turtle species are mostly associated with water sources, as well. Therefore, these species are most commonly found in the Central Texas: Floodplain Hardwood Forest, Central Texas: Floodplain Herbaceous Vegetation and Pineywoods: Small Stream and Riparian Temporarily Flooded Hardwood Forest, as well as any other vegetation type that occurs near a water source (**Table 3.6-3**).[39]

[37] Dixon, James R. *Amphibians and Reptiles of Texas.* College Station: Texas A&M University Press, 2013.
[38] Werler, John E., and James R. Dixon. *Texas Snakes.* Austin: University of Texas Press, 2000.
[39] Dixon, James R. *Amphibians and Reptiles of Texas.* College Station: Texas A&M University Press, 2013.

Table 3.6-3: Reptile and Amphibian Species with Potential to Occur within the Study Area

Common Name	Scientific Name	Dallas	Ellis		Navarro			Freestone		Limestone	Leon		Madison		Grimes			Waller	Harris
		1	2A	2B	3A	3B	3C	3C	4	4	3C	4	3C	4	3C	4	5	5	5
Salamanders																			
Small-mouthed salamander	*Ambystoma texanum*	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Frogs and Toads																			
Hurter's spadefoot	*Scaphiopus hurterii*	●	○	○	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Blanchard's cricket frog	*Acris blanchardi*	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Gray treefrog	*Hyla versicolor*	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Green treefrog	*Hyla cinerea*	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Spring peeper	*Pseudacris crucifer*	○	○	○	○	○	○	●	●	○	●	●	●	●	○	○	○	○	●
Gulf Coast toad	*Bufo nebulifer*	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Bullfrog	*Rana catesbeiana*	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Southern leopard frog	*Rana sphenocephala*	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Eastern narrow-mouthed toad	*Gastrophryne carolinensis*	●	○	○	○	○	○	●	●	●	●	●	●	●	●	●	●	●	●
Crocodiles																			
American alligator	*Alligator mississippiensis*	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Turtles																			
Texas cooter	*Pseudemys texana*	○	○	○	○	○	○	○	○	●	●	●	○	○	●	●	●	○	○
Eastern box turtle	*Terrapene carolina*	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Ornate box turtle	*Terrapene ornata*	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Pond slider	*Trachemys scripta*	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Lizards																			
Prairie lizard	*Sceloporus consobrina*	●	○	○	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Texas spiny lizard	*Sceloporus olivaceus*	●	●	●	●	●	●	○	○	●	○	○	○	○	○	○	○	●	●
Green anole	*Anolis carolinensis*	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Common five-lined skink	*Eumeces (Plestiodon) fasciatus*	●	●	●	●	●	●	●	●	●	●	●	●	●	○	○	○	●	●
Little brown skink	*Scincella lateralis*	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Eastern six-lined racerunner	*Cnemidophorus sexlineatus*	●	●	●	●	●	●	○	○	●	●	●	●	●	●	●	●	●	●
Snakes																			

Table 3.6-3: Reptile and Amphibian Species with Potential to Occur within the Study Area

Common Name	Scientific Name	Dallas	Ellis		Navarro			Freestone		Limestone	Leon		Madison		Grimes			Waller	Harris
		1	2A	2B	3A	3B	3C	3C	4	4	3C	4	3C	4	3C	4	5	5	5
Texas ratsnake	*Elaphe (Pantherophis) obsoleta*	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Eastern hog-nosed snake	*Heterodon platirhinos*	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Common kingsnake	*Lampropeltis getula*	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Coachwhip	*Masticophis (Coluber) flagellum*	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Plain-bellied watersnake	*Nerodia erythrogaster*	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Broad-banded watersnake	*Nerodia fasciata confluens*	○	○	○	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Diamond-backed watersnake	*Nerodia rhombifer*	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Rough greensnake	*Opheodrys aestivus*	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Western ribbonsnake	*Thamnophis proximus*	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Western diamondback rattlesnake	*Crotalus atrox*	●	●	●	●	●	●	○	○	○	○	○	○	○	○	○	○	○	○
Timber rattlesnake	*Crotalus horridus*	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Rough earthsnake	*Virginia striatula*	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Copperhead	*Agkistrodon contortix*	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Cottonmouth	*Agkistrodon piscivorus*	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●

Source: Conant, 2016; Dixon, 2013; TPWD, 2016
○ – No County Record; ● – County Record

3.6.4.3.2 Fish

As previously stated, the Study Area lies within the Texan Biotic Province.[40] Although the biotic provinces were originally separated on the basis of terrestrial animal distributions, research has shown that the distribution of freshwater fishes within the state generally corresponds with the terrestrial-vertebrate province boundaries.[41] As detailed in **Section 3.3, Water Quality**, the Study Area lies within the Brazos, Trinity and San Jacinto river basins. Aquatic habitats within the Study Area are influenced by the Navasota River, the Trinity River and the West Fork San Jacinto River and their tributaries. In addition to these major water features, the Study Area contains numerous small intermittent and ephemeral streams, reservoirs, wetlands, springs, ponds and man-made stock ponds. Many of the water features found in the Study Area are stock ponds, which have experienced various levels of anthropogenic disturbance and exhibit variability in age, drainage, livestock use, oil and gas production use, stocking, and fertilization history. Unlike the creeks and streams of the area, these man-made ponds are almost always exposed to full sunlight and do not experience the large fluctuations in water level and flow associated with streams during heavy precipitation. Bottom materials in these ponds are universally silt-sized to clay-sized particles, either naturally occurring where the pond was built or added as a liner. Wildlife species that occur in these man-made ponds include various aquatic insects, with mosquitoes and midges being the likely dominant species. These ponds also provide drinking water for many of the wildlife species within the Study Area. Additionally, regional planning groups may make recommendations for the designation of ecologically unique river and stream segments as part of regional water plans. These segments are known as Ecologically Significant Stream Segments. There are no Ecologically Significant Stream Segments within the Study Area. Other water considerations, including Waters of the U.S., are addressed in **Section 3.7, Waters of the U.S.** Maps depicting locations of Waters of the U.S., including wetlands, can be seen in the **Natural Resources Mapbook**, **Appendix D.**

Fish are prominent in the trophic structure of most streams, being the largest and most conspicuous of the ecosystem's resident consumers. Extensive environmental changes in an area can lead directly or indirectly to changes in the feeding habits of fish. However, changes in available feeding levels are not necessarily detrimental, unless the organism's feeding habits are very specialized. Food habits of fish vary with season, food availability and life cycle stages. For example, the diet of most young fish consists of microscopic plants and animals, including algae, protozoans and crustaceans found on plants, in bottom material or suspended in the water column. As fish develop and attain sexual maturity, feeding adaptations develop and the diets of some species become very restricted. Some fish are herbivorous, while others (e.g., bass) are strictly carnivorous. Most of the sunfish (*Lepomis* sp.) and catfish (*Ictalurus punctatus*) are omnivorous. Common species with potential to inhabit waters in and around the Study Area are included in **Table 3.6-4**.[42]

[40] Blair, W. Frank. "The Biotic Provinces of Texas." *Texas Journal of Science*, 1957: 93-117.
[41] Hubbs, Carl. "Distributional Patterns of Texas Freshwater Fishes." *Southwestern Naturalist 2* , 1957: 89-104.
[42] Ibid.

Table 3.6-4: Fish Species with Potential to Occur within the Study Area

Common Name	Scientific Name
Gizzard shad	*Dorosoma cepedianum*
Grass carp	*Ctenopharyngodon idella*
Red shiner	*Cyprinella lutrensis*
Common carp	*Cyprinus carpio*
Golden shiner	*Notemigonus crysoleucas*
Fathead minnow	*Pimephales promelas*
Bullhead minnow	*Pimephales vigilax*
River carpsucker	*Carpiodes carpio*
River chubshucker*	*Cuclepetus elongatus*
Smallmouth buffalo	*Ictiobus bubalus*
Black bullhead	*Ameiurus melas*
Blue catfish	*Ictalurus furcatus*
Channel catfish	*Ictalurus punctatus*
Flathead catfish	*Pylodictis olivaris*
Rainbow trout	*Oncorhynchus mykiss*
White bass	*Morone chrysops*
Striped bass	*Morone saxatilis*
Red-breasted sunfish	*Lepomis auritus*
Green sunfish	*Lepomis cyanellus*
Warmouth	*Lepomis gulosus*
Orangespotted sunfish	*Lepomis humilis*
Bluegill	*Lepomis macrochirus*
Longear sunfish	*Lepomis megalotis*
Redear sunfish	*Lepomis microlophus*
Largemouth bass	*Micropterus salmoides*
White crappie	*Pomoxis annularis*
Freshwater drum	*Aplodinotus grunniens*
"*" – The river chubshucker is not anticipated to be found in segments 2A and 2B in Ellis County.	

Source: Thomas et al, 2007

3.6.4.3.3 Mammals

Common mammalian species with potential to inhabit the Study Area are listed in **Table 3.6-5**. The Virginia opossum and armadillo (*Dasypus novemcinctus)* can be found in a variety of habitats[43] including all five of the most common EMST vegetation types. Bats within the Study Area are mostly forest dwellers[44] and are found in the Post Oak Savanna: Post Oak Motte and Woodland, Central Texas: Floodplain Hardwood Forest and Pineywoods: Small Stream and Riparian Temporarily Flooded Hardwood Forest. Some species, such as the tri-colored bat (*Perimyotis subflavus*), are found in manmade structures that can occur in any of the vegetation types.[45] The carnivores and even-toed ungulates mostly consist of habitat generalists that can also be found in all of the EMST vegetation types.[46] The rodents occur in varying habitat types. According to Schmidly, the squirrels are tree dwelling species that can be found in the Post Oak Savanna: Post Oak Motte and Woodland, Central Texas: Floodplain Hardwood Forest and Pineywoods: Small Stream and Riparian Temporarily Flooded Hardwood Forest, as well as any other woodland or forest vegetation types. American beaver (*Castor canadensis*) and nutria (*Myocastor coypus*) are found in aquatic habitats, and would mostly be

[43] Schmidly, David J. *The Mammals of Texas.* Austin: University of Austin Press, 2004.
[44] Ammerman, Loren K., Christina L. Hice, and David J. Schmidly. *Bats of Texas.* College Station: Texas A&M Press, 2004.
[45] Ibid.
[46] Schmidly, David J. *The Mammals of Texas.* Austin: University of Austin Press, 2004.

associated with water in the Central Texas: Floodplain Herbaceous Vegetation, Central Texas: Floodplain Hardwood Forest and Pineywoods: Small Stream and Riparian Temporarily Flooded Hardwood Forest, or any other aquatic vegetation type.[47] The white-footed mouse (*Peromyscus leucopus*) is typically found in bottomland forests in east Texas, and would potentially be found in the Central Texas: Floodplain Hardwood Forest and Pineywoods: Small Stream and Riparian Temporarily Flooded Hardwood Forest. The hispid cotton rat (*Sigmodon hispidus*) is a generalist species that are found in all five most common EMST vegetation types. While the swamp rabbit (*Sylvilagus aquaticus*) is mostly an aquatic species and expected to occur in the Central Texas: Floodplain Herbaceous Vegetation, Central Texas: Floodplain Hardwood Forest and Pineywoods: Small Stream and Riparian Temporarily Flooded Hardwood Forest, or any other aquatic vegetation type. Other rabbits are adapted to more open grasslands, and typically associated with Post Oak Savanna: Savanna Grassland and Central Texas: Floodplain Herbaceous Vegetation.[48]

[47] Schmidly, David J. *The Mammals of Texas.* Austin: University of Austin Press, 2004.
[48] Ibid.

Table 3.6-5: Mammalian Species with Potential to Occur within the Study Area

Common Name	Scientific Name	Dallas	Ellis		Navarro			Freestone		Limestone	Leon		Madison		Grimes			Waller	Harris
		1	2A	2B	3A	3B	3C	3C	4	4	3C	4	3C	4	3C	4	5	5	5
Marsupials																			
Virginia opossum	*Didelphis virginiana*	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Armadillos																			
Nine-banded armadillo	*Dasypus novemcinctus*	●	○	○	●	●	●	○	○	●	●	●	●	●	●	●	●	●	○
Bats																			
Southeastern myotis	*Myotis austroriparius*	○	○	○	○	○	○	●	●	○	●	●	○	○	○	○	○	○	●
Eastern red bat	*Lasiurus borealis*	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Hoary bat	*Lasiurus cinereus*	●	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	●
Northern yellow bat	*Lasiurus intermedius*	○	○	○	○	○	○	○	○	○	○	○	●	●	○	○	○	●	●
Seminole bat	*Lasiurus seminolus*	●	○	○	●	●	●	○	○	○	○	○	○	○	○	○	○	●	●
Eastern pipistrelle	*Pipistrellus subflavus*	●	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	●	●
Tri-colored bat	*Perimyotis subflavus*	●	○	○	○	○	○	○	○	○	○	○	○	○	●	●	●	●	●
Evening bat	*Nyctinomops humeralis*	●	○	○	○	○	●	●	●	●	●	●	●	●	●	●	●	●	●
Carnivores																			
Coyote	*Canis latrans*	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Common gray fox	*Urocyon cinereoargenteus*	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Striped skunk	*Mephitis mephitis*	●	●	●	○	○	●	●	●	●	●	●	●	●	●	●	●	●	●
Bobcat	*Lynx rufus*	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Even-toed Ungulates																			
Feral pig*	*Sus scrofa*	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
White-tailed deer	*Odocoileus virginianus*	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Rodents																			
Eastern gray squirrel	*Sciurus carolinensis*	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	●	●	●
Eastern fox squirrel	*Sciurus niger*	●	○	○	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
American beaver	*Castor canadensis*	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	○	○	○
White-footed mouse	*Peromyscus leucopus*	●	○	○	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Hispid cotton rat	*Sigmodon hispidus*	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Nutria*	*Myocastor coypus*	●	●	●	○	○	●	●	●	●	●	●	●	●	●	●	●	●	●
Rabbits																			
Swamp rabbit	*Sylvilagus aquaticus*	●	○	○	○	○	●	●	●	●	●	●	●	●	●	●	●	●	●

Table 3.6-5: Mammalian Species with Potential to Occur within the Study Area

Common Name	Scientific Name	Dallas	Ellis		Navarro			Freestone		Limestone	Leon		Madison		Grimes			Waller	Harris
		1	2A	2B	3A	3B	3C	3C	4	4	3C	4	3C	4	3C	4	5	5	5
Eastern cottontail	*Sylvilagus floridanus*	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Black-tailed jackrabbit	*Lepus californicus*	○	○	○	○	○	●	●	●	●	●	●	●	●	●	●	●	●	●

Source: Schmidly, 2004

○ – No County Record; ● – County Record; * – Invasive and/or Exotic Species

3.6.4.3.4 Birds

There are numerous year-round, summer and winter resident, as well as migrant, avian species with potential to inhabit the counties of the Study Area. The Study Area is located within the Central Flyway, a major bird migration corridor that leads to the Texas coast and Central/South America. **Table 3.6-6** lists some of the most common avian species, organized by family, with the potential to occur in the Study Area. Avian families most commonly found in the Central Texas: Floodplain Hardwood Forest, Central Texas: Floodplain Herbaceous Vegetation and Pineywoods: Small Stream and Riparian Temporarily Flooded Hardwood Forest, as well as any other vegetation type that occurs near ponds, wetlands or other water sources, include the swans, geese and ducks; loons; cormorants; bitterns and herons; rails, gallinules and coots; plovers; sandpipers, pharalopes and allies; and gulls, terns and allies. Many of these species will form colonial wading bird colonies, which are considered sensitive wildlife features by TPWD. The TXNDD reported one EOR within one mile of the Study Area and three within five miles of the Study Area in Dallas County, one within five miles in Ellis, Freestone, Grimes and Navarro counties (see **Natural Resources Mapbook, Appendix D)**. Typical grassland associated families potentially found in the Post Oak Savanna: Savanna Grassland includes New World sparrows and meadowlarks. Species usually associated with woodlands and forests that could potentially occur in the Post Oak Savanna: Post Oak Motte and Woodland, Central Texas: Floodplain Hardwood Forest and Pineywoods: Small Stream and Riparian Temporarily Flooded Hardwood Forest, or other woodland and forest vegetation types include the eagles, owls, woodpeckers and wood warblers.[49] All other avian families listed below typically occur in a variety of vegetation communities and habitats[50] and can potentially be found in all five of the dominant EMST vegetation types.

[49] Sibley, David Allen. The Sibley Field Guide to Birds of Eastern North America. New York: Alfred A. Knopf, Inc., 2003.
[50] Ibid.

Table 3.6-6: Avian Species with Potential to Occur within the Study Area

Common Name	Scientific Name	Dallas	Ellis		Navarro			Freestone		Limestone	Leon		Madison		Grimes			Waller	Harris
		1	2A	2B	3A	3B	3C	3C	4	4	3C	4	3C	4	3C	4	5	5	5
Swans, Geese and Ducks																			
Greater white-fronted goose	*Anser albifrons*	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	W
Snow goose	*Chen caerulescens*	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	W
Canada goose	*Branta canadensis*	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W
Wood duck	*Aix sponsa*	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR
Gadwall	*Anas strepera*	M W	M W	M W	M W	M W	M W	M W	M W	M W	M W	M W	M W	M W	M W	M W	M W	M W	M W
American wigeon	*Anas americana*	M W	M W	M W	M W	M W	M W	M W	M W	M W	M W	M W	M W	M W	M W	M W	M W	M W	M W
Mallard	*Anas platyrhynchos*	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W
Blue-winged teal	*Anas discors*	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M
Northern shoveler	*Anas clypeata*	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W
Northern pintail	*Anas acuta*	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W
Green-winged teal	*Anas crecca*	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M
New World Quail																			
Northern bobwhite	*Colinus virginianus*	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR
Loons																			
Common loon	*Gavia immer*	M W	M W	M W	M W	M W	M W	M W	M W	M W	M W	M W	M W	M W	M W	M W	M W	M W	M W
Cormorants																			
Double-crested cormorant	*Phalacrocorax auritus*	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	YR	YR	YR
Bitterns and Herons																			
Great blue heron	*Ardea herodias*	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR
Great egret	*Ardea alba*	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR
New World Vultures																			
Black vulture	*Coragyps atratus*	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR
Turkey vulture	*Cathartes aura*	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR
Eagles, Kites and Hawks																			
Bald eagle	*Haliaeetus leucocephalus*	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR
Northern harrier	*Circus cyaneus*	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W

Table 3.6-6: Avian Species with Potential to Occur within the Study Area

Common Name	Scientific Name	Dallas	Ellis		Navarro			Freestone		Limestone	Leon		Madison		Grimes			Waller	Harris
		1	**2A**	**2B**	**3A**	**3B**	**3C**	**3C**	**4**	**4**	**3C**	**4**	**3C**	**4**	**3C**	**4**	**5**	**5**	**5**
Sharp-shinned hawk	*Accipiter striatus*	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M
Cooper's hawk	*Accipiter cooperii*	YR	YR	YR	YR	W	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR
Red-tailed hawk	*Buteo jamaicensis*	YR	YR	YR	YR	W	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR
Falcons																			
American kestrel	*Falco sparverius*	YR	W	W	YR	YR	YR	YR	W	W	YR	W	YR	W	YR	W	W	W	W
Rails, Gallinules and Coots																			
American coot	*Fulica americana*	YR	YR	YR	YR	W	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR
Plovers																			
Killdeer	*Charadrius vociferus*	YR	YR	YR	YR	W	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR
Sandpipers, Pharalopes and Allies																			
Wilson's snipe	*Gallinago delicata*	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W
Gulls, Terns and Allies																			
Ring-billed gull	*Larus delawarensis*	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W
Pigeons and Doves																			
Rock pigeon	*Columba livia*	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR
Eurasian collared-dove	*Streptopelia decaocto*	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR
White-winged dove	*Zenaida asiatica*	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR
Mourning dove	*Zenaida macroura*	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR
Cuckoos and Allies																			
Greater Roadrunner	*Geococcyx californianus*	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR
Owls																			
Eastern screech owl	*Megascops asio*	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR
Great horned owl	*Bubo virginianus*	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR
Barred Owl	*Strix varia*	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR
Nighthawks and Nightjars																			
Chuck-will's-widow	*Antrostomus carolinensis*	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
Swifts																			
Chimney swift	*Chaetura pelagica*	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
Hummingbirds																			
Ruby-throated hummingbird	*Archilochus colubris*	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S

Table 3.6-6: Avian Species with Potential to Occur within the Study Area

Common Name	Scientific Name	Dallas	Ellis		Navarro			Freestone		Limestone	Leon		Madison		Grimes			Waller	Harris
		1	2A	2B	3A	3B	3C	3C	4	4	3C	4	3C	4	3C	4	5	5	5
Woodpeckers																			
Red-bellied woodpecker	*Melanerpes carolinus*	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR
Pileated woodpecker	*Dryocopus pileatus*	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR
Tyrant Flycatchers																			
Acadian flycatcher	*Empidonax virescens*	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
Least flycatcher	*Empidonax minimus*	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M
Eastern phoebe	*Saynoris phoebe*	YR	YR	YR	YR	W	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR
Great-crested flycatcher	*Myiarchus crinitus*	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
Eastern kingbird	*Tyrannus tyrannus*	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
Scissor-tailed flycatcher	*Tyrannus forficatus*	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
Vireos																			
White-eyed vireo	*Vireo griseus*	S	S	S	YR	YR	YR	YR	S	S	YR	S	YR	S	YR	S	YR	YR	YR
Red-eyed vireo	*Vireo olivaceus*	S	S	S	S	M	S	S	S	S	S	S	S	S	S	S	S	S	S
Jays and Crows																			
Blue jay	*Cyanocitta cristata*	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR
American crow	*Corvus brachyrhynchos*	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR
Martins and Swallows																			
Purple martin	*Progne subis*	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
Cliff swallow	*Petrochelidon pyrrhonta*	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
Barn swallow	*Hirundo rustica*	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
Chickadees and Titmice																			
Carolina chickadee	*Poecile carolinensis*	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR
Tufted titmouse	*Baeolophus bicolor*	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR
Wrens																			
Carolina wren	*Thryomanes ludovicianus*	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR
Kinglets																			
Ruby-crowned kinglet	*Regulus calendula*	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W
Thrushes																			
Eastern bluebird	*Sialia sialis*	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
Hermit thrush	*Catharus guttatus*	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W

Table 3.6-6: Avian Species with Potential to Occur within the Study Area

Common Name	Scientific Name	Dallas	Ellis		Navarro			Freestone		Limestone	Leon		Madison		Grimes			Waller	Harris
		1	2A	2B	3A	3B	3C	3C	4	4	3C	4	3C	4	3C	4	5	5	5
American robin	*Turdus migratorius*	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR
Mockingbirds and Thrashers																			
Northern mockingbird	*Mimus polyglottos*	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR
Starlings																			
European starling*	*Sturnus vulgaris*	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR
Wagtails and Pipits																			
American pipit	*Anthus rubescens*	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W
Cedar waxwing	*Bombycilla cedrorum*	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W
Wood Warblers																			
Orange-crowned warbler	*Vermivora celata*	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W
Nashville warbler	*Vermivora ruficapilla*	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M
Yellow warbler	*Setophaga petechia*	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M
Yellow-rumped warbler	*Setophaga coronata*	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W
New World Sparrows																			
Chipping sparrow	*Spizella passerina*	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W
Vesper sparrow	*Pooecetes gramineus*	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W
Lark sparrow	*Chondestes grammaus*	S	S	S	S	YR	S	S	S	S	S	S	S	S	S	S	S	S	S
Savannah sparrow	*Passerculus sandwichensis*	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W
White-crowned sparrow	*Zonotrichia leucophrys*	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W
Cardinals and Allies																			
Summer tanager	*Piranga rubra*	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
Northern cardinal	*Cardinalis cardinalis*	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR
Blue grosbeak	*Passerina caerula*	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
Painted bunting	*Passerina ciris*	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
Blackbirds, Meadowlarks and Orioles																			
Red-winged blackbird	*Agelaius phoeniceus*	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR
Eastern meadowlark	*Sturnella magna*	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR
Great-tailed grackle	*Quiscalus mexicanus*	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR
Brown-headed cowbird*	*Molothrus ater*	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR
Finches and Allies																			

Table 3.6-6: Avian Species with Potential to Occur within the Study Area

Common Name	Scientific Name	Dallas	Ellis		Navarro			Freestone		Limestone	Leon		Madison		Grimes			Waller	Harris
		1	2A	2B	3A	3B	3C	3C	4	4	3C	4	3C	4	3C	4	5	5	5
House finch	*Carpodacus mexicanus*	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR
American goldfinch	*Carduelis tristis*	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W
Old World Sparrows																			
House sparrow*	*Passer domesticus*	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR	YR

Source: Lockwood and Freeman, 2014
M – Present during migration; W – Present during winter; S – Present during summer; YR – Present year round; * – Invasive and/or Exotic Species

3.6.4.3.5 Commercially or Recreationally Important Wildlife

As stated in **Section 3.6.4.2**, a species is considered commercially important if one or more of the following criteria applies: (a) the species is recreationally or commercially valuable; (b) the species is endangered or threatened; (c) the species affects the well-being of some important species within criterion (a) or criterion (b); and (d) the species is critical to the structure and function of the ecological system or is a biological indicator.

Wildlife resources within the Study Area provide human benefits as a result of both non-consumptive and consumptive uses. Non-consumptive uses include activities such as observing and photographing wildlife or bird-watching. Several parks in the Study Area, managed by municipalities or private organizations, offer wildlife viewing opportunities. One state park, Fort Boggy State Park, is located within the Study Area. Native wildlife species within the Study Area provide the potential for non-consumptive use.

Several wildlife species within the Study Area are common for consumptive uses. The white-tailed deer is an important big game mammal in Texas and occurs throughout the Study Area.[51] This species requires woodlands containing shrub layers that provide foraging and coverage habitat. Other important game species in the Study Area include northern bobwhite, mourning dove, white-winged dove,[52] squirrel, rabbit and wild turkey.[53] Recreational fishing opportunities within the Study Area may be afforded by the Navasota River and the West Fork San Jacinto River, as well as reservoirs and minor water bodies or stock ponds for species including but not limited to sunfish, catfish, trout and bass.[54] There are no commercial fisheries in the Study Area. Cattle are included in **Section 3.13, Land Use** with additional discussion on agricultural practices in the Study Area.

3.6.4.4 Protected Species

3.6.4.4.1 Protected Plant Species

Based on the review of IPaC, RTEST and EORs, 40 protected plant species have the potential to occur in the Study Area. The query yielded 35 species designated as rare by TPWD, as well as numerous additional Species of Greatest Conservation Need (SGCN). SGCN are generally those that are declining or rare and in need of attention to recover or to prevent being listed under state or federal regulation. Since species identified as rare or SGCN have no regulatory protection, they are not included in this analysis. It was also determined that two species had no potential to occur due to local population extirpation. Based on the current distribution information and the presence of suitable habitat, it was determined that three protected plant species have potential to occur in the Study Area (**Table 3.6-7;** also see **Natural Resources Mapbook, Appendix D**). It should be noted that inclusion on the RTEST list does not imply that a species is known to occur in the area, but only acknowledges potential presence based on county or EOR documentation. Only those species listed as threatened or endangered by USFWS are afforded federal protection under the Endangered Species Act.

[51] Schmidly, David J. *The Mammals of Texas.* Austin: University of Austin Press, 2004.
[52] Lockwood, Mark, and Brush Freeman. *The Texas Ornithological Society Handbook of Texas Birds.* College Station: Texas A&M University Press, 2014.
[53] Schmidly, David J. *The Mammals of Texas.* Austin: University of Austin Press, 2004.
[54] Thomas, Chad, Tim H. Bonner, and Bobby G. Whiteside. *Freshwater Fishes of Texas.* College Station: Texas A&M University Press, 2007.

Table 3.6-7: Protected Plant Species with Potential to Occur within the Study Area

Common Name/ Scientific Name	Dallas	Ellis		Navarro			Freestone		Limestone	Leon		Madison		Grimes			Waller	Harris	USFWS	TPWD	Potential for Occurrence
	1	2A	2B	3A	3B	3C	3C	4	4	3C	4	3C	4	3C	4	5	5	5	--	--	--
Large-fruited sand verbena/ *Abronia macrocarpa*	○	○	○	○	○	○	●	●	○	●	●	○	○	○	○	○	○	○	E	E	Yes
Navasota ladies'-tresses/ *Spiranthes parksii*	○	○	○	○	○	○	●	●	●	●	●	●	●	●	●	●	○	○	E	E	Yes
Texas prairie dawn/ *Hymenoxys texana*	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	●	E	E	Yes

Source: Poole et al, 2007; USFWS, 2016; TPWD, 2016
○ – Not Recorded in County; ● – Recorded in County; E – Endangered, in danger of extinction

The Texas prairie dawn is endemic to the Texas Gulf Coastal Plain in the counties of Fort Bend, Harris and Trinity. It is an herbaceous perennial that grows up to approximately seven inches tall with 1-7 stems. They are pale yellow to deep yellow in color and flowering occurs between March and April. It occurs only in poorly drained, sparsely vegetated areas (slick spots) at the base of mima mounds in open grasslands or almost barren areas on slightly saline soils that are sticky when wet and almost powdery when dry.[55] According to the TXNDD, 26 EORs exist within five miles of the Study Area in Harris County (see **Natural Resources Mapbook, Appendix D**).[56] Out of the 26 EORs, 12 did not occur within areas identified as suitable habitat based on the habitat model. In addition, 9 of the 12 were recorded prior to the year 2000 and, based on aerial imagery, these areas are now developed. Due to the association between Texas prairie dawn and mima mounds, the LOD was further investigated for the occurrence of these mounds using historical aerial imagery and field investigations. Based on current aerial imagery, all areas where historical aerial imagery indicated possible mounds were determined to be developed or plowed for crops. During field investigations, no mima mounds were observed within the LOD. Based on the absence of these mounds, impacts to Texas prairie dawn or suitable habitat are not anticipated. Should mima mounds be observed during any field efforts, presence/absence surveys for the species would be conducted.

The large-fruited sand-verbena is known to occur within the Post Oak Belt of east-central Texas in Freestone, Leon and Robertson counties.[57] It is an herbaceous perennial that grows to approximately 20 inches tall with magenta flowers that bloom from late February through May or June.[58] It occurs only in deep, somewhat excessively drained sands in openings in post oak woodlands. According to the TXNDD, there is one EOR for this species within five miles of the Study Area in Leon County (see **Natural Resources Mapbook, Appendix D**).[59] Presence/absence surveys for the large-fruited sand verbena were conducted between March 30 and April 4, 2017 in areas along the segments of the LOD within Freestone and Leon counties (Segments 3C and 4) identified in the habitat suitability model for this species. Surveys were conducted on approximately 108 acres of identified habitat. During these surveys, no large-fruited sand verbena were observed. Although there were no large-fruited sand verbena identified during the field surveys, absence of the species cannot be presumed because it can persist as a taproot and not bloom until 2-3 years after germination.[60] During this survey approximately 208 acres (approximately 66 percent) of potential habitat were not accessible. In addition, it is important to note that large-fruited sand verbena flowering is positively correlated with rainfall from the months of February to April.[61] Due to the previously confirmed occurrence of the species, the fact that approximately 66 percent of the potential habitat has not been surveyed and the presence of deep, somewhat excessively drained sand in post oak woodlands, there is potential for this species to occur within the Study Area.

---

[55] Poole, Jackie M., William R Carr, Dana M. Price and Jason R. Singhurst. 2007. *Rare Plants of Texas*. College Station, Texas: Texas A&M University Press.
[56] Texas Parks and Wildlife Department, Wildlife Division, Diversity and Habitat Assessment Programs. 2016. TPWD County Lists of Protected Species and Species of Greatest Conservation Need.
[57] Poole, Jackie M., William R Carr, Dana M. Price and Jason R. Singhurst. 2007. *Rare Plants of Texas*. College Station, Texas: Texas A&M University Press.
[58] Ibid.
[59] TPWD. "Texas Natural Diversity Database. Annotated County Lists of Rare Species by County." 2014. Austin: Texas Parks and Wildlife Department, Wildlife Diversity Branch.
[60] Williamson, P.S. Final Report: Response to disturbance by large-fruited sand-verbena (Abronia macrocarpa). 1998. (USFWS Cooperative Agreement No. 14-16-0002-91-284).
[61] USFWS. Large-Fruited Sand-Verbena (Abronia macrocarpa) Galloway 5-Year Review: Summary and Evaluation. Austin, Texas: U.S. Fish and Wildlife Service, 2010.

The Navasota ladies'-tresses are known to occur in association with post oak savanna vegetation[62] and endemic to Bastrop, Brazos, Burleson, Fayette, Freestone, Grimes, Jasper, Leon, Limestone, Madison, Milam, Robertson and Washington counties.[63] It is a perennial creamy white flower that grows to approximately 6-13 inches tall and flowers from late October through November or early December.[64] It occurs only in openings in post oak woodlands on sandy loams along upland drainages or intermittent streams, often in areas with a perched water table associated with underlying claypan. According to the TXNDD, there are two EORs within five miles of the Study Area in Freestone County, one within five miles in Leon County, one within five miles in Madison County, and as well as one within the Study Area, two within one mile of the Study Area and 4 within five miles of the Study Area in Grimes County (see **Natural Resources Mapbook, Appendix D**). Presence/absence surveys were conducted for Navasota ladies'-tresses on approximately 659 acres of potentially suitable habitat from October 31 to November 15, 2016. During these surveys, no Navasota ladies'-tresses were observed. It is important to note that Navasota ladies'-tresses flowering is positively correlated with rainfall from the months of August and September.[65] Rainfall in Madisonville, Texas (located approximately four to eight miles east of the LOD) was greater in 2016 than in 2015 for both months; 0.12 of an inch in August and 1.4 inches in September 2015, and 8.63 inches in August and 2.98 inches in September 2016.[66] Rainfall in August 2016 was also 5.68 inches higher than the 30-year average in Madisonville, and only 1.2 inches lower than the 30-year average in September.[67] Given the adequate amounts of rainfall prior to the flowering season combined with the high occurrence of nodding ladies' tresses (a known sympatric species), it is likely that there should have been an increased chance for detecting Navasota ladies'-tresses during the 2016 field surveys. However, plants that flower one year have a low probability of flowering the following year, and it has been found that even in ideal years, it is unlikely that all of the viable plants will flower.[68] Therefore, nonflowering or dormant individuals may in fact be present but undetectable at any given location. Due to the previously confirmed EORs[69] of the species, the presence of post oak woodlands on sandy loams along upland drainages and the potential for undetectable individuals during the field surveys, there is potential for this species to occur within the Study Area.

---

[62] USFWS. "Navasota Ladies'-Tresses (Spiranthes parksii) Recovery Plan." Albuquerque, New Mexico: U.S. Fish and Wildlife Service, 1984.

[63] Poole, Jackie M., William R Carr, Dana M. Price and Jason R. Singhurst. 2007. *Rare Plants of Texas*. College Station, Texas: Texas A&M University Press.

[64] Ibid.

[65] Wonkka, C. L., W. E. Rogers, F. E. Smeins, J. R. Hammons, S. J. Haller, and M. C. Ariza. "Biology, ecology, and conservation of Navasota ladies'-tresses (Spiranthes parksii Correll), and endangered terrestrial orchid of Texas." 2012. *Native Plants Journal* 13. No.3: 236-243.

[66] National Oceanic and Atmospheric Administration. "Climate Data Online: Dataset Discovery – Global Summary of the Month." https://www.ncdc.noaa.gov/cdo-web/datasets (accessed December 5, 2016).

[67] USDA NRCS. "Field Office Technical Guide – Madison County, Texas: WETS Tables." http://agacis.rcc-acis.org/48313/mtot (accessed December 5, 2016).

[68] USFWS. *Navasota Ladies'-Tresses (Spiranthes parksii) 5-Year Review: Summary and Evaluation.* Austin, Texas: U.S. Fish and Wildlife Service, 2009.

[69] Texas Parks and Wildlife Department, Wildlife Division, Diversity and Habitat Assessment Programs. 2016. TPWD County Lists of Protected Species and Species of Greatest Conservation Need.

3.6.4.4.2 Protected Wildlife Species

Based on the review of IPaC, RTEST and EORs, 37 protected wildlife species and/or subspecies have the potential to occur in the Study Area. Inclusion on the IPaC and RTEST list does not imply that a species is known to occur in the Study Area, but only acknowledges potential presence based on county or EOR documentation. Using the habitat model developed for this Project and described in **Section 3.6.3**, FRA determined that 23 protected wildlife species had the potential to occur within the Study Area. Of these, six are considered to be transient or migrant bird species that do not have breeding or wintering habitat within the Study Area and these species include: white-faced ibis, wood stork, peregrine falcon (including the American subspecies), whooping crane, piping plover, and red knot. Reviewing the results of the habitat model developed for this Project, FRA also determined that 14 species have no potential to occur as the Study Area is outside of their geographic range or their habitats (e.g., marine environment) are not present. In addition, 15 wildlife species in the Study Area are designated as rare by TPWD, as well as hundreds of SGCN. Since rare species or SGCN have no regulatory protection with the state, they are not included in this analysis with the exception of three species that are federally protected (**Table 3.6-8**). Only those species listed as threatened or endangered by USFWS are afforded federal protection under the Endangered Species Act.

Two federal and state-listed endangered wildlife species have the potential to occur; these are the Houston toad and interior least tern (see **Natural Resources Mapbook, Appendix D**).

The Houston toad is a federal and state-listed endangered species. It typically averages 2 to 3.5 inches long and has a light mid-dorsal stripe, a pale underside often with small, dark spots and varies in overall coloration from light brown to gray or purplish gray occasionally displaying green patches. It is typically inactive during the coldest months and when it is hot and dry.[70] The Houston toad has varying habitat requirements for its different life stages, but deep sandy soils and high canopy cover are typically identified as necessary components.[71] The breeding season for the Houston toad lasts from January to June, with a typical year's peak in March and April.[72] The TXNDD reported one historical EOR within the Study Area in Harris County and no others within five miles of the Study Area. Presence/absence surveys were started in February, 2017 and completed on May 25, 2017. No Houston toads were observed within the survey area during the year one surveys; however, Houston toads were observed multiple times throughout the survey period at a location where toads had been found previously near Blackjack, Texas. Deep sandy soils and areas with high canopy cover occur throughout the Study Area in Leon County (see **Natural Resources Mapbook**, **Appendix D)**; therefore, there is potential for this species to occur within the Study Area.

---

[70] USFWS. "Houston Toad (*Bufo houstonensis*) 5-year Review: Summary and Evaluation." Austin, TX: U. S. Fish and Wildlife Service, 2011.
[71] Forstner, Michael R. J. and James R. Dixon. 2011. "Houston Toad (*Bufo houstonensis*) 5-year Review: Summary and Evaluation. Final Report for Section 6 project E-101." Austin: Texas Parks and Wildlife Department and U.S. Fish and Wildlife Service.
[72] USFWS. "Houston Toad (*Bufo houstonensis*) 5-year Review: Summary and Evaluation." Austin, TX: U. S. Fish and Wildlife Service, 2011.

Table 3.6-8: Protected Wildlife Species with Potential to Occur within the Study Area

Common Name/ Scientific Name	Dallas	Ellis		Navarro			Freestone		Limestone	Leon		Madison		Grimes			Waller	Harris	USFWS	TPWD	Potential for Occurrence
	1	2A	2B	3A	3B	3C	3C	4	4	3C	4	3C	4	3C	4	5	5	5	--	--	--
Amphibians																					
Houston toad/ *Bufo houstonensis*	○	○	○	○	○	○	○	○	○	●	●	○	○	○	○	○	○	○	E	E	Yes
Birds																					
White-faced ibis/ *Plegardis chihi*	●	●	●	●	●	●	○	○	●	○	○	○	○	●	●	●	●	●	-	T	Yes*
Wood stork/ *Mycteria americana*	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	-	T	Yes*
Bald eagle/ *Haliaeetus leucocephalus*	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	DL	T	Yes
White-tailed hawk/ *Buteo albicaudatus*	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	●	●	-	T	Yes
Peregrine falcon/ *Falco peregrinus*	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	DL	T	Yes*
American peregrine falcon/ *Falco peregrinus anatum*	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	DL	T	Yes*
Attwater's greater prairie-chicken/ *Tympnauchus cupido attwateri*	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	●	○	E	E	No
Whooping crane/ *Grus americana*	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	E	E	Yes*
Piping Plover/*Charadrius melodus*	●	○	○	●	●	●	●	●	○	○	○	○	○	○	○	○	○	○	T	T	Yes*
Red knot/ *Calidris canutus rufa*	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	T	R	Yes*
Interior least tern/ *Sterna antillarum athalassos*	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	○	E	E	Yes
Red-cockaded woodpecker/ *Picoides borealis*	○	○	○	○	○	○	○	○	○	○	○	○	○	●	●	●	○	○	E	E	No+
Black-capped vireo/ *Vireo atricapilla*	●	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	E	E	No
Golden-cheeked warbler/ *Setophaga chrysoparia*	●	●	●	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	E	E	No

Table 3.6-8: Protected Wildlife Species with Potential to Occur within the Study Area

Common Name/ Scientific Name	Dallas	Ellis		Navarro			Freestone		Limestone	Leon		Madison		Grimes			Waller	Harris	USFWS	TPWD	Potential for Occurrence
	1	2A	2B	3A	3B	3C	3C	4	4	3C	4	3C	4	3C	4	5	5	5	--	--	--
Bachman's sparrow/ *Aimophila aestivalis*	○	○	○	○	○	○	●	●	○	●	●	●	●	○	○	○	○	○	-	T	No
Fish																					
Smalleye shiner/ *Notropis buccola*	○	○	○	○	○	○	○	○	●	○	○	○	○	○	○	○	○	○	E	R	No
Sharpnose shiner/ *Notropis oxyrhyncus*	○	○	○	○	○	○	○	○	○	○	○	○	○	●	●	●	●	○	E	R	No
Blue sucker/ *Clycleptus elongates*	○	○	○	○	○	○	○	○	○	○	○	○	○	●	●	●	○	○	-	T	Yes
Creek chubsucker/ *Erimyzon oblongus*	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	●	●	-	T	Yes
Smalltooth sawfish/ *Pristis pectinate*	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	●	E	E	No
Mammals																					
Rafinesque's big-eared bat/ *Corynorhinus rafinesquii*	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	●	-	T	Yes
Red wolf/ *Canis rufus*	○	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	E	E	No
Louisiana black bear/ *Ursus amerincanus luteolus*	○	○	○	○	○	○	○	○	○	●	●	●	●	●	●	●	●	●	DL	T	No
Mollusks																					
Texas pigtoe/*Fusconaia askewi*	●	●	●	●	●	●	●	●	○	●	●	●	●	●	●	●	○	●	-	T	Yes
Sandbank pocketbook/ *Lampsilis satura*	●	●	●	●	●	●	●	●	○	●	●	●	●	○	○	○	○	●	-	T	Yes
Louisiana pigtoe/ *Pleurobema riddellii*	●	●	●	●	●	●	●	●	○	●	●	●	●	○	○	○	○	●	-	T	Yes
Texas heelsplitter/ *Potamilus amphichaenus*	●	●	●	●	●	●	●	●	○	●	●	●	●	○	○	○	○	○	-	T	Yes
Smooth pimpleback/ *Quadrula houstonensis*	○	○	○	○	○	○	○	○	●	●	●	●	●	●	●	●	●	○	C	T	Yes
Texas fawnsfoot/ *Truncilla macrodon*	○	○	○	○	○	○	○	○	●	●	●	●	●	●	●	●	●	○	C	T	Yes
Reptiles																					

Table 3.6-8: Protected Wildlife Species with Potential to Occur within the Study Area

Common Name/ Scientific Name	Dallas	Ellis		Navarro			Freestone		Limestone	Leon		Madison		Grimes			Waller	Harris	USFWS	TPWD	Potential for Occurrence
	1	2A	2B	3A	3B	3C	3C	4	4	3C	4	3C	4	3C	4	5	5	5	--	--	--
Loggerhead sea turtle/ *Caretta caretta*	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	●	T	T	No
Green sea turtle/ *Chelonia mydas*	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	●	T	T	No
Kemp's Ridley sea turtle/ *Lepidochelys kempii*	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	●	E	E	No
Leatherback sea turtle/ *Demochelys coriacea*	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	●	E	E	No
Alligator snapping turtle/ *Macrochelys temminckii*	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	-	T	Yes
Texas horned lizard/ *Phrynosoma cornutum*	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	-	T	Yes
Timber rattlesnake/ *Crotalus horridus*	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	-	T	Yes

Source: USFWS, 2016; TPWD, 2016

○ – Not Recorded in County; ● – Recorded in County; E – Endangered, in danger of extinction; T – Threatened, severely depleted or impacted by man; DL – Federally delisted; C – Candidate for federal listing; R - indicates a species listed as "Rare" by TPWD, this listing carries no regulatory meaning; "-" indicates a species that is not recognized as a federally-listed candidate, threatened or endangered species. "*"Assumed to be a transient/migrant species within the Study Area; "+" Analysis of EMST within the Study Area revealed no vegetation types with park-like stands of pines which is a habitat requirement for this species.

Note: Potential for occurrence in the Study Area determinations made for each species using either USFWS recovery plans or 5-year reviews, if available, or one of the following sources: Dixon, James R. *Amphibians and Reptiles of Texas.* College Station: Texas A&M University Press, 2013; Howells, Robert G., Raymond W. Neck and Harold D. Murray. *Freshwater Mussels of Texas.* Austin: University of Texas Press, 1996; Lockwood, Mark and Brush Freeman. *The Texas Ornithological Society Handbook of Texas Birds.* College Station: Texas A&M University Press, 2014; Schmidly, David J. *The Mammals of Texas.* Austin: University of Austin Press, 2004; Forstner, Michael R.J. and James R. Dixon. *Houston Toad (Bufo houstonensis) 5-year Review: Final Report for Section 6 project E-101.* Austin: Texas Parks and Wildlife Department, 2011; USFWS. Large-fruited Sand-Verbana (Abronia macrocarpa) Recovery Plan, Albuquerque: USFWS, 1992; USFWS. *Interior Least Tern (Sternula antillarum) 5-Year Review: Summary and Evaluation.* Albuquerque: USFWS, 2013.; USFWS. *International Recovery Plan Whooping Crane (Grus americana) Third Revision.* Albuquerque: USFWS, 2007.; USFWS. *Navasota Ladies'-Tresses (Spiranthes parksii) Recovery Plan.* Albuquerque: USFWS, 1984.; NatureServe. *NatureServe.* 2016 http://explorer.natureserve.org/servlet/NatureServe?searchName=Rhododon+ciliatus (accessed January 13, 2016); Thompson, Bruce C., Jerome A. Jackson, Joanna Burger, Eileen M. Kirsch and Jonathan L. Atwood. *The Birds of North America.* Philadelphia: The Academy of Natural Sciences, 1997; and Campbell, Linda. *Endangered and Threatened Animals of Texas: Their Life History and Management.* Austin: Texas Parks and Wildlife Press, 1995.

The interior least tern has historically nested in Texas on sandbars of the Colorado River, Red River and Rio Grande River. Only small breeding populations exist at isolated locations within the species' historic range, although its winter range includes the entire Texas Gulf Coast. The interior least tern's preferred nesting habitat is unvegetated, frequently flooded sand flats, salt flats, sand and gravel bars; and sand, shell and/or gravel beaches.[73, 74] Currently, this species is known to breed along the Red River to Hall County, along the Canadian River to Roberts County, locally in north-central Texas and at reservoirs around San Angelo, Tom Green County; Lake Amistad, Val Verde County; and Falcon Reservoir, Zapata County[75]. The species is also known to utilize man-made disturbance areas such as mines, rooftops, and gravel covered locations. This species is believed to generally follow major river basins to their confluence with the Mississippi River and then south to the Gulf of Mexico during fall migration.[76] According to the TXNDD, there are two EORs within five miles of the Study Area in Dallas County, two EORs within five miles of the Study Area in Freestone County, and one EOR within one mile of the Study Area in Leon County (see **Natural Resources Mapbook, Appendix D**). The interior least tern is assumed to be transient and/or migrant; however, the EORs in Freestone and Leon County, and one in the Study Area in Harris County, are for breeding/nesting populations. However, nesting at these locations has not been reported since 2006. While there is potential for them to re-establish breeding/nesting colonies within the Study Area, due to the variability of the potential nesting habitat (e.g., sandbars are frequently flooded and vary in availability from year to year), mapping of such habitats is not feasible at this time.

Two candidate species for federal listing have the potential to occur in the Study Area; these are the smooth pimpleback and the Texas fawnsfoot.

The smooth pimpleback, a species of freshwater mussel, is listed as a federal Candidate species and a state-listed threatened species. It is found in the Colorado, Brazos and San Jacinto River drainage basins on substrates consisting of mixed mud, sand and fine gravel.[77] The Study Area is located within the distribution range. The TXNDD search did not report any EORs for this species within or immediately surrounding the Study Area.[78] The EOR record nearest in location was from the Navasota River approximately 12 miles away from the Study Area; however, due to the presence of substrates consisting of mixed mud, sand and fine gravel within water resources located throughout the Study Area, there is potential for this species to occur.

The Texas fawnsfoot, a species of freshwater mussel, is listed as a federal candidate species and a state-listed threatened species. It is found in the Colorado, Trinity and Brazos river drainages. Preferred substrates for this species have not been extensively documented; however, an individual was found on a sandy shore of the Colorado River.[79] The TXNDD search did not report any EORs for this species within

[73] Campbell, Linda. 1995. *Endangered and Threatened Animals of Texas: Their Life History and Management*. Austin, Texas: Texas Parks and Wildlife Press.
[74] Thompson, Bruce C.; Jackson, Jerome A.; Burger, Joanna; Kirsch, Eileen M.; Atwood, Jonathan L. 1997. *The Birds of North America.* Philadelphia: The Academy of Natural Sciences.
[75] Lockwood, Mark and Brush Freeman. 2014. *The Texas Ornithological Society Handbook of Texas Birds*. College Station: Texas A&M University Press.
[76] USFWS. "Interior Least Tern (*Sternula antillarum*) 5-Year Review: Summary and Evaluation." Albuquerque, New Mexico: U.S. Fish and Wildlife Service, 2013.
[77] Howells, Robert G., Raymond W. Neck and Harold D. Murray. 1996. *Freshwater Mussels of Texas*. Austin, Texas: University of Texas Press.
[78] Texas Parks and Wildlife Department, Wildlife Division, Diversity and Habitat Assessment Programs. 2016. TPWD County Lists of Protected Species and Species of Greatest Conservation Need. [Dallas, Ellis, Freestone, Grimes, Harris, Leon, Limestone, Madison, Navarro, Waller, accessed December 16, 2015 and January 11, 2016].
[79] Howells, Robert G., Raymond W. Neck and Harold D. Murray. 1996. *Freshwater Mussels of Texas*. Austin, Texas: University of Texas Press.

or immediately surrounding the Study Area.[80] The EOR records nearest the Study Area are from the Brazos and Navasota Rivers, approximately 14 miles away. The Study Area is located within this species' distribution range and sandy substrates are present within the Study Area; therefore, there is potential for this species to occur.

Twelve state-listed species have the potential to inhabit the Study Area. The following are descriptions of these species.

The bald eagle is a rare to locally common resident primarily in the eastern third of the state. Recently, nesting pairs have been found over a wider area of the state, including sites in the Panhandle and Edwards Plateau. Post-breeding dispersal is unclear. During winter they are more widely distributed throughout the state.[81] They are found along lakes, rivers and coasts where prey is abundant and trees afford nest sites and an unobstructed view of surroundings.[82] According to the TXNDD, there are two EORs for this species within the Study Area, one in Navarro and one in Limestone counties. Additionally, there is a single EOR within five miles of the Study Area in Limestone, Leon, Grimes and Harris counties (see **Natural Resources Mapbook, Appendix D**).[83] Due to the previously confirmed occurrence near the Study Area and the presence of lakes and rivers near and within the Study Area, there is potential for this species to occur within the Study Area.

The white-tailed hawk, a state-listed threatened species, is an uncommon to locally common resident of the Coastal Prairies. They are found mostly south of Matagorda Bay,[84] generally on prairies, cordgrass flats and in scrub-live oak near the coast. Further inland, this species is found on prairies, mesquite and oak savannas and in mixed savanna-chaparral.[85] The TXNDD search did not report any EORs for this species within or immediately surrounding the Study Area;[86] however, mesquite and oak savannas and mixed savanna-chaparral are present within the Study Area. Therefore, there is potential for this species to occur.

The blue sucker, a state-listed threatened species, occurs in main channels, deep chutes and riffles of major rivers of the state. Its general characteristics include a small head and eyes, with eyes positioned closer to the operculum than the mouth. This fish is dark olive or blue-black on the dorsal and lateral areas with dusky to black fins.[87] TPWD's TXNDD has no documentation of this species within the Study Area;[88] however, main channels, deep chutes and riffles of the Navasota River and West Fork San Jacinto

[80] Texas Parks and Wildlife Department, Wildlife Division, Diversity and Habitat Assessment Programs. 2016. TPWD County Lists of Protected Species and Species of Greatest Conservation Need. [Dallas, Ellis, Freestone, Grimes, Harris, Leon, Limestone, Madison, Navarro, Waller, accessed December 16, 2015 and January 11, 2016].
[81] Lockwood, Mark and Brush Freeman. 2014. The Texas Ornithological Society Handbook of Texas Birds. College Station: Texas A&M University Press.
[82] Sibley, David Allen. 2003. The Sibley Field Guide to Birds of Eastern North America. New York: Alfred A. Knopf, Inc.
[83] Texas Parks and Wildlife Department, Wildlife Division, Diversity and Habitat Assessment Programs. 2016. TPWD County Lists of Protected Species and Species of Greatest Conservation Need. [Dallas, Ellis, Freestone, Grimes, Harris, Leon, Limestone, Madison, Navarro, Waller, accessed December 16, 2015 and January 11, 2016].
[84] Lockwood, Mark and Brush Freeman. 2014. The Texas Ornithological Society Handbook of Texas Birds. College Station: Texas A&M University Press.
[85] Sibley, David Allen. 2003. The Sibley Field Guide to Birds of Eastern North America. New York: Alfred A. Knopf, Inc.
[86] Texas Parks and Wildlife Department, Wildlife Division, Diversity and Habitat Assessment Programs. 2016. TPWD County Lists of Protected Species and Species of Greatest Conservation Need. [Dallas, Ellis, Freestone, Grimes, Harris, Leon, Limestone, Madison, Navarro, Waller, accessed December 16, 2015 and January 11, 2016].
[87] Thomas, Chad, Tim H. Bonner and Bobby G. Whiteside. 2007. Freshwater Fishes of Texas. College Station: Texas A&M University Press.
[88] Texas Parks and Wildlife Department, Wildlife Division, Diversity and Habitat Assessment Programs. 2016. TPWD County Lists of Protected Species and Species of Greatest Conservation Need. [Dallas, Ellis, Freestone, Grimes, Harris, Leon, Limestone, Madison, Navarro, Waller, accessed December 16, 2015 and January 11, 2016].

River occur within the Study Area and therefore, there is potential for this species to occur within the Study Area.

The creek chubsucker, a state-listed threatened species, occurs in the small rivers and creek tributaries of the Red, Sabine, Neches, Trinity and San Jacinto rivers. Spawning occurs in river mouths or pools and the young are typically found in headwater rivulets or marshes, riffles, lake outlets and upstream in creeks.[89] The TXNDD has no documentation of this species within the Study Area;[90] however, they are known to occur in Harris County. There is a potential for this species in the Study Area because of their use of the Trinity and San Jacinto river systems.

Rafinesque's big-eared bat, a state-listed threatened species, is found throughout the forested areas of the southeastern U.S. and reaches the westernmost boundary of its range in extreme west Texas in the South Central Plains region. These bats roost in hollow trees, crevices behind loose bark, caves, culverts, bridges, barns and abandoned buildings. It prefers hollows in water tupelo and black gum trees in bottomland hardwoods. While the TXNDD did not report an EOR for this species within the Study Area,[91] bottomland hardwoods do exist within Study Area and this species has been recorded in Harris County.[92] Therefore, there is potential for this species to occur within the Study Area.

The Texas pigtoe is listed as state threatened. It is found in mixed mud, sand and fine gravel in protected areas associated with fallen trees or other structures in river systems including the Brazos, Neches, Sabine and San Jacinto rivers. Current TXNDD records contain no documentation of this species within or near the Study Area[93] (see **Natural Resources Mapbook, Appendix D**). However, the Study Area is located within the Brazos and San Jacinto River systems and streams with substrates consisting of mixed mud, sand and fine gravel occur within the Study Area; therefore, there is potential for this species to occur.

The sandbank pocketbook is listed as state threatened. It is found in small to large streams with moderate flows on gravel, gravel-sand and sand bottoms including the San Jacinto River and areas to the north and east.[94] The TXNDD reported one EOR for this species within one mile of the Study Area in Dallas County[95] (see **Natural Resources Mapbook, Appendix D**). In addition, the Study Area is located within the distribution range of the species. Small and large streams with gravel, gravel-sand and sand bottoms occur within the Study Area; therefore, there is potential for this species to occur.

The Louisiana pigtoe is listed as state threatened. It is found in streams in the Trinity, Neches and Sabine River systems.[96] The TXNDD reported two EORs for this species within five miles of the Study Area in

[89] Thomas, Chad, Tim H. Bonner and Bobby G. Whiteside. 2007. Freshwater Fishes of Texas. College Station: Texas A&M University Press.
[90] Texas Parks and Wildlife Department, Wildlife Division, Diversity and Habitat Assessment Programs. 2016. TPWD County Lists of Protected Species and Species of Greatest Conservation Need. [Dallas, Ellis, Freestone, Grimes, Harris, Leon, Limestone, Madison, Navarro, Waller, accessed December 16, 2015 and January 11, 2016].
[91] Texas Parks and Wildlife Department, Wildlife Division, Diversity and Habitat Assessment Programs. 2016. TPWD County Lists of Protected Species and Species of Greatest Conservation Need. [Dallas, Ellis, Freestone, Grimes, Harris, Leon, Limestone, Madison, Navarro, Waller, accessed December 16, 2015 and January 11, 2016].
[92] Ammerman, Loren K., Christina L. Hice and David J. Schmidly. 2012. Bats of Texas. College Station, Texas: Texas A&M Press.
[93] Texas Parks and Wildlife Department, Wildlife Division, Diversity and Habitat Assessment Programs. 2016. TPWD County Lists of Protected Species and Species of Greatest Conservation Need. [Dallas, Ellis, Freestone, Grimes, Harris, Leon, Limestone, Madison, Navarro, Waller, accessed December 16, 2015 and January 11, 2016].
[94] Howells, Robert G., Raymond W. Neck and Harold D. Murray. 1996. Freshwater Mussels of Texas. Austin, Texas: University of Texas Press.
[95] Texas Parks and Wildlife Department, Wildlife Division, Diversity and Habitat Assessment Programs. 2016. TPWD County Lists of Protected Species and Species of Greatest Conservation Need. [Dallas, Ellis, Freestone, Grimes, Harris, Leon, Limestone, Madison, Navarro, Waller, accessed December 16, 2015 and January 11, 2016].
[96] Howells, Robert G., Raymond W. Neck and Harold D. Murray. 1996. *Freshwater Mussels of Texas*. Austin, Texas: University of Texas Press.

Dallas County and one EOR for this species within one mile of the Study Area in Dallas County[97] (see **Natural Resources Mapbook, Appendix D**). In addition, the Study Area is located within the Trinity River system and streams occur within the Study Area; therefore, there is potential for this species to occur.

The Texas heelsplitter is listed as state threatened. It is found in quiet waters on sand and mud in the Sabine, Neches and Trinity River system.[98] The TXNDD did not report an EOR for this species within the Study Area.[99] However, the Study Area is located within the Trinity River system quiet waters on sand and mud occur within the Study Area; therefore, there is potential for this species to occur.

Alligator snapping turtles are state-listed threatened by TPWD. They are characterized by their large head and strongly hooked beak.[100] The alligator snapping turtle is the largest freshwater turtle in North America and spends most of its time at the bottom of lakes, swamps and rivers.[101] The TXNDD reports one EOR for this species within one mile of the Study Area in Harris County[102] and lakes, swamps and rivers exist within and near the Study Area (see **Natural Resources Mapbook, Appendix D**). Therefore, there is potential for this species to occur within the Study Area.

The Texas horned lizard, a state-listed threatened species, is a flat-bodied lizard covered with numerous prominent horns. They can be found in open, arid and semi-arid regions with sparse vegetation, including grass, cactus, scattered brush or scrubby trees. This species will burrow into soil, enter rodent burrows or hide under rocks when inactive.[103] There are records for this species in every county in the Study Area but Waller. The TXNDD did not report an EOR for this species within the Study Area,[104] but since the Study Area is located within the historical range, there is potential for this species to occur.

The timber rattlesnake, a state-listed threatened species, is a large venomous snake with jagged-edged, dark brown to black crossbands. This species prefers moist lowland forests and woodlands near rivers, streams and lakes.[105] While there are no EORs reported for this species in the Study Area,[106] it has been recorded in all counties except Limestone.[107] As lowland forest and woodlands near water sources occur within the Study Area, there is potential for this species to be present.

[97] Texas Parks and Wildlife Department, Wildlife Division, Diversity and Habitat Assessment Programs. 2016. TPWD County Lists of Protected Species and Species of Greatest Conservation Need. [Dallas, Ellis, Freestone, Grimes, Harris, Leon, Limestone, Madison, Navarro, Waller, accessed December 16, 2015 and January 11, 2016].
[98] Howells, Robert G., Raymond W. Neck and Harold D. Murray. 1996. *Freshwater Mussels of Texas*. Austin, Texas: University of Texas Press.
[99] Texas Parks and Wildlife Department, Wildlife Division, Diversity and Habitat Assessment Programs. 2016. TPWD County Lists of Protected Species and Species of Greatest Conservation Need. [Dallas, Ellis, Freestone, Grimes, Harris, Leon, Limestone, Madison, Navarro, Waller, accessed December 16, 2015 and January 11, 2016].
[100] Conant, Roger and Joseph T. Collins. 1998. *Reptiles and Amphibians of Eastern and Central North America*. Third Edition. Expanded. Boston: Houghton Mifflin Company.
[101] Ibid.
[102] Texas Parks and Wildlife Department, Wildlife Division, Diversity and Habitat Assessment Programs. 2016. TPWD County Lists of Protected Species and Species of Greatest Conservation Need. [Dallas, Ellis, Freestone, Grimes, Harris, Leon, Limestone, Madison, Navarro, Waller, accessed December 16, 2015 and January 11, 2016].
[103] Dixon, James R. 2013. *Amphibian and Reptiles of Texas*. College Station: Texas A&M University Press.
[104] Texas Parks and Wildlife Department, Wildlife Division, Diversity and Habitat Assessment Programs. 2016. TPWD County Lists of Protected Species and Species of Greatest Conservation Need. [Dallas, Ellis, Freestone, Grimes, Harris, Leon, Limestone, Madison, Navarro, Waller, accessed December 16, 2015 and January 11, 2016].
[105] Werler, John E. and James R. Dixon. 2000. Texas Snakes. Austin: University of Texas Press.
[106] Texas Parks and Wildlife Department, Wildlife Division, Diversity and Habitat Assessment Programs. 2016. TPWD County Lists of Protected Species and Species of Greatest Conservation Need. [Dallas, Ellis, Freestone, Grimes, Harris, Leon, Limestone, Madison, Navarro, Waller, accessed December 16, 2015 and January 11, 2016].
[107] Dixon, James R. 2013. *Amphibian and Reptiles of Texas*. College Station: Texas A&M University Press.

3.6.4.4.3 Critical Habitat

No designated critical habitat for any protected wildlife species occurs within any of the counties of the Study Area.[108]

3.6.5 Environmental Consequences

3.6.5.1 No Build Alternative

In the No Build Alternative, the HSR system would not be constructed or operated. Existing trends affecting natural resources would be expected to continue because no construction activities would occur. Potential impacts could still occur under the No Build Alternative as new developments would continue due to natural growth in the area that would require land clearing of vegetation and wildlife habitat for construction. However, the No Build Alternative would not contribute to this impact. Additionally, existing and future developments may be permitted in accordance with federal, state and local requirements under the No Build Alternative.

3.6.5.2 Build Alternatives

This section analyzes the potential impacts to natural ecological systems and protected species as a result of constructing and operating the Build Alternatives. The direct impacts and indirect impacts (potential effects that may occur off-site or later in time associated with the long-term physical presence and operation of a passenger rail system on the landscape, and the short-term disturbance associated with construction activities) are addressed.

3.6.5.2.1 Vegetation Types

All Build Alternatives would include land that has been previously disturbed by conversion to agricultural or urban uses, or being adjacent to existing transportation and utility corridors, grasslands and agriculture. Nonetheless, all Build Alternatives would result in the direct loss of native vegetation. Some of these impacts would be reduced by locating the HSR ROW contiguous with existing transportation and utility corridors and other facilities where vegetation is already disturbed and/or fragmented; however, existing vegetation that may remain between parallel developed corridors would be isolated from larger blocks, potentially resulting in habitat fragmentation.

Construction of the Build Alternatives, including the rail infrastructure and ancillary facilities, would result in the permanent loss of habitat. Construction of the Build Alternatives would involve vegetation removal, ground clearing, placement of fill material, and construction of roads, culverts, bridges, viaduct, embankment, stations facilities. These potentially could also result in disturbance to, and destruction of, rare plant populations, modification of habitat, or reduction of habitat value.

Staging areas, access roads and development of other facilities needed to support construction could also result in a permanent modification of habitat or reduction of habitat value. In some cases, habitat could revert back to pre-construction conditions or could be enhanced for mitigation purposes. Until disturbed areas are stabilized, the potential exists for increased sediment transport during storm events and an increased potential for the introduction or spread of non-native and invasive plant species.

To routinely maintain and inspect the HSR infrastructure, it would be necessary to preserve a clear ROW. This would result in the permanent conversion to a mowed and maintained herbaceous habitat. Ground disturbance associated with the maintenance of roadways and tracks provides additional

[108] USFWS. *Critical Habitat Portal.* 2015. http://criticalhabitat.fws.gov/crithab (accessed December 15, 2015).

opportunities for establishment and/or spread of non-native or invasive species. Opportunistic species, such as mesquite and numerous grasses, can be introduced through dispersal methods including wind, being tracked in on vehicles or spread by wildlife. In addition, increased soil compaction can inhibit the establishment of desirable native species.

The following sections present potential temporary and permanent impacts to the EMST vegetation types by county and segment.

Dallas County

The temporary and permanent impacts to the 21 vegetation types represented in Segment 1 can be found in **Table 3.6-9**. The three vegetation types with the largest acreage of impacts for Segment 1 would be:

- Blackland Prairie: Disturbance or Tame Grassland
- Native Invasive: Deciduous Woodland
- Row Crops

Table 3.6-9: Potential Impacts to Vegetation (acres) – Dallas County

Vegetation Type (EMST Code)	Segment 1	
	Temp.	Perm.
Blackland Prairie: Disturbance or Tame Grassland (207)	39	94
Post Oak Savanna: Post Oak Motte and Woodland (604)	0	5
Edwards Plateau: Live Oak Motte and Woodland (1102)	0	1
Edwards Plateau: Deciduous Oak / Evergreen Motte and Woodland (1103)	0	11
Edwards Plateau: Oak / Hardwood Motte and Woodland (1104)	16	18
Edwards Plateau: Savanna Grassland (1107)	1	24
Central Texas: Floodplain Hardwood / Evergreen Forest (1803)	0	3
Central Texas: Floodplain Hardwood Forest (1804)	9	63
Central Texas: Floodplain Deciduous Shrubland (1806)	0	1
Central Texas: Floodplain Herbaceous Vegetation (1807)	0	9
Central Texas: Riparian Hardwood Forest (1904)	0	3
Central Texas: Riparian Herbaceous Vegetation (1907)	0	1
Swamp (9004)	0	1
Native Invasive: Deciduous Woodland (9104)	40	68
Native Invasive: Juniper Shrubland (9105)	0	4
Native Invasive: Mesquite Shrubland (9106)	9	3
Row Crops (9307)	210	99
Urban High Intensity (9410)	23	95
Urban Low Intensity (9411)	30	120
Open Water (9600)	1	6

Source: TPWD, 2014
'--' - Vegetation types not located in the segment.

Impacts to vegetation that occur within USACE-owned property in Dallas County are detailed in **Appendix E, Impacts to USACE Properties Technical Memorandum**.

Ellis County

The temporary and permanent impacts to the five vegetation types represented in Segment 1 can be found in **Table 3.6-10**. The two vegetation types with the largest acreage of impacts in Segment 1 would be:

- Blackland Prairie: Disturbance or Tame Grassland
- Row Crops

The temporary and permanent impacts to the 14 vegetation types represented in Segment 2A can be found in **Table 3.6-10**. The two vegetation types with the largest acreage of impacts in Segment 2A would be:

- Blackland Prairie: Disturbance or Tame Grassland
- Row Crops

The temporary and permanent impacts to the 12 vegetation types represented in Segment 2B can be found in **Table 3.6-10**. The two vegetation types with the largest acreage of impacts in Segment 2B would be:

- Blackland Prairie: Disturbance or Tame Grassland
- Row Crops

The temporary and permanent impacts to the four vegetation types represented in Segment 3A can be found in **Table 3.6-10**. The three vegetation types with the largest acreage of impacts in Segment 3A would be:

- Blackland Prairie: Disturbance or Tame Grassland
- Row Crops
- Native Invasive: Deciduous Woodland

The temporary and permanent impacts to the four vegetation types represented in Segment 3B can be found in **Table 3.6-10**. The three vegetation types with the largest acreage of impacts in Segment 3B would be:

- Blackland Prairie: Disturbance or Tame Grassland
- Row Crops
- Native Invasive: Deciduous Woodland

The temporary and permanent impacts to the four vegetation types represented in Segment 3C can be found in **Table 3.6-10**. The three vegetation types with the largest acreage of impacts in Segment 3C would be:

- Blackland Prairie: Disturbance or Tame Grassland
- Row Crops
- Native Invasive: Deciduous Woodland

Table 3.6-10: Potential Impacts to Vegetation (acres) – Ellis County

Vegetation Type (EMST Code)	Segment 1		Segment 2A		Segment 2B		Segment 3A		Segment 3B		Segment 3C	
	Temp.	Perm.	Temp.	Perm.	Temp.	Perm.	Temp.	Perm.	Temp.	Perm.	Temp.	Perm.
Blackland Prairie: Disturbance or Tame Grassland (207)	0	11	36	325	44	252	0	3	0	8	0	3

Table 3.6-10: Potential Impacts to Vegetation (acres) – Ellis County												
Vegetation Type (EMST Code)	**Segment 1**		**Segment 2A**		**Segment 2B**		**Segment 3A**		**Segment 3B**		**Segment 3C**	
	Temp.	**Perm.**	**Temp.**	**Perm.**	**Temp.**	**Perm.**	**Temp.**	**Perm.**	**Temp.**	**Perm.**	**Temp.**	**Perm.**
Edwards Plateau: Oak / Hardwood Slope Forest (904)	--	--	0	1	--	--	--	--	--	--	--	--
Central Texas: Floodplain Live Oak Forest (1802)	--	--	0	1	--	--	--	--	--	--	--	--
Central Texas: Floodplain Hardwood Forest (1804)	0	1	0	21	1	25	--	--	--	--	--	--
Central Texas: Floodplain Herbaceous Vegetation (1807)	--	--	0	7	1	9	--	--	--	--	--	--
Central Texas: Riparian Hardwood Forest (1904)	--	--	1	8	1	9	0	1	0	1	0	1
Central Texas: Riparian Deciduous Shrubland (1906)	--	--	0	1	--	--	--	--	--	--	--	--
Central Texas: Riparian Herbaceous Vegetation (1907)	--	--	1	6	1	8	--	--	--	--	--	--
Swamp (9004)	--	--	0	1	0	1	--	--	--	--	--	--
Native Invasive: Deciduous Woodland (9104)	0	2	7	38	7	61	0	3	0	3	0	3
Native Invasive: Juniper Shrubland (9105)	--	--	--	--	0	1	--	--	--	--	--	--
Native Invasive: Mesquite Shrubland (9106)	--	--	0	5	1	1	--	--	--	--	--	--
Row Crops (9307)	0	8	179	332	153	378	0	112	0	110	0	112
Urban Low Intensity (9411)	0	2	2	5	2	6	--	--	--	--	--	--
Open Water (9600)	--	--	0	2	0	1	--	--	--	--	--	--

Source: TPWD, 2014
Note: "--" Vegetation type not present in segment

Navarro County

The temporary and permanent impacts to the 18 vegetation types represented in Segment 3A can be found in **Table 3.6-11**. The two vegetation types with the largest acreage of impacts in Segment 3A would be:

- Blackland Prairie: Disturbance or Tame Grassland
- Row Crops

The temporary and permanent impacts to the 15 vegetation types represented in Segment 3B can be found in **Table 3.6-11**. The two vegetation types with the largest acreage of impacts in Segment 3B would be:

- Blackland Prairie: Disturbance or Tame Grassland
- Row Crops

The temporary and permanent impacts to the 17 vegetation types represented in Segment 3C can be found in **Table 3.6-11**. The two vegetation types with the largest acreage of impacts in Segment 3C would be:

- Blackland Prairie: Disturbance or Tame Grassland
- Row Crops

Table 3.6-11: Potential Impacts to Vegetation (acres) – Navarro County

Vegetation Type (EMST Code)	Segment 3A		Segment 3B		Segment 3C	
	Temp.	Perm.	Temp.	Perm.	Temp.	Perm.
Blackland Prairie: Disturbance or Tame Grassland (207)	80	495	124	536	101	504
Post Oak Savanna: Post Oak Motte and Woodland (604)	38	17	0	79	35	20
Post Oak Savanna: Savanna Grassland (607)	2	15	11	34	2	8
Post Oak Savanna: Post Oak - Yaupon Motte and Woodland (613)	1	3	--	--	1	1
Edwards Plateau: Oak / Hardwood Slope Forest (904)	0	1	0	1	0	1
Central Texas: Floodplain Hardwood Forest (1804)	0	13	0	19	1	36
Central Texas: Floodplain Deciduous Shrubland (1806)	0	2	0	2	0	1
Central Texas: Floodplain Herbaceous Vegetation (1807)	1	60	2	44	2	68
Central Texas: Riparian Hardwood - Evergreen Forest (1903)	0	1	--	--	0	1
Central Texas: Riparian Hardwood Forest (1904)	1	4	0	5	1	3
Central Texas: Riparian Deciduous Shrubland (1906)	--	--	--	--	--	--
Central Texas: Riparian Herbaceous Vegetation (1907)	1	6	0	13	1	6
Marsh (9007)	1	1	--	--	0	1
Native Invasive: Juniper Woodland (9101)	1	1	--	--	1	1
Native Invasive: Deciduous Woodland (9104)	37	47	5	26	15	51
Native Invasive: Mesquite Shrubland (9106)	5	15	0	15	4	20
Row Crops (9307)	56	235	77	210	59	201
Urban Low Intensity (9411)	2	8	13	15	2	9
Urban High Intensity	-	-	0	5	--	--
Open Water (9600)	1	0	0	2	--	--

Source: TPWD, 2014
Note: “--“ Vegetation type not present in segment

Freestone County

The potential temporary and permanent impacts to the Blackland Prairie: Disturbance or Tame Grassland vegetation type represented in Segment 3A can be found in **Table 3.6-12**.

The potential temporary and permanent impacts to the Blackland Prairie: Disturbance or Tame Grassland vegetation type represented in Segment 3B can be found in **Table 3.6-12**.

The temporary and permanent impacts to the 21 vegetation types represented in Segment 3C can be found in **Table 3.6-12**. The two vegetation types with the largest acreage of impacts in Segment 3C would be:

- Post Oak Savanna: Post Oak Motte and Woodland
- Post Oak Savanna: Savanna Grassland

The potential temporary and permanent impacts to the 16 vegetation types represented in Segment 4 can be found in **Table 3.6-12**. The three vegetation types with the largest acreage of impacts in Segment 4 would be:

- Blackland Prairie: Disturbance or Tame Grassland
- Post Oak Savanna: Post Oak Motte and Woodland

- Post Oak Savanna: Savanna Grassland

Table 3.6-12: Potential Impacts to Vegetation (acres) – Freestone County

Vegetation Type (EMST Code)	Segment 3A		Segment 3B		Segment 3C		Segment 4	
	Temp.	Perm.	Temp.	Perm.	Temp.	Perm.	Temp.	Perm.
Blackland Prairie: Disturbance or Tame Grassland (207)	0	1	0	1	1	35	84	118
Post Oak Savanna: Post Oak Motte and Woodland (604)	--	--	--	--	126	218	5	200
Post Oak Savanna: Savanna Grassland (607)	--	--	--	--	121	377	54	312
Post Oak Savanna: Post Oak - Yaupon Motte and Woodland (613)	--	--	--	--	3	8	0	14
Post Oak Savanna: Sandyland Woodland and Shrubland (706)	--	--	--	--	0	1	0	15
Post Oak Savanna: Sandyland Grassland (707)	--	--	--	--	0	1	0	1
Central Texas: Floodplain Hardwood Forest (1804)	--	--	--	--	24	49	3	47
Central Texas: Floodplain Deciduous Shrubland (1806)	--	--	--	--	0	1	0	1
Central Texas: Floodplain Herbaceous Vegetation (1807)	--	--	--	--	9	23	22	56
Central Texas: Floodplain Seasonally Flooded Hardwood Forest (1814)	--	--	--	--	0	1	--	--
Central Texas: Riparian Hardwood - Evergreen Forest (1903)	--	--	--	--	0	1	--	--
Central Texas: Riparian Hardwood Forest (1904)	--	--	--	--	0	1	0	5
Central Texas: Riparian Deciduous Shrubland (1906)	--	--	--	--	0	1	0	1
Central Texas: Riparian Herbaceous Vegetation (1907)	--	--	--	--	0	4	0	7
Barren (9000)	--	--	--	--	0	6	--	--
Native Invasive: Juniper Woodland (9101)	--	--	--	--	5	21	1	23
Native Invasive: Deciduous Woodland (9104)	--	--	--	--	2	1	1	3
Native Invasive: Mesquite Shrubland (9106)	--	--	--	--	1	10	2	7
Urban High Intensity (9410)	--	--	--	--	1	189	--	--
Urban Low Intensity (9411)	--	--	--	--	1	128	1	15
Open Water (9600)	--	--	--	--	0	1	--	--

Source: TPWD, 2014
Note: "--" Vegetation type not present in segment

Limestone County

The potential temporary and permanent impacts to the 11 vegetation types represented in Segment 4 can be found in **Table 3.6-13**. The vegetation type with the largest acreage of impacts in Segment 4 would be:

- Post Oak Savanna: Savanna Grassland

Table 3.6-13: Potential Impacts to Vegetation – Limestone County

Vegetation Type (EMST Code)	Segment 4	
	Temp.	Perm.
Post Oak Savanna: Post Oak Motte and Woodland (604)	1	82
Post Oak Savanna: Savanna Grassland (607)	13	222
Post Oak Savanna: Post Oak - Yaupon Motte and Woodland (613)	0	1
Central Texas: Floodplain Hardwood Forest (1804)	0	16
Central Texas: Floodplain Herbaceous Vegetation (1807)	0	12
Central Texas: Riparian Hardwood Forest (1904)	0	6
Central Texas: Riparian Herbaceous Vegetation (1907)	0	2
Barren (9000)	1	3
Urban High Intensity (9410)	1	1
Urban Low Intensity (9411)	0	1
Open Water (9600)	0	1

Source: TPWD, 2014

Leon County

The temporary and permanent impacts to the 17 vegetation types represented in Segment 3C can be found in **Table 3.6-14**. The vegetation type with the largest acreage of impacts in Segment would be:

- Post Oak Savanna: Post Oak Motte and Woodland
- Post Oak Savanna: Savanna Grassland

The potential temporary and permanent impacts to the 18 vegetation types represented in Segment 4 can be found in **Table 3.6-14**. The vegetation type with the largest acreage of impacts in Segment 4 would be:

- Post Oak Savanna: Post Oak Motte and Woodland
- Post Oak Savanna: Savanna Grassland

Table 3.6-14: Potential Impacts to Vegetation – Leon County

Vegetation Type (EMST Code)	Segment 3C		Segment 4	
	Temp.	Perm.	Temp.	Perm.
Blackland Prairie: Disturbance or Tame Grassland (207)	0	17	0	11
Post Oak Savanna: Post Oak Motte and Woodland (604)	52	345	4	427
Post Oak Savanna: Savanna Grassland (607)	22	655	175	429
Post Oak Savanna: Post Oak - Yaupon Motte and Woodland (613)	0	3	0	1
Post Oak Savanna: Sandyland Woodland and Shrubland (706)	0	8	0	17
Post Oak Savanna: Sandyland Grassland (707)	0	14	0	13
Central Texas: Floodplain Hardwood Forest (1804)	0	28	<0.01	21
Central Texas: Floodplain Herbaceous Vegetation (1807)	0	44	1	14
Central Texas: Riparian Hardwood Forest (1904)	--	--	2	5
Central Texas: Riparian Herbaceous Vegetation (1907)	0	2	1	4
Pineywoods: Pine Forest or Plantation (3001)	0	7	--	--
Pineywoods: Small Stream and Riparian Temporarily Flooded Hardwood Forest (4804)	--	--	0	3
Pineywoods: Small Stream and Riparian Wet Prairie (4817)	--	--	0	1
Barren (9000)	0	1	1	4
Marsh (9007)	0	1	--	--
Native Invasive: Juniper Woodland (9101)	0	2	--	--

Table 3.6-14: Potential Impacts to Vegetation – Leon County

Vegetation Type (EMST Code)	Segment 3C		Segment 4	
	Temp.	Perm.	Temp.	Perm.
Native Invasive: Deciduous Woodland (9104)	--	--	0	4
Native Invasive: Juniper Shrubland (9105)	0	10	--	--
Row Crops (9307)	--	--	0	1
Urban High Intensity (9410)	8	69	1	1
Urban Low Intensity (9411)	5	80	2	4
Open Water (9600)	0	1	0	2

Source: TPWD, 2014
Note: "--" Vegetation type not present in segment

Madison County

The potential temporary and permanent impacts to the nine vegetation types represented in Segment 3C can be found in **Table 3.6-15**. The vegetation type with the largest acreage of impacts in Segment 3C would be:

- Post Oak Savanna: Savanna Grassland

The potential temporary and permanent impacts to the eight vegetation types represented in Segment 4 can be found in **Table 3.6-15**. The vegetation type with the largest acreage of impacts in Segment 4 would be:

- Post Oak Savanna: Savanna Grassland

Table 3.6-15: Potential Impacts to Vegetation (acres) – Madison County				
Vegetation Type (EMST Code)	**Segment 3C**		**Segment 4**	
	Temp.	**Perm.**	**Temp.**	**Perm.**
Post Oak Savanna: Post Oak Motte and Woodland (604)	0	55	11	93
Post Oak Savanna: Savanna Grassland (607)	1	438	138	426
Post Oak Savanna: Post Oak - Yaupon Motte and Woodland (613)	0	1	0	4
Pineywoods: Small Stream and Riparian Temporarily Flooded Hardwood Forest (4804)	0	42	2	39
Pineywoods: Small Stream and Riparian Seasonally Flooded Hardwood Forest (4814)	--	--	0	1
Pineywoods: Small Stream and Riparian Wet Prairie (4817)	1	26	0	8
Marsh (9007)	0	1	--	--
Native Invasive: Juniper Woodland (9101)	--	--	0	5
Urban High Intensity (9410)	0	36	--	--
Urban Low Intensity (9411)	0	3	0	2
Open Water (9600)	0	<0.01	--	--

Source: TPWD, 2014
Note: "--" Vegetation type not present in segment

Grimes County

The potential temporary and permanent impacts to the four vegetation types represented in Segment 3C can be found in **Table 3.6-16**. The vegetation type with the largest acreage of impacts in Segment 3C would be:

- Post Oak Savanna: Savanna Grassland

The potential temporary and permanent impacts to the four vegetation types represented in Segment 4 can be found in **Table 3.6-16**. The vegetation type with the largest acreage of impacts in Segment would be:

- Post Oak Savanna: Savanna Grassland

The potential temporary and permanent impacts to the 25 vegetation types represented in Segment 5 can be found in **Table 3.6-16**. The three vegetation types with the largest acreage of impacts in Segment 5 would be:

- Post Oak Savanna: Savanna Grassland
- Post Oak Savanna: Post Oak Motte and Woodland
- Pineywoods: Disturbance or Tame Grassland

Table 3.6-16: Potential Impacts to Vegetation (acres) – Grimes County

Vegetation Type (EMST Code)	Segment 3C		Segment 4		Segment 5	
	Temp.	Perm.	Temp.	Perm.	Temp.	Perm.
Blackland Prairie: Disturbance or Tame Grassland (207)	--	--	--	--	5	232
Post Oak Savanna: Post Oak - Redcedar Motte and Woodland (603)	--	--	--	--	0	1
Post Oak Savanna: Post Oak Motte and Woodland (604)	0	28	0	16	57	197
Post Oak Savanna: Savanna Grassland (607)	0	51	0	36	141	422
Post Oak Savanna: Post Oak - Yaupon Motte and Woodland (613)	--	--	--	--	0	10
Central Texas: Floodplain Hardwood Forest (1804)	--	--	--	--	3	12
Central Texas: Floodplain Herbaceous Vegetation (1807)	--	--	--	--	4	7
Central Texas: Riparian Hardwood - Evergreen Forest (1903)	--	--	--	--	1	1
Central Texas: Riparian Hardwood Forest (1904)	--	--	--	--	1	4
Central Texas: Riparian Herbaceous Vegetation (1907)	--	--	--	--	2	9
Pineywoods: Pine Forest or Plantation (3001)	--	--	--	--	1	101
Pineywoods: Pine - Hardwood Forest or Plantation (3003)	--	--	--	--	2	33
Pineywoods: Upland Hardwood Forest (3004)	--	--	--	--	15	149
Pineywoods: Small Stream and Riparian Temporarily Flooded Mixed Forest (4803)	--	--	--	--	0	2
Pineywoods: Small Stream and Riparian Temporarily Flooded Hardwood Forest (4804)	0	4	0	19	6	25
Pineywoods: Small Stream and Riparian Wet Prairie (4817)	0	7	0	9	14	25
Barren (9000)	--	--	--	--	0	1
Marsh (9007)	--	--	--	--	0	1
Native Invasive: Deciduous Woodland (9104)	--	--	--	--	2	17
Native Invasive: Mesquite Shrubland (9106)	--	--	--	--	1	1
Native Invasive: Deciduous Shrubland (9126)	--	--	--	--	1	1
Pineywoods: Disturbance or Tame Grassland (9197)	--	--	--	--	165	176
Pine Plantation > 3 meters tall (9301)	--	--	--	--	--	--
Row Crops (9307)	--	--	--	--	--	--
Urban High Intensity (9410)	--	--	--	--	0	3
Urban Low Intensity (9411)	--	--	--	--	1	12
Open Water (9600)	--	--	--	-	0	1

Source: TPWD, 2014
Note: "--" Vegetation type not present in segment

Waller County

The potential temporary and permanent impacts to the 15 vegetation types represented in Segment 5 can be found in **Table 3.6-17**. The vegetation type with the largest acreage of impacts in Segment 5 would be:

- Gulf Coast: Coastal Prairie

Table 3.6-17: Potential Impacts to Vegetation (acres) – Waller County

Vegetation Type (EMST Code)	Segment 5	
	Temp.	Perm.
Blackland Prairie: Disturbance or Tame Grassland (207)	0	1
Post Oak Savanna: Post Oak Motte and Woodland (604)	2	44
Post Oak Savanna: Savanna Grassland (607)	1	5
Pineywoods: Pine Forest or Plantation (3001)	0	48
Pineywoods: Pine - Hardwood Forest or Plantation (3003)	0	12

Table 3.6-17: Potential Impacts to Vegetation (acres) – Waller County

Vegetation Type (EMST Code)	Segment 5	
	Temp.	Perm.
Pineywoods: Upland Hardwood Forest (3004)	0	58
Pineywoods: Small Stream and Riparian Temporarily Flooded Hardwood Forest (4804)	0	9
Pineywoods: Small Stream and Riparian Wet Prairie (4817)	0	2
Gulf Coast: Coastal Prairie (5207)	4	99
Native Invasive: Deciduous Woodland (9104)	0	1
Native Invasive: Deciduous Shrubland (9126)	0	1
Pineywoods: Disturbance or Tame Grassland (9197)	0	21
Pine Plantation > 3 meters tall (9301)	0	1
Row Crops (9307)	0	1
Urban Low Intensity (9411)	0	1

Source: TPWD, 2014

Harris County

The potential temporary and permanent impacts to the 16 vegetation types represented in Segment 5 can be found in **Table 3.6-18**. The vegetation type with the largest acreage of impacts in this Segment 5 would be:

- Gulf Coast: Coastal Prairie

Table 3.6-18: Potential Impacts to Vegetation (acres) – Harris County

Vegetation Type (EMST Code)	Segment 5		Industrial Site Terminal		Northwest Mall Terminal		Northwest Transit Center Terminal	
	Temp.	Perm.	Temp.	Perm.	Temp.	Perm.	Temp.	Perm.
Post Oak Savanna: Live Oak Motte and Woodland (602)	1	12	--	--	--	--	--	--
Post Oak Savanna: Post Oak - Redcedar Motte and Woodland (603)	0	1	--	--	--	--	--	--
Post Oak Savanna: Post Oak Motte and Woodland (604)	1	3	--	--	--	--	--	--
Pineywoods: Small Stream and Riparian Temporarily Flooded Hardwood Forest (4804)	0	2	--	--	--	--	--	--
Gulf Coast: Coastal Prairie (5207)	330	521	--	--	--	--	--	--
Gulf Coast: Coastal Prairie Pondshore (5307)	0	9	--	--	--	--	--	--
Barren (9000)	0	1	0	<0.01	0	3	4	2
Marsh (9007)	0	1	--	--	--	--	--	--
Native Invasive: Deciduous Woodland (9104)	0	25	--	--	--	--	--	--
Native Invasive: Mesquite Shrubland	0	1	--	--	--	--	--	--

Table 3.6-18: Potential Impacts to Vegetation (acres) – Harris County

Vegetation Type (EMST Code)	Segment 5		Industrial Site Terminal		Northwest Mall Terminal		Northwest Transit Center Terminal	
	Temp.	Perm.	Temp.	Perm.	Temp.	Perm.	Temp.	Perm.
(9106)								
Native Invasive: Huisache Woodland or Shrubland (9124)	6	25	--	--	--	--	--	--
Pineywoods: Disturbance or Tame Grassland (9197)	--	--	0	1	--	--	--	--
Pine Plantation > 3 meters tall (9301)	1	6	--	--	--	--	--	--
Row Crops (9307)	46	195	--	--	--	--	--	--
Urban High Intensity (9410)	2	112	1	88	1	77	2	78
Urban Low Intensity (9411)	20	83	0	9	0	1	0	1
Open Water (9600)	0	1	--	--	--	--	--	--

"—" Vegetation type not present
Source: TPWD, 2014

3.6.5.2.2 Wildlife

All Build Alternatives would result in the direct loss of wildlife habitat, increase habitat fragmentation and contribute to impediments of the movement of wildlife across the landscape. Impacts to wildlife would be minimized by locating the HSR infrastructure adjacent to existing transportation infrastructure, utility corridors and other development. Fragmented habitat areas would be created between the Build Alternatives and existing infrastructure, creating areas of less value to wildlife. A loss of species diversity and abundance would be expected to occur within these fragmented habitat areas. **Table 3.6-19** and **Table 3.6-20** identifies the percent change in edge to area ratios and the total acres of permanent habitat loss for grasslands and shrub/woodlands for each segment and Build Alternative. This information is a relative measure between the segments and is not separated by county as it would create false edges, skewing the data. The habitat classifications of grassland and shrub/woodland are based on EMST data and descriptions. For grasslands, all areas along the Build Alternatives that would be constructed on embankment would be considered fragmented post construction. For shrub/woodlands, all areas along the Build Alternatives that would be constructed on embankment or viaduct would be considered fragmented post construction.

Table 3.6-19: Habitat Fragmentation by Segment

Habitat Type	Segment 1		Segment 2A		Segment 2B		Segment 3A	
	Percent Change in Edge/Area Ratio	Loss of Habitat (acres)	Percent Change in Edge/Area Ratio	Loss of Habitat (acres)	Percent Change in Edge/Area Ratio	Loss of Habitat (acres)	Percent Change in Edge/Area Ratio	Loss of Habitat (acres)
Grassland	9.2	131.7	6.3	261.9	4.8	204.0	2.0	503.2
Shrub/Woodland	13.0	255.0	2.3	80.9	3.6	104.5	10.0	185.2
Habitat Type	Segment 3B		Segment 3C		Segment 4		Segment 5	
	Percent Change in Edge/Area Ratio	Loss of Habitat (acres)	Percent Change in Edge/Area Ratio	Loss of Habitat (acres)	Percent Change in Edge/Area Ratio	Loss of Habitat (acres)	Percent Change in Edge/Area Ratio	Loss of Habitat (acres)
Grassland	2.5	598.0	3.9	1,872.8	5.7	1,768.0	4.4	1,841.7
Shrub/Woodland	13.5	154.8	3.6	1,245.0	10.8	1,098.3	14.0	896.5

Source: AECOM, 2017

The summary of percent change in edge to area ratio and loss of habitat for the segments are provided below:

- Segment 3A would have the lowest percent of change in edge to area ratio for grasslands at 2.0 percent and Segment 2A would have the lowest change in edge to area ratio for shrub/woodlands at 2.3 percent.
- Segment 1 would have the highest percent of change in edge to area ratio for grasslands at 9.2 percent and Segment 5 would have the highest percent of change in edge to area ratio for shrub/woodlands at 14.0 percent.
- Segment 1 would have the lowest loss of habitat for grasslands at 131.7 acres and Segment 2A would have the lowest loss of habitat for shrub/woodlands at 80.9 acres.
- Segment 3C would have the highest loss of habitat for grasslands at 1,872.8 acres and the highest loss of habitat for shrub/woodlands at 1,245.0 acres.

Table 3.6-20: Habitat Fragmentation by Alternative

Habitat Type	ALT A		ALT B		ALT C	
	Percent Change in Edge/ Area Ratio	Loss of Habitat (acres)	Percent Change in Edge/ Area Ratio	Loss of Habitat (acres)	Percent Change in Edge/ Area Ratio	Loss of Habitat (acres)
Grassland	4.4	4,506.6	4.5	4,601.3	4.2	4,108.1
Shrub/Woodland	10.6	2,515.9	10.9	2,485.5	5.9	2,477.4
Habitat Type	**ALT D**		**ALT E**		**ALT F**	
	Percent Change in Edge/ Area Ratio	**Loss of Habitat (acres)**	**Percent Change in Edge/ Area Ratio**	**Loss of Habitat (acres)**	**Percent Change in Edge/ Area Ratio**	**Loss of Habitat (acres)**
Grassland	4.3	4,448.6	4.4	4,543.4	4.1	4,050.2
Shrub/Woodland	10.8	2,539.5	11.1	2,509.1	6.0	2,501.0

Source: AECOM, 2017

The summary of percent change in edge to area ratio and loss of habitat for the Build Alternatives are provided below:

- Alternative F would have the lowest percent of change in edge to area ratio for grasslands at 4.1 percent and Alternative B would have the highest percent of change in edge to area ratio for grasslands at 4.5 percent.
- Alternative C would have the lowest change in edge to area ratio for shrub/woodlands at 5.9 percent and Alternative E would have the highest percent of change in edge to area ratio for shrub/woodlands at 11.1 percent.
- Alternative F would have the lowest loss of habitat for grasslands at 4,050.2 acres and Alternative B would have the highest loss of habitat for grasslands at 4,601.3 acres.
- Alternative C would have the least amount of habitat loss for shrub/woodlands at 2,477.4 acres and Alternative D would have the highest loss of habitat for shrub/woodlands at 2,539.5 acres.

Wildlife habitat values are generally greater in areas of denser native vegetation, such as along riparian areas. These temporarily or seasonally dry creek beds provide a source of water and also provide important corridors for wildlife movement across the landscape. In areas of limited or scattered human development, these habitats are used by a wide array of species.
All Build Alternatives could result in a barrier to wildlife movement for both large and small species. Based on the preliminary design, approximately 60 percent of the Build Alternatives would be constructed on viaduct, allowing for unimpeded movement of wildlife beneath the tracks in these areas. However, the open and herbaceous vegetation beneath the tracks may be less desirable to wildlife when compared to undisturbed riparian corridors. When on embankment, wildlife crossings would be constructed (see **Appendix E, Wildlife Crossings Technical Memorandum)**. As discussed in **Sections 3.7, Waters of the U.S. and 3.8, Floodplains,** similar features installed for drainage and flood control may

also be used by wildlife.[109] Mitigation measures to minimize impacts to wildlife movement are described in **Section 3.6.6**.

While habituation to transportation noise, such as at airports, highways and urban centers, is commonly seen in some species and wildlife, the effect of train noise and associated vibration on wildlife is unclear as it has not been thoroughly studied. While the passage of a train may not cause degradation in adjacent habitat, wildlife may respond to this type of disturbance. Noise may affect different animals in different ways. Some animal species that live near active railroad tracks may become accustomed to noise and vibration from trains. Migratory species and species that do not consistently inhabit the area may be more likely to be affected by noise from passing trains.[110] As detailed in **Section 3.4, Noise and Vibration** and according to the *FRA Interim Criteria for Train Noise Effects on Animals*, noise exposure limits for domestic (livestock and poultry) and wild animals (mammals and birds) is 100 decibels.[111] For HSR trains operating on viaduct at the maximum speed of 205 mph, the 100 decibel limit would only be exceeded within about 15 feet from the tracks. Where the HSR tracks would be on viaduct or embankment and there would be wildlife or livestock crossings enclosed in a culvert, noise levels would be reduced by shielding either below the viaduct or within the culvert. Therefore, noise impact on wildlife would not be significant. Additionally, high levels of vibration or repeated exposure to vibrations may cause the collapse of small mammal dens and reptile burrows. Currently, there are no criteria for assessment of impacts from vibration on wildlife.

The construction of the Build Alternatives could result in the disturbance and potential mortality of wildlife, particularly during vegetation clearing and grading. The removal of vegetation during breeding season, late winter through spring and summer could result in the loss of active bird nests. The MBTA prohibits taking, attempting to take, capturing, killing, selling/purchasing, possessing, transporting, and importing of migratory birds, their eggs, parts and nests, except when specifically authorized by USFWS. While there is a permitting process for the transport, research and taxidermy of migratory birds, there is not currently a permit process for the incidental take of migratory bird species. Measures should be taken to ensure that migratory bird species within and near the Study Area are not adversely impacted by construction, maintenance, and operation activities. If migratory bird species are found nesting in or adjacent to the Study Area, they would be dealt with in a manner consistent with the MBTA. In addition, according to TPWD (**Appendix C, Agency Correspondence**), artificial nighttime lighting can attract and disorient night-migrating birds. Birds circling the lights' glare can cause collision with structures or exhaustion mortality. The Build Alternatives would be located within a bird migration corridor; therefore, TPWD recommends only the minimum amount of light for safety and security be used during night construction and operations. In addition, TPWD recommends that lighting be down-shielded to light only the ground and reduce glare. Per TCRR's preliminary design, all lighting for the Build Alternatives would be primarily motion-activated and down-shielded to solely focus on the rail line. Mitigation measures to avoid impacts to migratory birds and comply with the MBTA are described in **Section 3.6.6.**

Construction of the Build Alternatives would not have significant impacts on commercially or recreationally important wildlife species occurring within the Study Area. Game species, such as the

[109] TCRR, Mr. Christopher Taylor to Ms. Melissa Hatcher, January 3, 2016, Arup, Wildlife Crossing Considerations for Texas High Speed Rail, File reference 234180-4.01.
[110] Hanson, C. E. "High Speed Train Noise Effects on Wildlife and Domestic Livestock." In *Noise and Vibration Mitigation for Rail Transportation Systems*, edited by Burkhard Schulte-Werning, et al., 26-32. Springer, 2008.
[111] FRA, "Interim Criteria for Train Noise Effects on Animals," last updated October 24, 2012, https://www.fra.dot.gov/eLib/Details/L04090.

white-tailed deer, northern bobwhite, mourning dove, white-winged dove, squirrel, rabbit and wild turkey, are highly mobile and would leave the immediate vicinity during the construction period, and likely return following construction. Wildlife, including commercially or recreationally important species, in the immediate area may experience a loss of forage vegetation; however, the prevalence of similar habitats in adjacent areas would minimize the short-term effect of the loss.

There are currently no permitting mechanisms for incidental take of non-protected wildlife species in Texas or migratory birds under the MBTA. However, the Build Alternatives would have no significant impacts on wildlife through the implementation of mitigation measures as described in **Section 3.6.6.**

3.6.5.2.3 Protected Species

A total of 14 state-listed threatened species, including two federal Candidate species, may be impacted by each of the Build Alternatives. These impacts could be minimized and/or avoided by deploying qualified biologists to conduct surveys prior to construction and during construction activities within or near protected species and their habitat to ensure implementation and compliance with environmental protection measures. These qualified biologists could also identify these protected species and relocate individuals so direct mortality is avoided. Mitigation measures are described in **Section 3.6.6**. It is important to note that Texas does not have a permitting mechanism for incidental take of state-listed species. Therefore, avoidance is the only path for ensuring compliance with state laws and regulations.

In addition, there would be four federally- and state-listed endangered species that have the potential to occur in the Study Area: Houston toad, interior least tern, Navasota ladies'-tresses and the large-fruited sand-verbena. The interior least tern, if present, would be anticipated to frequent the streams and waterbodies within the Study Area, as detailed in **Section 3.7, Waters of the U.S.**, that contain sand flats, sand and gravel bars or beaches. For the remaining three federally listed species, **Table 3.6-21** provides acreage of potential impacts to habitat by Build Alternative Segment for each county. For mapped potential habitat of each of the federally listed species, please refer to the **Natural Resources Mapbook**, **Appendix D.**

Dallas, Ellis, Navarro and Limestone counties do not have potential habitat mapped within the Study Area; therefore, their acreage of impacts to federally-listed species is zero.

Table 3.6-21: Potential Habitat of Federally Endangered Species within the Study Area (acres)

Common Name/ Scientific Name	Freestone				Leon				Madison				Grimes						Waller		Harris	
	3C		4		3C		4		3C		4		3C		4		5		5		5	
	Temp.	Perm.	Temp.	Perm.	Temp.	Perm.	Temp.	Perm.	Temp.	Perm.	Temp.	Perm.	Temp.	Perm.	Temp.	Perm.	Temp.	Perm.	Temp.	Perm.	Temp.	Perm.
Wildlife																						
Houston toad/ *Bufo houstonensis*	--	--	--	--	10	238	4	228	--	--	--	--	0	3	0	1	27	272	--	--	--	--
Plants																						
Large-fruited sand verbena/ *Abronia macrocarpa*	3	29	1	19	7	120	56	81	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Navasota ladies'-tresses/ *Spiranthes parksii*	47	68	--	--	46	231	0	9	1	318	57	348	0	61	0	48	198	333	--	--	--	--

"—" No potential habitat present

Source: TPWD, 2014; AECOM 2017

Based on the presence/absence species surveys completed to date, FRA anticipates that the Build Alternatives may affect, but are not likely to adversely affect, the interior least tern, Houston toad, large-fruited sand verbena and Navasota ladies' tresses based on the implementation of various avoidance and mitigation measures described in **Section 3.6.6**. Surveys for the Navasota ladies' tresses, Houston toad and large-fruited sand verbena will continue in 2017, 2018 and 2019 (as necessary, to obtain three consecutive years of data). If future surveys yield no occurrences of these species, FRA would submit the rationale for the May Affect, Not Likely to Adversely Affect determination to USFWS for concurrence. If USFWS concurs with FRA's determination, formal consultation would not be required and Section 7 consultation would be complete. Should any of these species be discovered during future surveys, FRA would need to initiate formal consultation with USFWS through the preparation of a BA documenting the potential impacts of the Build Alternatives on the affected species. The BA would be evaluated by the USFWS for concurrence prior to construction. Approval from USFWS would be obtained via a BO and incidental take statement following their concurrence on the BA.

In addition, while golden eagles are not likely to occur within the Study Area, bald eagles are year-round residents in all Study Area counties. There is a potential for interaction with bald eagles due to the crossing of lakes, rivers and streams by the Build Alternatives. Impacts would be avoided following mitigation efforts outlined in the National Bald Eagle Management Guidelines and in accordance with the Bald and Golden Eagle Protection Act. The Build Alternatives would be anticipated to have no significant impacts on bald eagles through the implementation of mitigation measures described in **Section 3.6.6.**

3.6.6 Avoidance, Minimization and Mitigation

FRA consulted with TPWD regarding environmental and land use constraints and other issues of interest to TPWD. TPWD made specific recommendations in regard to the Build Alternatives (**Appendix C**), which included mitigation measures to avoid and minimize impacts to vegetation, wildlife (both terrestrial and aquatic), SGCN and protected species. The following measures are consistent with TPWD recommendations, as well as applicable federal regulations. TCRR would implement these measures to reduce adverse effects to natural ecological resources and protected species. Design features would be implemented to avoid and minimize impacts including aligning the Build Alternatives to maximize the use of disturbed lands and minimize habitat fragmentation by co-locating the Build Alternatives with existing transportation and utility corridors, where practicable. Additionally, approximately 60 percent of the Build Alternatives would be constructed on viaduct. TCRR shall implement additional mitigation measures for vegetation, wildlife and protected species in compliance with applicable regulations as detailed in **Section 3.6.2, Regulatory Context**.

For compliance with the ESA, FRA is currently undergoing informal consultation with USFWS. Should any federally-listed species be discovered during future presence/absence surveys, FRA shall submit a BA for approval by USFWS. If USFWS concurs, USFWS will issue a BO and incidental take statement. The BA would be made legally binding through the issuance of a BO and gives USFWS regulatory enforcement authority. Additional mitigation measures may be determined in the BO issued by USFWS, and in compliance with aforementioned state and federal laws and regulations.

No state regulations exist for mitigation of impacts to general wildlife and vegetation. Therefore, all mitigation measures for general wildlife and vegetation detailed below would be considered due diligence measures and do not have associated regulations or an associated enforcement agency.

3.6.6.1 Compliance Measures and Permitting

The following Compliance Measures (CM) and permits for wildlife and vegetation would be required for Build Alternatives A through F.

NR-CM#1: MBTA Compliance. During construction, TCRR and its construction contractor shall implement seasonal restrictions on the removal of vegetation to protect nesting birds during the nesting season, which is defined as March 1 through August 31. If ground clearing would occur during the nesting season, TCRR and its construction contractor shall hire a qualified biologist to perform preconstruction surveys for nesting birds prior to the removal of vegetation.

NR-CM#2: Bald and Golden Eagle Protection Act Compliance. Prior to the start of construction, TCRR and its construction contractor shall hire a qualified biologist to conduct surveys for bald eagles nests within the LOD and 660 feet beyond the LOD. In accordance with the National Bald Eagle Management Guidelines and the Bald and Golden Eagle Protection Act, should bald eagle nests be discovered during the surveys or construction, TCRR shall avoid take of those nests. Additionally, a buffer distance of 660 feet shall be placed around the nests, in which construction shall be prohibited until the nest is no longer active and nesting season, defined as August 1 through January 31, is over. However, if an active or inactive nest is located within the vegetation clearing limits, TCRR shall acquire a USFWS Bald and Golden Eagle permit from the USFWS before the removal of the nest. Acquisition of this permit would trigger formal coordination between TCRR and USFWS and the preparation of a BO by the USFWS.

NR-CM#3: Impacts to Bats. During construction, TCRR shall hire qualified biologists to conduct surveys of potential roost habitat for Rafinesque's big-eared bat including, but not limited to, large hollow trees, culverts and bridges for maternity colonies. If found TCRR shall not disturb the colonies until pups have fledged.

NR-CM#4: Avoid Transporting Nonnative Seed. During construction, TCRR and its construction contractor shall ensure vehicles and equipment are washed before entering and leaving worksites for a minimum of six minutes to avoid potential transport of nonnative seed to construction areas. Vehicles and equipment shall have extra cleaning time to remove soil when off-road driving and activities occur.

NR-CM#5: Houston Toad Surveys. The first year of presence/absence surveys have been conducted for the Houston toad by qualified biologists that hold federal and state permits for identifying and locating, the Houston toad. FRA will complete two additional years of surveys in 2018 and 2019 prior to construction of the Project.

NR-CM#6: Presence of Houston Toad During Construction. If the presence of Houston toad is identified through species surveys, or if USFWS determined that any area of potential habitat could not be accessed for species surveys, systematic pedestrian survey should precede construction within occupied/presumed occupied habitat. In addition, physical exclusion (silt fence or other physical barrier to anurans) should be erected at the boundary of work areas located within occupied/presumed occupied habitat to exclude entry by Houston toads. Daily monitoring and maintenance of this perimeter is necessary to ensure integrity of exclusion measures. Active survey and trapping (e.g., pitfall traps and cover boards) should continue within the exclusion barrier and particularly following precipitation events. A 24 hour stop work following rain events, cumulatively of 2 inches or more, in the preceding 48 hours should be required. TCRR will deploy a qualified biologist to monitor construction activities within all areas identified as potential habitat for active species (see the **Natural Resources Mapbook**, **Appendix D)**. During construction, should an unexpected Houston toad be encountered, TCRR and its construction contractor shall cease work in that area immediately. The Houston toad monitor shall secure the area containing the Houston toad and consult FRA and USFWS.

NR-CM#7: Protected Plant Species Surveys for Navasota ladies'-tresses, and large-fruited sand-verbena in Freestone, Leon, Madison, Grimes, and Waller Counties. One year of presence/absence surveys have been conducted for Navasota ladies'-tresses and large-fruited sand verbena. While no individuals were observed, additional surveys are necessary and will be completed by FRA in 2017-2019 (as necessary, to obtain three consecutive years of data). If FRA determines species absence based on three years of surveys, the agency will complete informal consultation with USFWS. No additional pre-construction surveys would be anticipated.

NR-CM#8: Presence of Navasota Ladies' Tresses or Large-fruited Sand Verbena During Construction. If presence of Navasota ladies' tresses and/or large-fruited sand verbena is determined through species surveys or if any area of potential habitat could not be accessed for species surveys, TCRR and its construction contractor shall hire qualified biologists approved by the USFWS to monitor the construction site for the protected plant species. During construction, should an unexpected protected plant species be encountered, TCRR and its construction contractor shall cease work in that area immediately. The monitor shall secure the area containing the plant species and consult FRA and USFWS.

NR-CM#9: Nesting Interior Least Tern Inspection and Coordination in all counties excluding Harris County. Prior to and during construction, TCRR and its construction contractor shall hire a qualified biologist to inspect all sandbars and open gravel areas prior to disturbance during the species breeding season, defined as April 1 through August 31. Inspections shall occur immediately prior to construction to determine the presence or absence of nesting interior least terns. Should nesting interior least terns be discovered by a qualified biologist, FRA shall reinitiate consultation with USFWS to determine measures to avoid impacts to the species. Due to the proximity of Jewett Mine to Build Alternatives A, B, D and E, which would be approximately one-half mile from Segment 4, where interior least terns have been documented to nest, prior to construction, TCRR will coordinate with the lignite mine operators to obtain the latest data on known nesting locations to avoid impacts to this species.

3.6.6.2 Mitigation Measures

TCRR would implement the following Mitigation Measures (MM) to reduce impacts to protected species as a result of Build Alternatives A through F.

NR-MM#1: Site Training. Prior to and during construction, TCRR and its construction contractor shall hire a qualified biologist to provide all site personnel with environmental awareness training. The training shall include the definition of "take" relative to protected species, the potential presence of protected species, and reporting requirements and measures to be taken to minimize impacts to the natural environment.

Prior to and during construction, TCRR and its construction contractor shall hire a Houston toad biologist to train all work crews prior to starting work within potential Houston toad habitat. Training of onsite personnel shall be documented (names, dates, and materials) and retained for reference.

NR-MM#2: Sensitive Habitat Areas. Prior to the start of construction, TCRR and its construction contractor shall hire a qualified biologist to flag or fence sensitive habitats to preclude construction impacts from occurring within the area. Sensitive habitats shall include:

- Areas identified that provide habitat for protected species.
- Areas adjacent to habitats of protected species.
- Areas where shorebird rookeries and nests are located.
- Areas where migratory birds or bald eagle nests are located.
- All lakes, wetlands, estuaries, lagoons, streams and rivers.
- Riparian corridors.

In addition, prior to the start of construction, TCRR shall hire a qualified biologist to install temporary environmental fencing around sensitive biological resources, as well as install signs signaling the need for avoidance of these areas to avoid unnecessary adverse impacts.

NR-MM#3: Aquatic Species. Prior to construction, TCRR and its construction contractor shall develop a storm water pollution prevention plan (SWPPP) to minimize impacts to aquatic protected species. In addition, protected mussel species presence/absence surveys may be required prior to construction in streams that would be directly impacted to avoid take of individual species.

NR-MM#4: Minimize Limits of Disturbance. During construction, TCRR and its construction contractor shall minimize disturbance to vegetation by using previously disturbed areas for staging and equipment storage and limit driving speeds in sensitive areas. Appropriate speed limits for sensitive areas shall be determined in coordination with USFWS and documented in the Final EIS and/or BO developed by USFWS, if necessary. The speed limits are dependent on the natural resources present within sensitive areas. In addition, TCRR and its construction contractor shall ensure disturbed ground is rehabilitated as soon as possible following construction activities to minimize exposure of bare ground susceptible to colonization by nonnative plants.

NR-MM#5: Cover Open Trenches. During construction, TCRR and its construction contractor shall ensure that open trenches are covered overnight and/or inspected every morning by an onsite biologist to ensure that no protected species or other wildlife are trapped. Should wildlife become trapped, a qualified biologist hired by TCRR would free the wildlife before construction could restart.

NR-MM#6: Escape Ramps. During construction, TCRR and its construction contractor shall ensure that escape ramps are placed in any open trenches during the day to ensure that wildlife, including protected species, can escape.

NR-MM#7: Documentation of Vegetation Impacts. Prior to and during construction, TCRR and its construction contractor shall hire a qualified biologist to document pre- and post-construction conditions for impacts to vegetation and listed plant species. These reports shall be conducted as part of coordination with the USFWS.

NR-MM#8: Minimize Nighttime Lighting. During nighttime construction and operation, TCRR shall use the minimum amount of nighttime lighting needed for safety and security.

NR-MM#9: Wildlife Crossings. TCRR and its construction contractors shall install wildlife crossings where the Build Alternatives are on embankment to facilitate the movement of large and small species of wildlife and avoid habitat fragmentation. Through environmental analysis, TCRR, along with TPWD and USFWS, will identify existing wildlife corridors and large habitat blocks to facilitate in the placement of crossings. The wildlife crossings would be designed under the following recommendations (see **Appendix E, Wildlife Crossings Technical Memorandum)**:

a. Wildlife crossings shall be designed to facilitate movement of large and small species of wildlife across the landscape
b. Wildlife crossings shall include culvert crossings constructed within the Project embankments in areas with surrounding wildlife cover, such as woodlands and forests
c. Culverted wildlife crossings shall be anticipated to have minimum constructed dimensions of 23 by 13 feet tall for larger animals (e.g., white-tailed deer), and 6.5 by 10 feet tall for small animals (e.g., rabbits)
d. Water crossing designs shall incorporate aquatic and wildlife movement requirements in order for their facilitation as wildlife crossings
e. Water crossings in the 100-year floodplain may be impassible during large flood events and create a barrier to terrestrial wildlife movement. Therefore, dryland culvert crossings with the previously mentioned dimensions shall be collocated with these riparian locations outside the 100-year floodplain.
f. Wildlife crossings shall be placed regardless of frequency to accommodate special situations (e.g., fenced stations or maintenance facilities and large road crossings).
g. Wildlife crossings in in the City of Dallas and Houston shall be limited due to small wildlife populations.
h. Wildlife corridors shall be situated in areas with limited noise and human activity, to the greatest extent practicable, and with a straight line of sight for wildlife
i. Locate crossings away from highways and other hazard areas to prevent wildlife mortality due to exposure to traffic or other threats, unless studies or expertise from researchers and professionals indicate a high mortality along certain areas necessitating placement of wildlife crossings in such locations
j. In areas where the Build Alternative parallels roadways, wildlife crossings shall be placed to avoid funneling wildlife towards roadways, but would be placed in locations with low road mortality and known wildlife corridors
k. Frequency and monitoring of wildlife crossings shall be determined in coordination with TPWD and USFWS for species of special concern (e.g., Houston toad), and largely based on species' biology, such as home range size, and habitat

NR-MM#10: Protected Plant Species Site Restoration Plan. Prior to construction a site restoration plan identifying techniques, timing and success criteria for protected plant species shall be prepared by TCRR through coordination with the USFWS. Displaced native vegetation shall be transplanted to adjacent lands by a qualified biologist hired by TCRR, when feasible. TCRR shall restore sites with native seed mixes certified as "weed free."

NR-MM#11: Downed Tree, Log and Stump Removal within Houston Toad Habitat. During construction, TCRR and its construction contractor shall hire a qualified biologist that holds federal and state permits for the Houston Toad. The qualified biologist shall lift and inspect downed trees and logs to be moved, removed to a staging area, mulched, disturbed by a falling tree that is scheduled to be cut, or otherwise disturbed to determine if any Houston toads are sheltering beneath, per USFWS survey guidance. In addition, during removal of any stumps the qualified biologist shall inspect the area prior to removal and monitor the activity during removal.

NR-MM#12: Mowing Height Restriction within Houston Toad Habitat. During construction and operation, TCRR and its construction contractor shall set any mowing equipment used for clearing grass, forbs and small-diameter woody vegetation to a height of at least five inches above the ground to minimize the potential for striking toads. Seasonal restrictions on mowing operations within potential Houston toad habitat may also be implemented.

NR-MM#13: Vegetation Removal near Houston Toad Breeding Sites. During construction, Vegetation that occurs within 200 feet of potential Houston toad breeding sites, as determined by the Houston toad monitor (e.g., riparian areas, ravines, ephemeral wet weather ponds, creeks, streams, drainages, ponds, stock tanks, wetlands, seeps, and springs) shall be hand-cut. Any soil disturbance or operation of heavy equipment within 200 feet of a potential breeding site shall be approved by the Houston toad monitor prior to the start of work.

3.6.7 Build Alternatives Comparison

Impacts to the vegetation types by Build Alternative are summarized in **Table 3.6-22** and impacts to vegetation by Houston Terminal Options are summarized in **Table 3.6.23**. Total acreage of temporary and permanent vegetation impacts varies by alternative. Alternative F would have the least acreage of temporary impacts at 2,018 acres, while Alternative B would have the highest at 2,185 acres. In addition, Alternatives A and D would have the least acreage of permanent impacts at 7,961 acres, while Alternatives C and F would have the highest (8,230 acres). Post Oak Savanna: Savanna Grassland would have the highest acreage of permanent impacts for all Build Alternatives, ranging from 1,866 acres under Alternatives A and D to 1,956 acres under Alternatives C and F. Central Texas: Floodplain Seasonally Flooded Hardwood Forest would have the least amount of acreage of temporary and permanent impacts with no temporary impacts and one acre permanently impacted by Alternatives C and F only. The Industrial Site Terminal Option would have the highest acreage of permanent impacts at 97 acre, while the Northwest Mall and Northwest Transit Terminal Options would have the least acreage of permanent impacts at 81 acres. The primarily impacted vegetation type would be Urban Low Intensity.

Alternative F would have the least loss of habitat for grasslands at 4,050.2 acres, and Alternative C would have the lowest loss of habitat for shrub/woodlands at 2,477.4 acres. Alternative B would have the highest loss of habitat for grasslands at 4,601.3 acres, and Alternative D would have the highest loss of habitat for shrub/woodlands at 2,539.5 acres.

Table 3.6-24 presents acreages of temporary and permanent impacts to potential habitat of 3 of the 4 federally-listed species with potential to occur in the Study Area. As previously stated, impacts to the interior least tern are not presented due to the variability of the species habitat. Impacts and mitigation for the interior least tern will be assessed and permitted through the BA, BO and the incidental take statement issued by USFWS. Alternatives A, B, D, and E would have the same temporary and permanent impacts to listed species' potential habitats at 341 and 1,334 acres, respectively. Alternatives C and F would have the same temporary and permanent impacts to listed species' potential habitat at 337 and 1,669, respectively. Impacts to common wildlife are not presented because they do not vary between alternatives.

Given the urban component of the Houston Terminal Station options, the three options have similarly negligible impacts for ecological systems and do not contain habitat for protected species.

Table 3.6-22: Vegetation Impacts by Build Alternative (acres)

Vegetation Types (EMST Code)	ALT A		ALT B		ALT C		ALT D		ALT E		ALT F	
	Temp	Perm	Temp	Perm	Temp	Perm	Temp	Perm	Temp	Perm	Temp	Perm
Blackland Prairie: Disturbance or Tame Grassland (207)	245	1,292	289	1,337	182	1223	252	1,219	296	1,265	189	1,150
Post Oak Savanna: Live Oak Motte and Woodland (602)	1	12	1	12	1	12	1	12	1	12	1	12
Post Oak Savanna: Post Oak - Redcedar Motte and Woodland (603)	0	1	0	1	0	1	0	1	0	1	0	1
Post Oak Savanna: Post Oak Motte and Woodland (604)	116	1,084	78	1,146	271	915	116	1,084	78	1,146	271	915
Post Oak Savanna: Savanna Grassland (607)	526	1,866	532	1,885	286	1,956	523	1,866	532	1,885	286	1,956
Post Oak Savanna: Post Oak - Yaupon Motte and Woodland (613)	1	32	0	29	4	22	1	32	0	29	4	22
Post Oak Savanna: Sandyland Woodland and Shrubland (706)	0	32	0	32	0	9	0	32	0	32	0	9
Post Oak Savanna: Sandyland Grassland (707)	0	14	0	14	0	15	0	14	0	14	0	15
Edwards Plateau: Oak / Hardwood Slope Forest (904)	0	1	0	1	0	1	0	1	0	1	0	1
Edwards Plateau: Live Oak Motte and Woodland (1102)	0	1	0	1	0	1	0	1	0	1	0	1
Edwards Plateau: Deciduous Oak / Evergreen Motte and Woodland (1103)	0	11	0	11	0	11	0	11	0	11	0	11
Edwards Plateau: Oak / Hardwood Motte and Woodland (1104)	16	18	16	18	16	18	16	18	16	18	16	18
Edwards Plateau: Savanna Grassland (1107)	1	24	1	24	1	24	1	24	1	24	1	24
Central Texas: Floodplain Live Oak Forest (1802)	0	1	0	1	0	1	--	--	--	--	--	--
Central Texas: Floodplain Hardwood / Evergreen Forest (1803)	0	3	0	3	0	3	0	3	0	3	0	3
Central Texas: Floodplain Hardwood Forest (1804)	15	193	15	199	36	210	15	197	15	203	37	214
Central Texas: Floodplain Deciduous Shrubland (1806)	0	3	0	3	0	2	0	3	0	3	0	2
Central Texas: Floodplain Herbaceous Vegetation (1807)	26	163	28	147	14	157	27	165	28	149	15	159
Central Texas: Floodplain Seasonally Flooded Hardwood Forest (1814)	--	--	--	--	0	1	--	--	--	--	0	1
Central Texas: Riparian Hardwood / Evergreen Forest (1903)	1	1	1	1	1	1	1	1	1	1	1	1
Central Texas: Riparian Hardwood Forest (1904)	3	35	2	36	1	21	3	36	3	36	2	21
Central Texas: Riparian Deciduous Shrubland (1906)	0	1	0	1	0	1	0	1	0	1	0	1
Central Texas: Riparian Herbaceous Vegetation (1907)	3	34	3	41	2	28	4	36	3	43	3	29
Pineywoods: Pine Forest or Plantation (3001)	1	149	1	149	1	156	1	149	1	149	1	156
Pineywoods: Pine - Hardwood Forest or Plantation (3003)	2	45	2	45	2	45	2	45	2	45	2	45
Pineywoods: Upland Hardwood Forest (3004)	15	207	15	207	16	207	15	207	15	207	15	207
Pineywoods: Small Stream and Riparian Temporarily Flooded Mixed Forest (4803)	0	2	0	2	0	2	0	2	0	2	0	2
Pineywoods: Small Stream and Riparian Temporarily Flooded Hardwood Forest (4804)	8	96	8	96	6	82	8	96	8	96	6	82
Pineywoods: Small Stream and Riparian Seasonally Flooded Hardwood Forest (4814)	0	1	0	1	--	--	0	1	0	1	--	--

Table 3.6-22: Vegetation Impacts by Build Alternative (acres)

Vegetation Types (EMST Code)	ALT A		ALT B		ALT C		ALT D		ALT E		ALT F	
	Temp	Perm	Temp	Perm	Temp	Perm	Temp	Perm	Temp	Perm	Temp	Perm
Pineywoods: Small Stream and Riparian Wet Prairie (4817)	14	44	14	44	14	60	14	44	14	44	14	60
Gulf Coast: Coastal Prairie (5207)	334	620	334	620	334	620	334	620	334	620	334	620
Gulf Coast: Coastal Prairie Pondshore (5307)	0	9	0	9	0	9	0	9	0	9	0	9
Barren (9000)	1	9	1	9	0	8	1	9	1	9	0	8
Swamp (9004)	0	1	0	1	0	1	0	1	0	1	0	1
Marsh (9007)	1	1	0	1	0	2	1	1	0	1	0	2
Native Invasive: Juniper Woodland (9101)	2	29	1	28	6	23	2	29	1	28	6	23
Native Invasive: Deciduous Woodland (9104)	86	207	54	186	66	205	86	230	54	209	66	227
Native Invasive: Juniper Shrubland (9105)	0	4	0	4	0	14	0	4	0	4	0	14
Native Invasive: Mesquite Shrubland (9106)	17	33	12	33	15	41	17	29	12	29	15	37
Native Invasive: Huisache Woodland or Shrubland (9124)	6	25	6	25	6	25	6	25	6	25	6	25
Native Invasive: Deciduous Shrubland (9126)	1	2	1	2	1	2	1	2	1	2	1	2
Pineywoods: Disturbance or Tame (9197)	165	197	165	197	165	197	165	197	165	197	165	197
Pine Plantation > 3 meters tall (9301)*	1	6	1	6	1	6	1	6	1	6	1	6
Row Crops (9307)*	491	980	512	954	494	946	465	1,025	486	1000	468	992
Urban High Intensity (9410)	25	212	25	216	34	502	25	212	25	216	34	502
Urban Low Intensity (9411)	58	252	69	258	61	441	58	253	69	259	61	442
Open Water (9600)	1	12	1	14	1	9	1	11	1	13	1	9
Total Acreage of Impacts	**2,176**	**7,960**	**2,185**	**8,045**	**2,035**	**8,230**	**2,158**	**7,961**	**2,167**	**8,046**	**2,018**	**8,230**

Source: AECOM, 2017
"—" Vegetation type not present, * Are considered agricultural types

Table 3.6-23: Vegetation Impacts by Houston Terminal Station Options (acres)

Vegetation Types (EMST Code)	Industrial Site		Northwest Mall		Northwest Transit	
	Temp	Perm	Temp	Perm	Temp	Perm
Barren (9000)	0	1	0	3	4	2
Pineywoods: Disturbance or Tame (9197)	0	1	--	--	--	--
Urban High Intensity (9410)	1	88	1	77	2	78
Urban Low Intensity (9411)	0	9	0	1	0	1
Total Acreage of Impacts	**1**	**97**	**1**	**81**	**6**	**81**

Source: AECOM, 2017
"—" Vegetation type not present

Table 3.6-24: Protected Species Impacts by Build Alternative (acres)

	ALT A		ALT B		ALT C		ALT D		ALT E		ALT F	
	Temp	**Perm**	**Temp**	**Perm**	**Temp**	**Perm**	**Temp**	**Perm**	**Temp**	**Perm**	**Temp**	**Perm**
Houston toad/ *Bufo houstonensis*	31	499	31	499	37	511	31	499	31	499	37	511
Large-fruited sand verbena/ *Abronia macrocarpa*	56	99	56	99	9	149	56	99	56	99	9	149
Navasota ladies'-tresses/ *Spiranthes parksii*	254	736	254	736	291	1009	254	736	254	736	291	1009
Protected Species Habitat	**341**	**1,334**	**341**	**1,334**	**337**	**1,669**	**341**	**1,334**	**341**	**1,334**	**337**	**1,669**

Source: AECOM, 2017

3.7 Waters of the U.S.

3.7.1 Introduction

This section examines potential impacts to potentially jurisdictional waters of the U.S., including intrastate rivers, streams, wetlands and waterbodies within the Study Area, as a result of the No Build Alternative and the Build Alternatives.

3.7.2 Regulatory Context

Federal

Section 404 of the Clean Water Act

For the purposes of the Clean Water Act,[1] waters of the U.S. are defined to include:

- 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 and their tributaries
- All interstate waters including interstate wetlands (all rivers, lakes and other waters that flow across or form part of, state boundaries) and their tributaries
- All waters such as intrastate lakes, rivers, streams, mudflats, sandflats, wetlands, sloughs, prairie potholes, wet meadows, playa lakes or natural ponds, in use, degradation or destruction of which would affect interstate or foreign commerce and their tributaries
- All impoundments of waters otherwise defined as waters of the U.S. under the definition and their tributaries
- Wetlands adjacent (bordering, contiguous or neighboring) to the above mentioned waters (other than waters that are themselves wetlands)[2]

The USACE and EPA have statutory responsibilities under Section 404 of the Clean Water Act. Under this act, discharges of dredged or fill material into waters of the U.S. are regulated; therefore, such activities may require permit authorization. The Project lies within the USACE Fort Worth and Galveston Districts' Areas of Responsibility (AOR). USACE is evaluating the Project under the provisions of one standard Individual Permit within each District's AOR. USACE is evaluating the overall Project, subject to its applicable authority, and will render single permit decisions within each District's AOR. Any permission USACE SWF renders for the Project would be conditioned such that construction of each phase of the Project that impacts jurisdictional waters will not be allowed to occur until such time that each phase of the Project is designed, submitted for review and is subsequently approved by the USACE.

Section 401 of the Clean Water Act

As part of Section 404 compliance, Section 401 of the Clean Water Act regulates the discharge of pollutants into waters of the U.S. and is enforced by TCEQ. Tier I projects are those that affect less than three acres of waters in the state and/or less than 1,500 linear feet of streams and Tier II projects are

---

[1] 33 U.S.C. § 1251 *et seq.*
[2] 33 C.F.R. § 328.3U.S.C.1251.

those that affect greater than three acres of waters in the state, and/or greater than 1,500 linear feet of streams. Tier I projects require the use of TCEQ approved BMPs and Tier II projects require the use of TCEQ approved BMPs as well as an individual certification review by TCEQ.[3]

Executive Order 11990

For projects that are undertaken, financed or assisted by federal agencies, potential impact to wetlands not determined to be waters of the U.S. are regulated under EO 11990, Protection of Wetlands. The objective of EO 11990 is to minimize the destruction, loss or degradation of wetlands while enhancing and protecting the natural and beneficial values. This order requires federal agencies to avoid or minimize impacts to these resources.[4]

Section 10 of the Rivers and Harbors Act of 1899

The USACE has statutory authority under Section 10 of the Rivers and Harbors Act to regulate the construction of any structure in or over a navigable water of the U.S. In addition, a Section 10 permit is required for any structure or work that affects the course, location or condition of the navigable water body.[5]

Section 14 of the Rivers and Harbors Act of 1899

Section 14 of the Rivers and Harbors Act, commonly referred to as Section 408, requires approval from the USACE to alter a USACE federally authorized civil works project.[6] Any proposed alteration must not be injurious to the public interest or affect the USACE project's ability to meet its authorized purpose. Current Section 408 policy can be found within Engineer Circular (EC) 1165-2-216, Policy and Procedural Guidance for Processing Requests to Alter U.S. Army Corps of Engineers Civil Works Projects Pursuant to 33 USC 408.[7]

State

Sand and Marl Permit

If a stream/creek is perennial or is more than 30 feet wide between the banks, the state claims the bed and the sand and gravel in it as state-owned. A "Sand and Marl" permit from TPWD is required to "disturb or take" streambed materials from a streambed claimed by the state. Pursuant to Chapter 86, Subtitle F, of the TPWD Code, the Texas Parks and Wildlife Commission shall manage, control and protect marl and sand of commercial value and all gravel, shell and mudshell located within tidewater limits of the state, and on islands within those limits and within the freshwater areas of the state not embraced by a survey of private land, and on islands within those areas.[8] In some cases, the Texas GLO may need to be contacted to determine whether the state claims a streambed.

---

[3] 33 U.S.C. § 1341
[4] *The White House. Executive Order 11990 - Protection of Wetlands, 42 F.R. 2696.1 Office of the White House Press Secretary, 1977.*
[5] 33 U.S.C. § 403
[6] 33 U.S.C. § 408
[7] USACE. *Policy and Procedural Guidance for Processing Requests to Alter US Army Corps of Engineers Civil Works Projects Pursuant to 33 U.S.C. 408*. U.S. Army Corps of Engineers: Washington, D.C., 2015.
[8] TPWD. Parks and Wildlife Code, Title 5, Subtitle F, Chapter 86 Marl, Sand, Gravel, Shell, and Mudshell. Parks and Wildlife Department, 1975.

3.7.3 Methodology

The Study Area is defined as the LOD (See **Natural Resources Mapbook** attached in **Appendix D**).

A desktop analysis using publicly available data was conducted to determine the existence and extent (acreage or linear feet) of potentially jurisdictional waters of the U.S., including wetlands, within the Study Area. Data reviewed included:

- USFWS NWI maps that consist of wetland maps and geospatial wetland data showing wetlands and deepwater habitats in the U.S.[9]
- Aerial imagery
- Light Detection and Ranging (LIDAR) data which creates three-dimensional information about the Earth's characteristics using light in the form of a pulsed lazer[10]
- National Hydrography Dataset (NHD) that represents the drainage network including rivers, streams, canals, lakes, ponds, coastline and dams[11]

To determine soil associations, which are taxonomic soil units occurring together in individual and characteristic patterns within the same geographical area, Natural Resources Conservation Service (NRCS) Soil Surveys were reviewed for each county within the Study Area.[12, 13, 14, 15, 16, 17, 18, 19, 20, 21] In addition, the Digital General Soils Map of the U.S., also referred to as STATSGO2, was reviewed for each Build Alternative.[22] Soils are an important factor when analyzing the potential presence of waters of the U.S., including wetlands, as certain areas mapped by the soil survey indicate a general likelihood that hydric soils would be found within the given area. Hydric soils are a technical parameter for wetland determination and may indicate the presence of wetlands.

FEMA FIRMs and Digital FIRMs were used to identify 100-year flood zones in the Study Area and the amount of floodplain located within the Study Area for all counties except Freestone County,[23] which is not currently mapped by FEMA. A floodplain is defined as a low area adjoining or adjacent to the channel of a river, stream, watercourse, ocean, lake or other body of water, which is susceptible to being inundated by water from any natural source.[24] These areas, if inundated or saturated frequently enough, may provide a hydrologic environment sufficient to support wetland vegetation and hydric soil conditions. See **Section 3.8, Floodplains** for project-specific analysis of floodplain impacts.

[9] USFWS, *"National Wetlands Inventory,"* Last modified December 07, 2016. http://www.fws.gov/wetlands/Data/Mapper.html (accessed May 03, 2017)
[10] National Oceanic and Atmospheric Administration. *"National Ocean Service – What is LIDAR?"* Last modified May 29, 2015. http://oceanservice.noaa.gov/facts/lidar.html (accessed May 5, 2016).
[11] USGS. *"National Hydrography Dataset,"* Last modified September 28, 2016. http://nhd.usgs.gov/data.html.
[12] NRCS. *Soil Survey of Dallas County, Texas.* U.S. Department of Agriculture, 1980.
[13] NRCS. *Soil Survey of Ellis County, Texas.* U.S. Department of Agriculture, 1964.
[14] NRCS. *Soil Survey of Navarro County, Texas.* U.S. Department of Agriculture, 1974.
[15] NRCS. *Soil Survey of Freestone County, Texas*. U.S. Department of Agriculture, 2002.
[16] NRCS. *Soil Survey of Limestone County, Texas.* U.S. Department of Agriculture, 1997.
[17] NRCS. *Soil Survey of Leon County, Texas.* U.S. Department of Agriculture, 1989.
[18] NRCS. *Soil Survey of Madison County, Texas.* U.S. Department of Agriculture, 1994.
[19] NRCS. *Soil Survey of Grimes County, Texas.* U.S. Department of Agriculture, 1996.
[20] NRCS. *Soil Survey of Austin and Waller Counties, Texas.* U.S. Department of Agriculture, 1984.
[21] NRCS. *Soil Survey of Harris County, Texas.* U.S. Department of Agriculture, 1976.
[22] NRCS, "STATSGO Data by County," 2006.
[23] FEMA, "Digital Floodplain Insurance Rate Maps," 2014. http://www.fema.gov/flood-insurance-rate-map-firm (accessed May 03, 2017).
[24] Blanchard, B. Wayne. Guide to Emergency Management and Related Terms, Definitions, Concepts, Acronyms, Organizations, Programs, Guidance, Executive Orders and Legislation. October 22, 2008. https://training.fema.gov/hiedu/docs/terms%20and%20definitions/terms%20and%20definitions.pdf (accessed March 2016).

In addition, TPWD EMST was used to determine vegetation types within the Study Area.[25] These mapped vegetation types were useful in identifying areas that may require further investigation for the presence of potential waters of the U.S., including wetlands. See **Section 3.6, Natural Ecological Systems and Protected Species** for a discussion of the EMST vegetation types within the Study Area.

The confirmed presence and locations of potential waters of the U.S., including wetlands, is currently underway through field assessments and jurisdictional determinations within the Study Area. FRA is currently conducting surveys and data collected through April 25, 2017 are presented in this EIS (**Appendix E, Waters of the U.S. Technical Memorandum**). Field work to identify jurisdictional waters of the U.S. are ongoing and any additional fieldwork that may be conducted as access to private property is granted will be included in the Final EIS. The analysis for this Draft EIS assumes all wetlands and waterbodies within the LOD are waters of the U.S. The ongoing fieldwork could result in a determination that some presumed waters of the U.S. are non-jurisdictional. This could result in a change in impacts to wetlands and waterbodies, and potentially result in the Draft EIS identifying greater impacts to waters of the U.S. than would result from the Project.

Potential waters of the U.S. are recorded with sub-meter accuracy Global Positioning System (GPS) equipment, where possible. Potentially jurisdictional waters of the U.S. are determined following the procedures outlined in the USACE Wetlands Delineation Manual,[26] Regional Supplement to the Corps of Engineers Wetland Delineation Manual; Great Plains Region,[27] Atlantic and Gulf Coast Region[28] and subsequent Regulatory Guidance Letters.[29, 30]

Streams are classified as: [31]

- *Ephemeral stream*: An ephemeral stream has flowing water only during, and for a short duration after, precipitation events in a typical year. Ephemeral stream beds are located above the water table year-round. Groundwater is not a source of water for the stream. Runoff from rainfall is the primary source of water for stream flow.
- *Intermittent stream*: An intermittent stream has flowing water during certain times of the year, when groundwater provides water for stream flow. During dry periods, intermittent streams may not have flowing water. Runoff from rainfall is a supplemental source of water for stream flow.
- *Perennial stream*: A perennial stream has flowing water year-round during a typical year. The water table is located above the stream bed most of the year. Groundwater is the primary sources of water for stream flow. Runoff from rainfall is a supplemental source of water for stream flow.

[25] Elliott, Lee F.; Diamond, David D.; True, C. Diane; Blodgett, Clayton F.; Pursell, Dyan; German, Duane; and Treuer-Kuehn, Amie. Ecological Mapping Systems of Texas Data. 2014.

[26] USACE. *Corps of Engineers Wetland Delineations Manual.* Vicksburg, Mississippi: U.S. Army Corps of Engineers Waterways Experiment Station. 1987, http://el.erdc.usace.army.mil/elpubs/pdf/wlman87.pdf.

[27] USACE. *Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Great Plains Region (Version 2.0)*. Vicksburg, Mississippi: ERDC/DL TR 08 12, U.S. Army Corps of Engineers Waterway Experiment Station. 2010, http://www.usace.army.mil/Portals/2/docs/civilworks/regulatory/reg_supp/gp_supp.pdf.

[28] USACE. *Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Atlantic and Gulf Coastal Plain Region (Version 2.0)*. Vicksburg, MS: US Army Corps of Engineers ERDC/EL TR-10-20, 2010. http://www.usace.army.mil/Portals/2/docs/civilworks/regulatory/reg_supp/AGCP_regsupV2.pdf.

[29] USACE. Regulatory Guidance Letter No. 05-05. Ordinary high water mark identification. 2005, http://www.usace.army.mil/Portals/2/docs/civilworks/RGLS/rgl05-05.pdf.

[30] USACE and EPA. Joint agency memorandum regarding Clean Water Act jurisdiction following the U.S. Supreme Court's decision in Rapanos v. United States and Carabell v. United States. December 2, 2008.

[31] USACE. "Texas Rapid Assessment Method (TXRAM). Wetlands and Streams Modules, Version 2.0.Final." 2015. U.S. Army Corps of Engineers.

Lakes and freshwater ponds are open bodies of still water formed naturally or by artificial means. Lakes tend to be larger and deeper than ponds; however, there is no defined difference.[32] For the purposes of this analysis, freshwater ponds and lakes are separately considered.

Wetlands are defined as:

- emergent, typically dominated by perennial plants that are characterized as erect, rooted, herbaceous hydrophytes that are present during the majority of the growing season, including mosses and lichens
- scrub/shrub, dominated by woody vegetation less than 20 feet tall
- forested, dominated by woody vegetation with a minimum height of 20 feet and at least 30 percent canopy cover[33]

During the preliminary design phase, stream crossings were analyzed to determine the type of structure (culvert or bridge/viaduct) that would be required to reduce impacts and maintain flow. Culverts were used at stream features with a minimum flowline and defined channel width that would accommodate culvert configurations. For large crossings determined to exceed the capacity of culverts, a bridge/viaduct segment has been incorporated into the preliminary design.

3.7.4 Affected Environment

The following section describes the existing water resources, USACE federally authorized civil works projects, hydric soils and wetland vegetation within the Study Area by county and segment.

3.7.4.1 Dallas County

3.7.4.1.1 Water Resources

Within Dallas County, the Study Area is located within the Trinity River Basin. The Trinity River Basin is the largest river basin whose watershed is entirely within the state of Texas. This basin starts at the confluence of the Trinity River with its Elm and West Forks near Dallas, extending to Trinity Bay.[34] The streams, wetlands and waterbodies located within the Study Area in Dallas County are provided in **Tables 3.7-1** through **3.7-3**.

Table 3.7-1: Streams within the Study Area – Dallas County

Stream Type	Length within Segment 1 (linear feet)
Perennial	3,951
Intermittent	1,415
Ephemeral	55
Artificial/Man-made	1,526
Total	**6,947**

Source: USGS, 2016

[32] New Hampshire Department of Environmental Services. “Environmental Fact Sheet – Lake or Pond, What’s the Difference.” 2003. New Hampshire Department of Environmental Services.
[33] Cowardin, Lewis M, Virginia Carter, Francis C Golet and Edward T LaRoe. *Classification of Wetlands and Deepwater Habitats of the United States*. Washington, D.C.: U.S. Fish and Wildlife Services. 1979.
[34] TWDB, “Trinity River Basin.” http://www.twdb.texas.gov/surfacewater/rivers/river_basins/trinity/index.asp (accessed January 18, 2016).

Notable streams within the Study Area within Dallas County include the perennial Newton Creek, Tenmile Creek, Whites Branch and the Trinity River, and the intermittent Honey Springs Branch.

Table 3.7-2: Wetlands within the Study Area – Dallas County		
Wetland Type	**Classification**	**Area of Segment 1 (acres)**
Freshwater Emergent Wetland	PEM	0.02
	PEM1A	8.9
Freshwater Forested/Shrub Wetland	PFO	3.9
	PSS	0.07
	PFO1A	2.2
	PFO1C	0.04
	Total	**15.1**

Source: USFWS, 2016
P - Palustrine
EM1 - Persistent Emergent
FO1 - Broad-leaved Deciduous Forested
C - Seasonally Flooded
EM - Emergent
FO - Forested
A - Temporarily Flooded
h - Diked/Impounded

Table 3.7-3: Waterbodies within the Study Area – Dallas County	
Type	**Area of Segment 1 (acres)**
Lake	2.1
Freshwater Pond	3.7
Total	**5.8**

Source: USFWS, 2016

In addition, the Mooreland Lake is located within the Study Area.[35] Based on the FEMA FIRMs and Digital FIRMs, approximately 4 acres of the Study Area are located within a 500-year floodplain (Zone X – shaded) and approximately 179 acres are located within a 100-year floodplain (Zones A and AE).

3.7.4.1.2 USACE Projects

USACE federally authorized civil works projects (USACE Projects) subject to Section 408 approval located within Dallas County include the Dallas Floodway–Central Wastewater Treatment Plant, Dallas Floodplain Extension-Floodway, Dallas Floodway Extension-Rochester Levee, Dallas Floodway Extension-Future Levees, Dallas Floodway Extension-Chain of Wetlands, Dallas Floodway Extension IH-45 Realignment, Dallas Floodway, Dallas Floodway-Levees, and Dallas Floodway-Sumps.[36]

3.7.4.1.3 Hydric Soils

Based on the 2015 NRCS National Hydric Soil List, there are three hydric soils located within the Study Area.[37, 38] **Table 3.7-4** includes the area in acres for each hydric soil within the Study Area in Dallas County.

[35] USGS, "National Hydrography Dataset," Last modified September 28, 2016. http://nhd.usgs.gov/data.html.
[36] USACE, "USACE-Owned Properties Fort Worth District," 2014.
[37] NRCS, "SSURGO data by County," 2013.
[38] NRCS, "National Hydric Soils List 2015: Texas," 2015.

Table 3.7-4: Hydric Soils within the Study Area – Dallas County		
Soil Unit Name	**Soil Map Unit**	**Area of Segment 1 (acres)**
Frio silty clay, 0 to 1 percent slopes, frequently flooded	37	40.4
Trinity clay, occasionally flooded	72	2.0
Trinity clay, frequently flooded	73	41.4
	Total	**83.8**

Source: NRCS, 2013; NRCS, 2015

3.7.4.1.4 Vegetation

According to the EMST, the most common wetland vegetation within the Study Area is Central Texas: Floodplain Hardwood Forest and Central Texas: Floodplain Herbaceous Vegetation each described below. A complete list of wetland vegetation types that comprise the Study Area for Dallas County is provided in **Table 3.7-5**.

Table 3.7-5: Wetland Vegetation Types within the Study Area – Dallas County	
Vegetation Types	**Percent of Segment 1**
Central Texas: Floodplain Hardwood Forest	12.4
Central Texas: Floodplain Herbaceous Vegetation	1.4
Open Water	1.0
Central Texas: Riparian Hardwood Forest	0.50
Central Texas: Floodplain Hardwood / Evergreen Forest	0.51
Central Texas: Floodplain Deciduous Shrubland	0.06
Swamp	0.05
Central Texas: Riparian Herbaceous Vegetation	<0.01
Total Percent	**15.9**

Source: Elliot et al., 2014

The Central Texas: Floodplain Hardwood Forest vegetation type includes common trees such as pecan (*Carya illinoinensis*), white ash (*Fraxinus americana*), cedar elm (*Ulmus crassifolia*), American elm (*U. americana*), sugar hackberry (*Celtis laevigata*), willows (*Salix* spp.) and eastern cottonwood (*Populus deltoides*).[39]

The Central Texas: Floodplain Herbaceous vegetation type is typically located within floodplains that lack a substantial overstory or shrub canopy, but retain cover in the herbaceous layer. Non-native grass species such as bermudagrass and Johnson grass (*Sorghum halepense*) may frequently dominate this vegetation type and scattered shrubs such as mesquite (*Prosopis glandulosa*) and juniper (*Juniperus* spp.) are common. Eastern gamagrass or switchgrass may dominate some lowland sites.[40]

3.7.4.2 Ellis County

3.7.4.2.1 Water Resources

Within Ellis County, the Study Area is located within the Trinity River Basin.[41] The streams, wetlands and waterbodies located within this Study Area are provided in **Tables 3.7-6** through **3.7-8**.

[39] NRCS, "National Hydric Soils List 2015: Texas," 2015.
[40] Ibid.
[41] TWDB, "River Basins." http://www.twdb.texas.gov/surfacewater/rivers/river_basins/index.asp (accessed January 18, 2016).

Table 3.7-6: Streams within the Study Area – Ellis County						
Stream Type	Length within Segment 1 (linear feet)	Length within Segment 2A (linear feet)	Length within Segment 2B (linear feet)	Length within Segment 3A (linear feet)	Length within Segment 3B (linear feet)	Length within Segment 3C (linear feet)
Perennial	147	882	959	--	--	--
Intermittent	--	4,953	8,948	415	512	415
Ephemeral	--	2,408	--	--	--	--
Artificial/Man-made	--	182	498	--	--	--
Total	**147**	**8,425**	**10,405**	**415**	**512**	**415**

Source: USGS, 2016
'--' - not present

Notable streams within the Study Area within Ellis County include the perennial Bear Creek, Big Onion Creek, Long Branch, Red Oak Creek and Waxahachie Creek and the intermittent Clear Creek, Cottonwood Creek, Wlm Branch, Grove Creek and Mustang Creek.

Table 3.7-7: Wetlands within the Study Area – Ellis County						
Wetland Type	Classification	Area of Segment 2A (acres)	Area of Segment 2B (acres)	Area of Segment 3A (acres)	Area of Segment 3B (acres)	Area of Segment 3C (acres)
Freshwater Emergent Wetland	PEM	1.8	--	--	--	--
	PEM1Fh	0.40	--	--	--	--
Freshwater Forested/Shrub Wetland	PFO1A	0.28	0.81	--	--	--
	PFO1C	0.50	0.30	0.29	0.35	0.29
	Total	**3.0**	**1.1**	**0.29**	**0.35**	**0.29**

Source: USFWS, 2016
'--' - not present

P - Palustrine	EM - Emergent	EM1 - Persistent Emergent
FO – Forested	FO1 - Broad-leaved Deciduous Forested	F - Semi permanently Flooded
A - Temporarily Flooded	C - Seasonally Flooded	h - Diked/Impounded

Table 3.7-8: Waterbodies within the Study Area – Ellis County			
Type	Area of Segment 1 (acres)	Area of Segment 2A (acres)	Area of Segment 2B (acres)
Freshwater Pond	0.03	7.1	4.3
Total	**0.03**	**7.1**	**4.3**

Source: USFWS, 2016

Based on the FEMA FIRMs and Digital FIRMs, less than one acre of Segment 1, approximately one acre of the Segment 2A Study Area and approximately one acre of the Segment 2B Study Area are located within a 500-year floodplain (Zone X – shaded), and approximately one acre of Segment 1, approximately 50 acres of the Segment 2A Study Area and approximately 55 acres of the Segment 2B Study Area are located within a 100-year floodplain (Zones A and AE). The Segment 3A, 3B and 3C Study Areas are not located within mapped floodplain boundaries.[42]

[42] FEMA, "Digital Floodplain Insurance Rate Maps," 2014. http://www.fema.gov/flood-insurance-rate-map-firm (accessed May 03, 2017).

3.7.4.2.2 USACE Projects

One USACE Project subject to Section 408 approval is located within Segments 2A and 2B in Ellis County, Lake Bardwell.[43] Construction of the dam at Lake Bardwell was completed in 1966 with impoundment of water beginning in 1965. The lake is used for municipal water, flood control and recreation purposes and typically stores approximately 46,472 acre-feet of water with a surface area of approximately 3,138 acres.[44] No USACE federally authorized civil works projects subject to Section 408 approval are located within Segments 3A, 3B and 3C in Ellis County.[45]

3.7.4.2.3 Hydric Soils

Based on the 2015 NRCS National Hydric Soil List, there is one hydric soil located within Segment 1, three hydric soils located within Segments 2A and 2B, and none located within Segments 3A, 3B or 3C.[46, 47] **Table 3.7-9** includes the area in acres for each hydric soil.

Table 3.7-9: Hydric Soils within the Study Area – Ellis County

Soil Unit Name	Soil Map Unit	Area of Segment 1 (acres)	Area of Segment 2A (acres)	Area of Segment 2B (acres)
Frio silty clay, 0 to 1 percent slopes, frequently flooded	Fr	--	3.0	3.0
Trinity clay, frequently flooded	Tc	0.80	23.9	25.9
Trinity clay, occasionally flooded	To	--	9.2	7.0
	Total	**0.80**	**36.1**	**35.9**

Source: NRCS, 2013; NRCS, 2015

3.7.4.2.4 Vegetation

The most common wetland types within the Study Area are the previously described Central Texas: Floodplain Hardwood Forest and Central Texas: Floodplain Herbaceous Vegetation, as previously described in this section, and Central Texas: Riparian Hardwood Forest and Central Texas: Riparian Herbaceous Vegetation, described below. A complete list of wetland vegetation types that comprise the Study Area is provided in **Table 3.7-10**.

---

[43] USACE, "USACE-Owned Properties Fort Worth District." 2014
[44] TWDB. "Bardwell Lake (Trinity River Basin)." http://www.twdb.texas.gov/surfacewater/rivers/reservoirs/bardwell/index.asp (accessed February 3, 2016).
[45] USACE, "USACE-Owned Properties Fort Worth District." 2014
[46] NRCS, "SSURGO data by County," 2013.
[47] NRCS, "National Hydric Soils List 2015: Texas," 2015.

Table 3.7-10: Wetland Vegetation Types within the Study Area – Ellis County

Vegetation Types	Percent of Segment 1	Percent of Segment 2A	Percent of Segment 2B	Percent of Segment 3A	Percent of Segment 3B	Percent of Segment 3C
Central Texas: Floodplain Hardwood Forest	3.4	2.8	3.5	--	--	--
Central Texas: Riparian Hardwood Forest	--	1.2	1.6	0.58	0.55	0.58
Central Texas: Riparian Herbaceous Vegetation	--	1.0	1.3	--	--	--
Central Texas: Floodplain Herbaceous Vegetation	--	0.89	1.2	--	--	--
Central Texas: Floodplain Live Oak Forest	--	0.05	--	--	--	--
Central Texas: Riparian Deciduous Shrubland	--	0.05	--	--	--	--
Open Water	--	0.20	0.13	--	--	--
Swamp	--	0.02	0.05	--	--	--
Total Percent	**3.4**	**6.2**	**7.8**	**0.58**	**0.55**	**0.58**

Source: Elliot et al., 2014
'--' - not present

The Central Texas: Riparian Herbaceous vegetation type lacks a substantial overstory or shrub canopy but retains herbaceous cover. Sites may be dominated by bermudagrass (*Cynodon dactylon*), little bluestem (*Schizochyrium scoparium*), Texas wintergrass (*Nassella leucotricha*), Virginia wildrye (*Elymus virginicus*) or other grass species. Eastern gamagrass (*Tripsacum dactyloides*) or switchgrass (*Panicum virgatum*) may dominate some lowland areas.[48]

The Central Texas: Riparian Hardwood Forest vegetation type is dominated by deciduous trees such as sugar hackberry, cedar elm, American sycamore (*Platanus occidentalis*), eastern cottonwood, western soapberry (*Sapindus saponaria*), black willow (*S. nigra*) and ashes (*Fraxinus* spp.) in the understory. Plateau live oak (*Quercus fusiformis*) or coastal live oak (*Q. virginiana*) may also be a component.[49]

3.7.4.3 Navarro County

3.7.4.3.1 Water Resources

Within Navarro County, the Study Area is located within the Trinity River Basin.[50] The streams, wetlands and waterbodies located within the Study Area are provided in **Tables 3.7-11** through **3.7-13**.

[48] Ibid.
[49] Elliott, Lee F.; Diamond, David D.; True, C. Diane; Blodgett, Clayton F.; Pursell, Dyan; German, Duane; and Treuer-Kuehn, Amie. *Ecological Mapping Systems of Texas: Texas Ecological Systems Project: Phase I Interpretive Booklet.* Austin, Texas: Texas Parks and Wildlife Department. 2014.
[50] TWDB, "River Basins." http://www.twdb.texas.gov/surfacewater/rivers/river_basins/index.asp (accessed January 18, 2016).

Table 3.7-11: Streams within the Study Area – Navarro County			
Stream Type	**Length within Segment 3A (linear feet)**	**Length within Segment 3B (linear feet)**	**Length within Segment 3C (linear feet)**
Perennial	476	--	--
Intermittent	8,743	15,213	14,535
Ephemeral	1,845	--	--
Artificial/Man-made	18	1,380	18
Total	**11,082**	**16,693**	**14,553**

Source: USGS, 2016
'--' - not present

Notable streams within the Study Area include the intermittent Briar Creek, Cedar Creek, Little Pin Oak Creek, Mesquite Creek, Pin Oak Creek and Richland Creek, and the man-made/artificial Chambers Creek.

Table 3.7-12: Wetlands within the Study Area – Navarro County				
Wetland Type	**Classification**	**Area of Segment 3A (acres)**	**Area of Segment 3B (acres)**	**Area of Segment 3C (acres)**
Freshwater Emergent Wetland	PEM	17.0	--	--
	PEM1A	0.48	0.02	0.87
	PEM1C	--	0.16	--
	PEM1Ch	--	0.17	--
	PEM1Fh	--	0.63	--
Freshwater Forested/Shrub Wetland	PFO	0.10	--	--
	PFO1A	0.14	3.8	7.2
	PFO1C	0.08	0.90	0.85
	Total	**17.8**	**5.7**	**8.9**

Source: USFWS, 2016
'--' - not present
P - Palustrine
EM1 - Persistent Emergent
FO1 - Broad-leaved Deciduous Forested
C - Seasonally Flooded
h - Diked/Impounded
EM - Emergent
FO - Forested
A - Temporarily Flooded
F - Semi permanently Flooded

Table 3.7-13: Waterbodies within the Study Area – Navarro County			
Type	**Area of Segment 3A (acres)**	**Area of Segment 3B (acres)**	**Area of Segment 3C (acres)**
Lake	--	1.7	--
Freshwater Pond	11.5	7.2	2.6
Total	**11.5**	**8.9**	**2.6**

Source: USFWS, 2016
'--' - not present

In addition, the NRCS Site 138 reservoir is mapped within Segment 3B.[51] Based on the FEMA FIRMs and Digital FIRMs, approximately 97 acres of Segment 3A, approximately 56 acres of Segment 3B and approximately 124 acres of Segment 3C are located within a 100-year floodplain (Zone A).[52]

[51] USFWS, "National Wetlands Inventory," Last modified December 07, 2016. http://www.fws.gov/wetlands/Data/Mapper.html (accessed May 03, 2017).
[52] FEMA, "Digital Floodplain Insurance Rate Maps," 2014. http://www.fema.gov/flood-insurance-rate-map-firm (accessed May 03, 2017).

3.7.4.3.2 USACE Projects

No USACE Projects subject to Section 408 approval are located within the Study Area in Navarro County.[53]

3.7.4.3.3 Hydric Soils

Based on the 2015 NRCS National Hydric Soil List, there are two hydric soils located within Segment 3A, one hydric soil located within Segment 3B and, three hydric soils located within Segment 3C.[54, 55] **Table 3.7-14** presents the area for each hydric soil.

Table 3.7-14: Hydric Soils within the Study Area – Navarro County

Soil Unit Name	Soil Map Unit	Area of Segment 3A (acres)	Area of Segment 3B (acres)	Area of Segment 3C (acres)
Kaufman clay	Ka	12.0	--	11.1
Kaufman clay, frequently flooded	Kc	--	--	11.8
Trinity clay, frequently flooded	Tr	39.2	22.1	28.3
	Total	**51.2**	**22.1**	**51.2**

Source: NRCS, 2013; NRCS, 2015
'--' - not present

3.7.4.3.4 Vegetation

The most common wetland types within the Study Area are Central Texas: Floodplain Herbaceous Vegetation type, Central Texas: Floodplain Hardwood Forest and Central Texas: Riparian Herbaceous Vegetation, as previously described in this section.[56] A complete list of wetland vegetation types that comprise this Study Area is provided in **Table 3.7-15**.

Table 3.7-15: Wetland Vegetation Types within the Study Area – Navarro County

Vegetation Types	Percent of Segment 3A	Percent of Segment 3B	Percent of Segment 3C
Central Texas: Floodplain Herbaceous Vegetation	6.7	5.2	8.1
Central Texas: Floodplain Hardwood Forest	1.5	1.9	3.9
Central Texas: Riparian Herbaceous Vegetation	0.66	1.3	0.69
Central Texas: Riparian Hardwood Forest	0.59	0.48	0.52
Central Texas: Floodplain Deciduous Shrubland	0.25	0.21	0.07
Central Texas: Riparian Hardwood / Evergreen Forest	0.10	--	0.03
Marsh	0.06	--	0.07
Open Water	0.01	0.20	--
Total Percent	**9.9**	**9.3**	**13.4**

Source: Elliot et al., 2014
'--' - not present

[53] USACE, "USACE-Owned Properties Fort Worth District." 2014
[54] NRCS, "SSURGO data by County," 2013.
[55] NRCS, "National Hydric Soils List 2015: Texas," 2015.
[56] Elliott, Lee F.; Diamond, David D.; True, C. Diane; Blodgett, Clayton F.; Pursell, Dyan; German, Duane; and Treuer-Kuehn, Amie. *Ecological Mapping Systems of Texas Data.* 2014.

3.7.4.4 Freestone County

3.7.4.4.1 Water Resources

Within Freestone County, the Study Area is located within the Trinity River Basin.[57] The streams, wetlands and waterbodies located within the Study Area are provided in **Tables 3.7-16** through **3.7-18**.

Table 3.7-16: Streams within the Study Area - Freestone County

Stream Type	Length within Segment 3C (linear feet)	Length within Segment 4 (linear feet)
Perennial	747	168
Intermittent	18,691	7,015
Ephemeral	--	8,197
Artificial/Man-made	372	915
Total	**19,810**	**16,295**

Source: USGS, 2016
'--' - not present

Notable streams within the Study Area within Freestone County include the perennial Buffalo Creek, Cottonwood Creek and Tehuacana Creek and the intermittent Caney Creek, Caroline Creek, Cedar Creek Fulks Dugout, Jackson Branch, Little Tehuacana, Patton Creek, Tehuacana Creek and Wilkerson Spring Branch.

Table 3.7-17: Wetlands within the Study Area – Freestone County

Wetland Type	Classification	Area of Segment 3C (acres)	Area of Segment 4 (acres)
Freshwater Emergent Wetland	PEM	--	0.75
	PEM1A	0.06	0.44
	PEM1F	0.11	--
	PEM1C	0.19	1.5
	PEM1Ch	0.37	--
Freshwater Forested/Shrub Wetland	PFO	--	0.06
	PFO1A	6.0	2.0
	PFO1C	1.4	
	PSS1/EM1A	4.6	--
	PSS	--	0.06
Total		**12.7**	**4.8**

Source: USFWS, 2016
'--' - not present
P - Palustrine
EM1 - Persistent Emergent
FO1 - Broad-leaved Deciduous Forested
SS1 - Broad-leaved Deciduous Scrub-Shrub
C - Seasonally Flooded
h - Diked/Impounded
EM - Emergent
FO - Forested
SS - Scrub-Shrub
A - Temporarily Flooded
F - Semi permanently Flooded

[57] TWDB, "River Basins." http://www.twdb.texas.gov/surfacewater/rivers/river_basins/index.asp (accessed January 18, 2016).

Table 3.7-18: Waterbodies within the Study Area – Freestone County		
Type	**Area of Segment 3C (acres)**	**Area of Segment 4 (acres)**
Freshwater Pond	3.5	7.0
Total	**3.5**	**7.0**

Source: USFWS, 2016
'--' - not present

Based on the FEMA FIRMs and Digital FIRMs, approximately 56 acres of Segment 3C and approximately 53 acres of Segment 4 are located within a 100-year floodplain (Zone A).[58] Segments 3A and 3B are not located within mapped floodplain boundaries.[59]

3.7.4.4.2 USACE Projects

No USACE Projects subject to Section 408 approval are located within the Study Area in Freestone County.[60]

3.7.4.4.3 Hydric Soils

Based on the 2015 NRCS National Hydric Soil List, there are no hydric soils located within the Study Area of Segments 3A and 3B in Freestone County; however, there are nine hydric soils located within Segment 3C and six hydric soils located within Segment 4.[61, 62] **Table 3.7-19** includes the area in acres for each hydric soil within Segments 3C and 4**.**

Table 3.7-19: Hydric Soils within the Study Area – Freestone County			
Soil Unit Name	**Soil Map Unit**	**Area of Segment 3C (acres)**	**Area of Segment 4 (acres)**
Kaufman clay loam, overwash, occasionally flooded	Ka	--	30.1
Kaufman clay, occasionally flooded	Kc	4.9	--
Kaufman clay, frequently flooded	Kd	8.7	--
Mabank fine sandy loam, 0 to 1 percent slopes	MaA	0.37	2.0
Nahatche clay loam, frequently flooded	Na	10.3	--
Nahatche-Hatliff Association, frequently flooded	NH	74.1	24.6
Pluck loam, frequently flooded	Pu	6.2	1.5
Rader fine sandy loam, 0 to 3 percent slopes	RaB	3.8	--
Tabor-Lufkin complex, 0 to 1 percent slopes	TfA	16.1	44.3
Whitesboro clay loam, frequently flooded	Wm	3.9	18.8
	Total	**128.4**	**121.3**

Source: NRCS, 2013; NRCS, 2015
'--' - not present

3.7.4.4.4 Vegetation

According to the EMST, there are no wetland vegetation types within Segments 3A and 3B in Freestone County; however, there are wetland vegetation types within Segments 3C and 4, the most common of which are Central Texas: Floodplain Hardwood Forest and Central Texas: Floodplain Herbaceous

[58] FEMA, "Digital Floodplain Insurance Rate Maps," 2014. http://www.fema.gov/flood-insurance-rate-map-firm (accessed May 03, 2017).
[59] Ibid.
[60] USACE, "USACE-Owned Properties Fort Worth District," 2014.
[61] NRCS, "SSURGO data by County," 2013.
[62] NRCS, "National Hydric Soils List 2015: Texas," 2015.

Vegetation, as previously described in this section.[63] A complete list of wetland vegetation types that comprise Segments 3C and 4 in Freestone County is provided in **Table 3.7-20**.

Table 3.7-20: Wetland Vegetation Types within the Study Area – Freestone County

Vegetation Types	Percent of Segment 3C	Percent of Segment 4
Central Texas: Floodplain Hardwood Forest	12.9	7.3
Central Texas: Floodplain Herbaceous Vegetation	5.3	19.5
Central Texas: Riparian Herbaceous Vegetation	0.41	0.82
Central Texas: Riparian Hardwood Forest	0.12	0.61
Central Texas: Floodplain Deciduous Shrubland	0.10	0.02
Central Texas: Riparian Deciduous Shrubland	0.03	0.09
Central Texas: Floodplain Seasonally Flooded Hardwood Forest	0.02	--
Central Texas: Riparian Hardwood / Evergreen Forest	<0.01	--
Open Water	<0.01	--
Total Percent	**18.9**	**28.3**

Source: Elliot et al., 2014
'--' - not present

3.7.4.5 Limestone County

3.7.4.5.1 Water Resources

Within Leon County, the Study Area is located within the Trinity River Basin and Brazos River Basin.[64] The streams, wetlands and waterbodies located within this Study Area are provided in **Tables 3.7-21** through **3.7-23**.

Table 3.7-21: Streams within the Study Area – Limestone County

Stream Type	Length within Segment 4 (linear feet)
Perennial	220
Intermittent	4,928
Ephemeral	3,504
Artificial/Man-made	784
Total	**9,436**

Source: USGS, 2016

Notable streams within Segment 4 within Limestone County include the intermittent Chambers Creek, Coots Branch, Lambs Creek, Lies Branch and Sanders Creek.

Table 3.7-22: Wetlands within the Study Area – Limestone County

Wetland Type	Classification	Area of Segment 4 (acres)
Freshwater Emergent Wetland	PEM	2.4
	PEM1C	0.16
	PFO	0.11
Freshwater Forested/Shrub Wetland	PFO1A	0.90
	PFO1C	1.2
	Total	**4.8**

Source: USFWS, 2016

[63] Elliott, Lee F.; Diamond, David D.; True, C. Diane; Blodgett, Clayton F.; Pursell, Dyan; German, Duane; and Treuer-Kuehn, Amie. *Ecological Mapping Systems of Texas Data*. 2014.
[64] TWDB, "River Basins." http://www.twdb.texas.gov/surfacewater/rivers/river_basins/index.asp (accessed January 18, 2016).

Table 3.7-22: Wetlands within the Study Area – Limestone County		
Wetland Type	Classification	Area of Segment 4 (acres)

P - Palustrine
EM1 - Persistent Emergent
FO1 - Broad-leaved Deciduous Forested
C - Seasonally Flooded
EM - Emergent
FO - Forested
A - Temporarily Flooded

Table 3.7-23: Waterbodies within the Study Area – Limestone County	
Type	Area of Segment 4 (acres)
Freshwater Pond	2.1
Total	**2.1**

Source: USFWS, 2016

Based on the FEMA FIRMs and Digital FIRMs, approximately 25 acres of the Study Area in Limestone County are located within a 100-year floodplain (Zone A).[65]

3.7.4.5.2 USACE Projects

No USACE Projects subject to Section 408 approval are located within the Study Area in Limestone County.[66]

3.7.4.5.3 Hydric Soils

Based on the 2015 NRCS National Hydric Soil List, there are two hydric soils located within this Study Area.[67, 68] **Table 3.7-24** includes the area in acres for each hydric soil.

Table 3.7-24: Hydric Soils within the Study Area – Limestone County		
Soil Unit Name	Soil Map Unit	Area of Segment 4 (acres)
Nahatche loam, frequently flooded	Na	9.3
Uhland fine sandy loam, frequently flooded	Uh	17.3
	Total	**26.6**

Source: NRCS, 2015; NRCS, 2015

3.7.4.5.4 Vegetation

According to the EMST, the most common wetland vegetation types within the Study Area are Central Texas: Floodplain Hardwood Forest, Central Texas: Floodplain Herbaceous Vegetation and Central Texas: Riparian Hardwood Forest, as previously described in this section. A complete list of wetland vegetation types that comprise this Study Area are provided in **Table 3.7-25**.

Table 3.7-25: Wetland Vegetation Types within the Study Area – Limestone County	
Vegetation Types	Percent of Segment 4
Central Texas: Floodplain Hardwood Forest	4.5

[65] FEMA, "Digital Floodplain Insurance Rate Maps," 2014. http://www.fema.gov/flood-insurance-rate-map-firm (accessed May 03, 2017).
[66] USACE, "USACE-Owned Properties Fort Worth District," 2014.
[67] NRCS, "SSURGO data by County," 2015.
[68] NRCS, "National Hydric Soils List 2015: Texas," 2015.

Table 3.7-25: Wetland Vegetation Types within the Study Area – Limestone County	
Vegetation Types	**Percent of Segment 4**
Central Texas: Floodplain Herbaceous Vegetation	3.4
Central Texas: Riparian Hardwood Forest	1.6
Central Texas: Riparian Herbaceous Vegetation	0.66
Open Water	0.18
Total Percent	**10.3**

Source: Elliot et al., 2014

3.7.4.6 Leon County

3.7.4.6.1 Water Resources

Within Leon County, the Study Area is located within the Trinity River Basin and Brazos River Basin.[69, 70] The streams, wetlands and waterbodies located within the Study Area in Leon County are provided in **Tables 3.7-26** through **3.7-28**.

Table 3.7-26: Streams within the Study Area – Leon County		
Stream Type	**Length within Segment 3C (linear feet)**	**Length within Segment 4 (linear feet)**
Perennial	2,225	841
Intermittent	15,806	14,377
Ephemeral	--	2,102
Artificial/Man-made	332	369
Total	**18,363**	**17,689**

Source: USGS, 2016

Notable streams within segments 3C and 4 within Leon County include the perennial Beaver Creek, Bliss Creek, Boggy Creek, Mustang Creek and Spring Creek and the intermittent Cedar Creek, Leona Branch, Little Brushy Creek, Tiger Branch and Yellow Branch.

Table 3.7-27: Wetlands within the Study Areas – Leon County			
Wetland Type	**Classification**	**Area of Segment 3C (acres)**	**Area of Segment 4 (acres)**
Freshwater Emergent Wetland	PEM	--	0.75
	PEM/FO1F	0.33	--
	PEM1A	1.4	0.69
	PEM1F	0.86	--
	PEM1Fh	--	--
	PEM1C	1.3	0.42
	PEM1Ch	--	0.52
Freshwater Forested/Shrub Wetland	PFO	--	0.22
	PFO1A	2.5	0.42
	PFO/EM1F	0.59	--
	PFO1F	0.25	--
	PFO1C	1.2	1.4
	PSS1/EM1A	0.09	--

[69] TWDB, "River Basins." http://www.twdb.texas.gov/surfacewater/rivers/river_basins/index.asp (accessed January 18, 2016).
[70] Ibid.

Table 3.7-27: Wetlands within the Study Areas – Leon County			
Wetland Type	**Classification**	**Area of Segment 3C (acres)**	**Area of Segment 4 (acres)**
	PSS1C	0.06	--
	Total	**8.6**	**4.4**

Source: USFWS, 2016
'--' - not present
P - Palustrine
EM - Emergent
EM1 - Persistent Emergent
FO - Forested
FO1 - Broad-leaved Deciduous Forested
SS1 - Broad-leaved Deciduous Scrub-Shrub
A - Temporarily Flooded
C - Seasonally Flooded
F - Semi permanently Flooded
h - Diked/Impounded

Table 3.7-28: Waterbodies within the Study Area – Leon County		
Type	**Area of Segment 3C (acres)**	**Area of Segment 4 (acres)**
Lake	--	2.6
Freshwater Pond	2.2	5.5
Total	**2.2**	**8.1**

Source: USFWS, 2016
'--' - not present

Based on the FEMA FIRMs and Digital FIRMs, less than one acre of Segment 3C is located within a 500-year floodplain (Zone X). Approximately 62 acres of Segment 3C and approximately 15 acres of Segment 4 are located within a 100-year floodplain (Zones A and AE).[71]

3.7.4.6.2 USACE Projects

No USACE Projects subject to Section 408 approval are located within the Study Area in Leon County.[72]

3.7.4.6.3 Hydric Soils

Based on the 2015 NRCS National Hydric Soil List, there are four hydric soils located within Segment 3C and five hydric soils located within Segment 4.[73, 74] **Table 3.7-29** includes the area in acres for each hydric soil.

Table 3.7-29: Hydric Soils within the Study Areas – Leon County			
Soil Unit Name	**Soil Map Unit**	**Area of Segment 3C (acres)**	**Area of Segment 4 (acres)**
Derly silt loam, 0 to 1 percent slopes	De	4.0	19.3
Lufkin fine sandy loam, 0 to 1 percent slopes	LfA	1.7	7.6
Melhomes loamy fine sand, 0 to 1 percent slopes	Ms	2.5	3.4
Nahatche loam, frequently flooded	Na	46.0	14.2
Rader-Derly complex, gently undulating	Rd	--	3.0
	Total	**54.2**	**47.5**

Source: NRCS, 2013; NRCS, 2015
'--' - not present

[71] FEMA, "Digital Floodplain Insurance Rate Maps," 2014. http://www.fema.gov/flood-insurance-rate-map-firm (accessed May 03, 2017).
[72] USACE, "USACE-Owned Properties Fort Worth District," 2014.
[73] NRCS, "SSURGO data by County," 2013.
[74] NRCS, "National Hydric Soils List 2015: Texas," 2015.

3.7.4.6.4 Vegetation

According to the EMST, the most common wetland vegetation types within Study Area are Central Texas: Floodplain Herbaceous Vegetation, Central Texas: Floodplain Hardwood Forest and Central Texas: Riparian Hardwood Forest, as previously described in this section. A complete list of wetland vegetation types that comprise this Study Area is provided in **Table 3.7-30.**

Table 3.7-30: Wetland Vegetation Types within the Study Areas – Leon County

Vegetation Types	Percent of Segment 3C	Percent of Segment 4
Central Texas: Floodplain Herbaceous Vegetation	3.4	1.8
Central Texas: Floodplain Hardwood Forest	2.2	2.2
Central Texas: Riparian Hardwood Forest	--	1.5
Central Texas: Riparian Herbaceous Vegetation	0.15	0.87
Marsh	0.02	--
Open Water	<0.01	0.22
Pineywoods: Small Stream and Riparian Temporarily Flooded Hardwood Forest	--	0.26
Pineywoods: Small Stream and Riparian Wet Prairie	--	0.06
Total Percent	**5.8**	**6.9**

Source: Elliot et al., 2014
'--' - not present

3.7.4.7 Madison County

3.7.4.7.1 Water Resources

Within Madison County, the Study Area is located within the Trinity River Basin.[75] The streams, wetlands and waterbodies located within the Study Area are provided in **Table 3.7-31** through **Table 3.7-33**.

3.7-31: Streams within the Study Area – Madison County

Stream Type	Length within Segment 3C (linear feet)	Length within Segment 4 (linear feet)
Perennial	128	643
Intermittent	9,036	9,062
Ephemeral	--	3,524
Artificial/Man-made	516	12
Total	**9,680**	**13,241**

Source: USGS, 2016

Notable streams within the Study Area for Madison County include the perennial Bedias Creek and intermittent Caney Creek, Greenbriar Creek, Kickapoo Creek, Larrison Creek, Salt Creek and Twomile Creek.

[75] TWDB, "River Basins." http://www.twdb.texas.gov/surfacewater/rivers/river_basins/index.asp (accessed Jamuary 18, 2016).

Table 3.7-32: Wetlands within the Study Area – Madison County			
Wetland Type	**Classification**	**Area of Segment 3C (acres)**	**Area of Segment 4 (acres)**
Freshwater Emergent Wetland	PEM	--	0.79
	PEM1A	1.4	0.21
	PEM1Ah	--	0.23
	PEM1C	0.49	0.24
Freshwater Forested/Shrub Wetland	PFO	--	0.03
	PFO1A	11.4	10.6
	PFO1C	0.19	0.25
	PFO1F	--	0.19
	PFO1Fh	--	0.04
	Total	**13.5**	**12.6**

Source: USFWS, 2016
'--' - not present
P - Palustrine
EM - Emergent
EM1 - Persistent Emergent
FO - Forested
FO1 - Broad-leaved Deciduous Forested
A - Temporarily Flooded
C - Seasonally Flooded
F - Semi permanently Flooded
h - Diked/Impounded

Table 3.7-33: Waterbodies within the Study Area – Madison County		
Type	**Area of Segment 3C (acres)**	**Area of Segment 4 (acres)**
Swamp	1.8	--
Freshwater Pond	3.2	3
Total	**5**	**3**

Source: USFWS, 2016
'--' - not present

Based on the FEMA FIRMs and Digital FIRMs, approximately 12 acres of Segment 3C and approximately 64 acres of Segment 4 are located within a 100-year floodplain (Zone A).[76]

3.7.4.7.2 USACE Projects

No USACE Projects subject to Section 408 approval are located within the Madison County Study Area.[77]

3.7.4.7.3 Hydric Soils

Based on the 2015 NRCS National Hydric Soil List, there are four hydric soils located within Segment 3C and three hydric soils located within Segment 4 in Madison County.[78,79] **Table 3.7-34** includes the area in acres for each hydric soil.

[76] FEMA, "Digital Floodplain Insurance Rate Maps," 2014. http://www.fema.gov/flood-insurance-rate-map-firm (accessed May 03, 2017).
[77] USACE, "USACE-Owned Properties Fort Worth District," 2014.
[78] NRCS, "SSURGO data by County," 2013.
[79] NRCS, "Hydric Soils List 2015: Texas," 2015.

Table 3.7-34: Hydric Soils within the Study Area – Madison County

Soil Unit Name	Soil Map Unit	Area of Segment 3C (acres)	Area of Segment 4 (acres)
Derly-Rader complex, 0 to 1 percent slopes	DeA	10.1	--
Gowker clay loam, frequently flooded	Go	34.3	30.1
Nahatche loam, frequently flooded	Na	25.7	18.5
Rader-Derly complex, 0 to 2 percent slopes	RbA	37.1	4.2
	Total	**107.2**	**52.8**

Source: NRCS, 2013; NRCS, 2015
'--' - not present

3.7.4.7.4 Vegetation

According to the EMST, most common wetland vegetation types within the Study Area are Pineywoods: Small Stream and Riparian Wet Prairie and Pineywoods: Small Stream and Riparian Temporarily Flooded Hardwood Forest , described below.[80] A complete list of wetland vegetation types within the Study Area is provided in **Table 3.7-35**.

Table 3.7-35: Wetland Vegetation Types within the Study Area – Madison County

Vegetation Types	Percent of Segment 3C	Percent of Segment 4
Pineywoods: Small Stream and Riparian Wet Prairie	21.8	1.4
Pineywoods: Small Stream and Riparian Temporarily Flooded Hardwood Forest	7.0	8.1
Marsh	0.06	--
Open Water	<0.01	--
Pineywoods: Small Stream and Riparian Seasonally Flooded Hardwood Forest	--	0.07
Total Percent	**28.9**	**9.6**

Source: Elliot et al., 2014
'--' - not present

The Pineywoods: Small Stream and Riparian Wet Prairie vegetation type contains introduced grasses such as bermudagrass, Bahia grass (*Paspalum notatum*) and Johnsongrass which may dominate many areas of this mapped type. Native species within the area include broomsedge bluestem (*Andropogon virginicus*), bushy bluestem (*A. glomeratus*), switchgrass, little bluestem and Florida paspalum (*P. floridanum*). Common sparse woody cover may include black willow, wax-myrtle (*Myrica cerifera*), common buttonbush (*Cephalanthus occidentalis*), sweetgum, red maple (*Acer rubrum*) and water oak.[81]

The Pineywoods: Small Stream and Riparian Temporarily Flooded Hardwood Forest vegetation type contains deciduous trees such as sweetgum (*Liquidambar styraciflua*), water oak (*Q. nigra*), sugar hackberry, green ash (*Fraxinus pennsylvanica*), willow oak (*Q. phellos*), blackgum (*Nyssa sylvatica*), sycamore, black willow and American elm. American hornbeam (*Carpinus caroliniana*), possumhaw (*Ilex decidua*) and winged elm are common understory species.[82]

[80] NRCS, "Hydric Soils List 2015: Texas," 2015.
[81] Elliott, Lee F.; Diamond, David D.; True, C. Diane; Blodgett, Clayton F.; Pursell, Dyan; German, Duane; and Treuer-Kuehn, Amie. *Ecological Mapping Systems of Texas: Texas Ecological Systems Project: Phase II Interpretive Booklet*. Austin, Texas: Texas Parks and Wildlife Department. 2014.
[82] Ibid.

3.7.4.8 Grimes County

3.7.4.8.1 Water Resources

Within Grimes County, the Study Area is located within the Trinity River Basin, Brazos River Basin and San Jacinto River Basin.[83] The streams, wetlands and waterbodies located within this Study Area are provided in **Tables 3.7-36** through **3.7-38.**

Table 3.7-36: Streams within the Study Area – Grimes County

Stream Type	Length within Segment 3C (linear feet)	Length within Segment 4 (linear feet)	Length within Segment 5 (linear feet)
Perennial	--	--	795
Intermittent	3,302	1,029	20,834
Ephemeral	--	1,075	11,643
Artificial/Man-made	--	--	4,515
Total	**3,302**	**2,104**	**37,787**

Source: USGS, 2016
'--' - not present

Notable streams within the Study Area include the intermittent Bums Creek, Hurricane Creek, Panky Creek, Rocky Creek and Turkey Creek.

Table 3.7-37: Wetlands within the Study Area – Grimes County

Wetland Type	Classification	Area of Segment 3C (acres)	Area of Segment 4 (acres)	Area of Segment 5 (acres)
Freshwater Emergent Wetland	PEM	--	1.4	3.4
	PEM1F	--	--	0.52
	PEM1A	--	--	0.19
	PEM1C	--	--	1.2
Freshwater Forested/Shrub Wetland	PFO	--	1.4	1.2
	PFO1A	0.16	1.1	0.91
	PFO1C	--	--	0.82
	PSS	--	0.04	0.10
	Total	**0.16**	**3.9**	**8.4**

Source: USFWS, 2016
'—' Not Present
P - Palustrine
EM - Emergent
EM1 - Persistent Emergent
FO – Forested
SS – Shrub-Shrub
FO1 - Broad-leaved Deciduous Forested
A - Temporarily Flooded
C - Seasonally Flooded
F - Semi permanently Flooded

[83] TWDB, "River Basins." http://www.twdb.texas.gov/surfacewater/rivers/river_basins/index.asp (accessed January 18, 2016).

Table 3.7-38: Waterbodies within the Study Area – Grimes County			
Type	Area of Segment 3C (acres)	Area of Segment 4 (acres)	Area of Segment 5 (acres)
Reservoir (Unnamed)	--	--	0.20
Freshwater Pond	1.1	0.95	15.0
Total	**1.1**	**0.95**	**15.2**

Source: USFWS, 2016
'--' - not present

Based on the FEMA FIRMs and Digital FIRMs, approximately 21 acres of Segment 3C, approximately 26 acres of Segment 4 and approximately 16 acres of Segment 5 are located within a 100-year floodplain (Zone A).[84]

3.7.4.8.2 USACE Projects

No USACE Projects subject to Section 408 approval are located within the Grimes County Study Area.[85]

3.7.4.8.3 Hydric Soils

Based on the 2015 NRCS National Hydric Soil List, there is one hydric soil located within Segment 3C and 4 and four hydric soils located within Segment 5 in Grimes County.[86,87] **Table 3.7-39** includes the area in acres for each hydric soil.

Table 3.7-39: Hydric Soils within the Study Area – Grimes County				
Soil Unit Name	Soil Map Unit	Area of Segment 3C (acres)	Area of Segment 4 (acres)	Area of Segment 5 (acres)
Boy loamy fine sand, 1 to 5 percent slopes	BgD	--	--	51.4
Boy loamy fine sand, 1 to 5 percent slopes	BoC	--	--	0.5
Nahatche clay loam, frequently flooded	Na	10.9	5.1	69.4
Tinn clay, 0 to 1 percent slopes, frequently flooded	Tn	--	--	13.5
	Total	**10.9**	**5.1**	**134.8**

Source: NRCS, 2013; NRCS, 2015
'--' - not present

3.7.4.8.4 Vegetation

According to the EMST, the most common wetland vegetation types within the Study Area in Grimes County are Pineywoods: Small Stream and Riparian Wet Prairie, Pineywoods: Small Stream and Riparian Temporarily Flooded Hardwood Forest and Central Texas: Floodplain Hardwood Forest, as previously described in this section.[88] A complete list of wetland vegetation types within the Study Area is provided in **Table 3.7-40**.

[84] FEMA, "Digital Floodplain Insurance Rate Maps," 2014. http://www.fema.gov/flood-insurance-rate-map-firm (accessed May 03, 2017).
[85] USACE, "USACE-Owned Properties Fort Worth District," 2014.
[86] NRCS, "SSURGO data by County," 2013.
[87] NRCS, "Hydric Soils List 2015: Texas," 2015.
[88] TWDB, "River Basins." http://www.twdb.texas.gov/surfacewater/rivers/river_basins/index.asp (accessed January 18, 2016).

Table 3.7-40: Wetland Vegetation Types within Study Area – Grimes County

Vegetation Types	Percent of Segment 3C	Percent of Segment 4	Percent of Segment 5
Pineywoods: Small Stream and Riparian Wet Prairie	7.4	11.1	5.1
Pineywoods: Small Stream and Riparian Temporarily Flooded Hardwood Forest	4.7	23.6	3.2
Central Texas: Floodplain Hardwood Forest	--	--	1.6
Central Texas: Floodplain Herbaceous Vegetation	--	--	1.3
Central Texas: Riparian Herbaceous Vegetation	--	--	1.1
Central Texas: Riparian Hardwood - Evergreen Forest	--	--	0.35
Central Texas: Riparian Hardwood Forest	--	--	0.33
Pineywoods: Small Stream and Riparian Temporarily Flooded Mixed Forest	--	--	0.14
Open Water	--	--	0.09
Marsh	--	--	0.03
Total	**12.1**	**34.7**	**13.2**

Source: Elliot et al., 2014
'--' - not present

3.7.4.9 Waller County

3.7.4.9.1 Water Resources

Within Waller County, the Study Area is located within the San Jacinto River Basin.[89] The streams, wetlands and waterbodies located within this Study Area are provided in **Tables 3.7-41** through **3.7-43**.

Table 3.7-41: Streams within the Study Area – Waller County

Stream Type	Length within Segment 5 (linear feet)
Perennial	274
Intermittent	2,007
Ephemeral	133
Artificial/Man-made	241
Total	**2,655**

Source: USGS, 2016

Notable streams within the Study Area include the perennial Walnut Creek and the intermittent Brushy Creek and Threemile Creek.

[89] TWDB, "River Basins." http://www.twdb.texas.gov/surfacewater/rivers/river_basins/index.asp (accessed January 18, 2016).

Table 3.7-42: Wetlands within the Study Area – Waller County		
Wetland Type	**Classification**	**Area of Segment 5 (acres)**
Freshwater Emergent Wetland	PEM	0.01
	PEM1A	0.38
	PEM1Fh	0.14
	PEM1C	0.95
Freshwater Forested/Shrub Wetland	PFO1A	3.5
	PFO1C	0.64
	Total	**5.6**

Source: USFWS, 2016
P - Palustrine
EM1 - Persistent Emergent
SS1 - Broad-leaved Deciduous Scrub-Shrub
C - Seasonally Flooded
h - Diked/Impounded
FO1 - Broad-leaved Deciduous Forested
A - Temporarily Flooded
F - Semi permanently Flooded

Table 3.7-43: Waterbodies within the Study Area – Waller County	
Type	**Area of Segment 5 (acres)**
Freshwater Pond	0.55
Total	**0.55**

Source: USFWS, 2016

Based on the FEMA FIRMs and Digital FIRMs, approximately four acres of the Study Area are located within a 500-year floodplain (Zone X) and approximately 18 acres of the Study Area are located within a 100-year floodplain (Zone AE).[90]

3.7.4.9.2 USACE Projects

No USACE Projects subject to Section 408 approval are located within the Waller County Study Area.[91]

3.7.4.9.3 Hydric Soils

Based on the 2015 NRCS National Hydric Soil List, there are nine hydric soils located within the Study Area in Waller County.[92,93] **Table 3.7-44** includes the area in acres of each hydric soil.

Table 3.7-44: Hydric Soils within the Study Area – Waller County		
Soil Unit Name	**Soil Map Unit**	**Area of Segment 5 (acres)**
Boy loamy fine sand, 1 to 5 percent slopes	BoC	33.1
Edna loam, 0 to 1 percent slopes	EdA	6.2
Hatliff-Pluck-Kian complex, 0 to 1 percent slopes, frequently flooded	HatA	0.19
Katy fine sandy loam, 0 to 1 percent slopes	KaA	2.3
Katy fine sandy loam, 1 to 3 percent slopes	KaB	2.5
Nahatche loam, frequently flooded	Na	10.1
Splendora fine sandy loam, 0 to 2 percent slopes	SpB	42.6

90 FEMA, "Digital Floodplain Insurance Rate Maps," 2014. http://www.fema.gov/flood-insurance-rate-map-firm (accessed May 03, 2017).
91 USACE, "USACE-Owned Properties Fort Worth District," 2014.
92 NRCS, "SSURGO data by County," 2013.
93 NRCS, "Hydric Soils List 2015: Texas," 2015.

Table 3.7-44: Hydric Soils within the Study Area – Waller County		
Soil Unit Name	**Soil Map Unit**	**Area of Segment 5 (acres)**
Wockley fine sandy loam, 0 to 1 percent slopes	WoA	54.2
Wockley fine sandy loam, 1 to 3 percent slopes	WoB	14.3
	Total	**165.5**

Source: NRCS, 2013; NRCS, 2015

3.7.4.9.4 Vegetation

According to the EMST, the most common wetland vegetation type is Gulf Coast: Coastal Prairie, described below. A complete list of wetland vegetation types within the Study Area are provided in **Table 3.7-45**.

Table 3.7-45: Wetland Vegetation Types within the Study Area – Waller County	
Vegetation Types	**Percent of Segment 5**
Gulf Coast: Coastal Prairie	108.1
Pineywoods: Small Stream and Riparian Temporarily Flooded Hardwood Forest	2.9
Pineywoods: Small Stream and Riparian Wet Prairie	0.67
Total Percent	**111.7**

Source: Elliot et al., 2014

A variety of grasslands are located within Gulf Coast: Coastal Prairie vegetation type including species such as bermudagrass, bahia grass, rat-tail smutgrass (*Sporobolus indicus*), broomsedge bluestem, bushy bluestem, brownseed paspalum (*P. plicatulum*) and little bluestem. Shrubs such as baccharis (*Baccharis neglecta*), Chinese tallow (*Triadica sebifera*) and/or mesquite (*Prosopis glandulosa*) can be present.

3.7.4.10 Harris County

3.7.4.10.1 Water Resources

Within Harris County, the Study Area is located within the San Jacinto River Basin.[94] The streams, wetlands and waterbodies located within this Study Area are provided in **Tables 3.7-46** through **3.7-48**. As previously discussed there are three Houston Terminal Station options: Industrial Site Terminal, Northwest Mall and Northwest Transit Center options. There are no water resources within the LOD of these three Terminal Station options.

Table 3.7-46: Streams within the Study Area – Harris County	
Stream Type	**Length within Segment 5 (linear feet)**
Perennial	1,116
Intermittent	6,272
Ephemeral	4,136
Artificial/Man-made	12,228
Total	**23,752**

Source: USGS, 2016

Notable streams within Segment 5 within Harris County include the intermittent Cole Creek and Spring Creek.

[94] TWDB, "River Basins." http://www.twdb.texas.gov/surfacewater/rivers/river_basins/index.asp (accessed January 18, 2016).

Wetlands within the Study Area in Harris County are listed below in **Table 3.7-47**.

Table 3.7-47: Wetlands within the Study Area – Harris County

Wetland Type	Classification	Area of Segment 5 (acres)	Area of Northwest Transit Center Terminal Station Option (acres)
Freshwater Emergent Wetland	PEM	37.1	0.51
	PEM1A	5.4	--
	PEM1Cx	2.5	--
	PEM1F	0.27	--
	PEMF	--	--
	PEM1C	5.9	--
Freshwater Forested/Shrub Wetland	PFO	0.06	--
	PFO1A	0.09	--
	PFO1Ad	0.02	--
	PFO1Cx	0.83	--
	PSS1A	0.08	--
	PSS1C	0.05	--
	PSS	0.52	--
Other	Pf	22.1	
	Total	**74.9**	**0.51**

Source: USFWS, 2016
Note: There are no wetlands within the LOD of the either the Northeast Mall Terminal Station or Industrial Site Terminal Station options.

P - Palustrine
EM1 - Persistent Emergent
FO1 - Broad-leaved Deciduous Forested
SS1 - Broad-leaved Deciduous Scrub-Shrub
C - Seasonally Flooded
SS - Scrub-Shrub
f - Farmed
EM - Emergent
FO - Forested
FO4 – Forested Needle-leaved Evergreen
A - Temporarily Flooded
F - Semi permanently Flooded
d- Partly Drained/Ditched
x - Excavated

Waterbodies within the Harris County Study Area are listed below in **Table 3.7-48**. There are no waterbodies within the Industrial Site Terminal or Northwest Mall Terminal options.

Table 3.7-48: Waterbodies within the Study Area – Harris County

Type	Area of Segment 5 (acres)	Area of Northwest Transit Center Terminal Station Option (acres)
Swamp	6.8	--
Freshwater Pond	4.2	0.10
Total	**11.0**	**0.10**

Source: USFWS, 2016
Note: There are no waterbodies within the LOD of the either the Northeast Mall Terminal Station or Industrial Site Terminal Station options.

Based on the FEMA FIRMs and Digital FIRMs, approximately 37 acres of Segment 5 and less than one acre of the Industrial Site Terminal Option are located within a 500-year floodplain (Zone X) and approximately 31 acres of Segment 5 are located within a 100-year floodplain (Zones AE and AO).[95] There are no mapped floodplains within the Northwest Mall Terminal or Northwest Transit Center Terminal options.

[95] FEMA, "Digital Floodplain Insurance Rate Maps," 2014. http://www.fema.gov/flood-insurance-rate-map-firm (accessed May 03, 2017).

3.7.4.10.2 USACE Projects

No USACE Projects subject to Section 408 approval are located within the Harris County Study Area.[96]

3.7.4.10.3 Hydric Soils

Based on the 2015 NRCS National Hydric Soil List, there are 11 hydric soils located within Segment 5 and two hydric soils located within the Industrial Site Terminal, Northwest Mall Terminal and Northwest Transit Center Terminal options.[97, 98] **Table 3.7-49** includes the area in acres for each hydric soil.

Table 3.7-49: Hydric Soils within the Study Area – Harris County

Soil Unit Name	Soil Map Unit	Area of Segment 5 (acres)	Area of Northwest Transit Center Terminal Station Option (acres)	Area of Northwest Mall Terminal Station Option (acres)	Area of Industrial Site Terminal Station Option (acres)
Addicks loam	Ad	46.6	--	--	--
Addicks-Urban land complex	Ak	50.1	2.4	2.7	2.8
Aris fine sandy loam	Ap	2.9	--	--	--
Aris-Gessner complex	Ar	52.6	--	--	--
Aris-Urban land complex	As	--	41.6	0.58	8.1
Clodine fine sandy loam, 0 to 1 percent slopes	Cd	83.4	--	--	--
Clodine-Urban land complex	Ce	27.4	--	--	--
Gessner fine sandy loam, 0 to 1 percent slopes	Ge	163.8	--	--	--
Hatliff-Pluck-Kian complex, 0 to 1 percent slopes	HatA	1.1	--	--	--
Katy fine sandy loam, 0 to 1 percent slopes	Kf	7.0	--	--	--
Nahatche loam, frequently flooded	Na	0.14	--	--	--
Wockley fine sandy loam, 0 to 1 percent slopes	Wo	666.9	--	--	--
	Total	**1,101.9**	**44.0**	**3.3**	**10.9**

Source: NRCS, 2013; NRCS, 2015
'--' - not present

3.7.4.10.4 Vegetation

According to the EMST, the most common wetland vegetation type located in this Study Area is Gulf Coast: Coastal Prairie, as previously described in this section. A complete list of wetland vegetation types that comprise this Study Area is provided in **Table 3.7-50**. There are no wetland vegetation types located within the Study Area of the three Houston Terminal Station options.

[96] USACE, "USACE-Owned Properties Galveston District," 2014.
[97] NRCS, "SSURGO data by County," 2013.
[98] NRCS, "Hydric Soils List 2015: Texas," 2015.

Table 3.7-50: Wetland Vegetation Types within the Study Area – Harris County

Vegetation Types	Percent of Segment 5
Gulf Coast: Coastal Prairie	133.9
Gulf Coast: Coastal Prairie Pond Shore	0.87
Pineywoods: Small Stream and Riparian Temporarily Flooded Hardwood Forest	0.19
Open Water	0.03
Marsh	<0.01
Total Percent	**135.0**

Source: Elliot et al., 2014

3.7.5 Environmental Consequences

3.7.5.1 No Build Alternative

Under the No Build Alternative, the HSR system would not be constructed. Existing streams, wetlands or waterbodies would not be disturbed by the HSR system because no construction activities would occur related to the Build Alternatives. This alternative would not require any channel modifications. However, potential impacts could still occur to streams, wetlands or waterbodies under the No Build Alternative as new development would continue due to projected growth in the Study Area, especially in the urban areas.

3.7.5.2 Build Alternatives

Impacts would occur within waters of the U.S. during the construction and operation of any of the Build Alternatives. TCRR, in coordination with USACE, would develop the final design to avoid and minimize impacts to waters of the U.S., as practicable. Due to the linear nature of this Project and the curvature restrictions associated with the operation of the HSR system, some crossings would be unavoidable. Avoidance and minimization measures are included in **Section 3.7.6**. Potential impacts to streams, wetlands and waterbodies resulting from the implementation of any of the Build Alternatives are listed below by county and segment. For a more detailed breakdown of impacts, see **Appendix E, Waters of the U.S. Technical Memorandum**. The crossings types for wetlands and waters of the U.S. are defined as the following:

- **Viaduct/Bridge** – It is anticipated that 60 percent of any of the Build Alternatives would be placed on viaduct, resulting in many wetlands and waters of the U.S. being spanned by bridges and viaducts. Pier spacing would range from 80 feet to 140 feet, with a typical pier spacing of 110 feet (see **Appendix F, TCRR Conceptual Enginering Design Report**). If the width of the regulatory floodplain is less than 110 feet, the entire span would be designed and constructed with no piers in channel, and, if possible, avoid impacts to waters of the U.S. If the width of the crossing is more than 140 feet, the minimum number of piers required to support the viaduct crossing would be placed within the feature. Bridges would also be used for larger crossings determined to exceed the capacity of culverts.
- **Culvert** – Where any of the Build Alternatives would be on embankment, culverts would be used at stream features with a minimum flowline and defined channel width that would accommodate culvert configurations. Culverts are also anticipated to be used for access road crossing of features.
- **Excavation** – Includes areas that are excavated or regraded to redirect stormwater flow or create detention basins within the LOD.

- **Fill** – Placement of fill to support the permanent footprint of any of the Build Alternatives on embankment or ancillary facilities.
- **Conversion** – The permanent conversion of forested wetlands to emergent wetlands due to the removal of woody vegetation during construction and permanent maintenance of herbaceous vegetation within the permanent HSR ROW.

Permanent impacts would occur for the placement of culverts, viaduct support structure and within the permanent footprint of access roads, stations, MOWs, TMFs and where any of the Build Alternatives would be on embankment. Short-term impacts would include grading and temporary fill from construction access, staging and laydown areas. Operational impacts to waters of the U.S. would be limited to maintenance of culverts or bridges, and ongoing vegetation maintenance within the permanent HSR ROW.

Impacts to wetlands and waters of the U.S. would require permits and approvals from the USACE that would include permit provisions to avoid, minimize and mitigate impacts, as described in **Section 3.7.6**.

3.7.5.2.1 Dallas County

Estimated impacts to waters of the U.S. resulting from the construction of Segment 1 within Dallas County are provided in **Tables 3.7-51** thru **3.7-53.**

Table 3.7-51: Estimated Stream Impacts – Dallas County

Classification	Crossing Type	Segment 1		
		# of Crossings*	Temp	Perm
			linear feet	
Artificial/Man-made	Bridge/Viaduct	6	43.5	0.00
	Culvert	2	0.00	404.6
	Excavation	1	0.00	698.1
Ephemeral	Bridge/Viaduct	2	0.00	0.00
Intermittent	Bridge/Viaduct	9	17.0	0.00
	Culvert	1	0.00	54.6
Perennial	Bridge/Viaduct	12	0.00	0.00
	Excavation	2	0.00	165.1
	Total	**35**	**17.0**	**1,322.4**

Source: USGS, 2016; FNI, 2017
*Number of crossings was determined based on a combination of NHD and field collected data. Not all features have been field-verified. Each crossing is included by type, and includes where a single feature may be crossed multiple times within the LOD.

Table 3.7-52: Estimated Wetland Impacts – Dallas County

Wetland Type	Crossing Type	Segment 1		
		# of Crossings*	Temp	Perm
			acres	
Emergent	Bridge/Viaduct	8	0.27	0.00
	Excavation	2	0.00	2.1
Forested	Conversion	22	0.05	4.1
	Excavation	5	0.00	1.9
	Fill	5	0.11	0.05
Shrub/Scrub	Bridge/Viaduct	2	0.00	0.00
	Total	**44**	**0.43**	**8.2**

Source: USFWS, 2016; FNI, 2017
*Number of crossings was determined based on a combination of NWI and field collected data. Not all features have been field-verified.

Table 3.7-52: Estimated Wetland Impacts – Dallas County

Wetland Type	Crossing Type	Segment 1		
		# of Crossings*	Temp	Perm
			acres	

Each crossing is included by type, and includes where a single feature may be crossed multiple times within the LOD.

Table 3.7-53: Estimated Waterbody Impacts – Dallas County

Waterbody Type	Crossing Type	Segment 1		
		# of Crossings*	Temp	Perm
			acres	
Freshwater Pond	Bridge/Viaduct	10	<0.01	0.00
	Excavation	4	0.00	1.4
	Fill	4	0.00	0.69
Lake (Mooreland Lake)	Bridge/Viaduct	1	0.00	0.00
	Total	**10**	**<0.01**	**2.1**

Source: USGS, 2016; USFWS, 2016; FNI, 2017
*Number of crossings was determined based on a combination of NWI and field collected data. Not all features have been field-verified. Each crossing is included by type, and includes where a single feature may be crossed multiple times within the LOD.

USACE Projects

Estimated impacts to streams, wetlands and waterbodes as a result of Segment 1 in Dallas County include impacts to USACE Projects. Impacts to these Projects would require Section 408 permission which TCRR shall request from the USACE. All Build Alternatives (A through F) would require Section 408 permission from the USACE Fort Worth District. Impacts to streams, wetlands and waterbodies that occur within the USACE Projects are detailed in **Appendix E, Impacts to USACE Properties Technical Memorandum**.

3.7.5.2.2 Ellis County

Estimated impacts to waters of the U.S. resulting from the construction of Segments 1, 2A or 2B within Ellis County are provided in **Tables 3.7-54** through **3.7-56.** There are no waterbodies within Segments 3A, 3B or 3C in Ellis County; therefore, none would be impacted.[99]

[99] USFWS, "National Wetlands Inventory," Last modified December 07, 2016. http://www.fws.gov/wetlands/Data/Mapper.html (accessed May 3, 2017).

Table 3.7-54: Estimated Stream Impacts for – Ellis County

Classification	Crossing Type	Segment 1			Segment 2A			Segment 2B			Segment 3A			Segment 3B			Segment 3C		
		# of Crossings*	Temp	Perm	# of Crossings*	Temp	Perm	# of Crossings*	Temp	Perm	# of Crossings*	Temp	Perm	# of Crossings*	Temp	Perm	# of Crossings*	Temp	Perm
			linear feet			linear feet			linear feet			linear feet			linear feet			linear feet	
Artificial/ Man-made	Bridge/ Viaduct	--	--	--	--	--	--	4	0.00	0.00	--	--	--	--	--	--	--	--	--
	Culvert	--	--	--	4	0.00	181.5	1	0.00	280.8	--	--	--	--	--	--	--	--	--
	Excavation	--	--	--	--	--	--	1	0.00	5.6	--	--	--	--	--	--	--	--	--
Ephemeral	Bridge/ Viaduct	--	--	--	12	0.00	0.00	--	--	--	--	--	--	--	--	--	--	--	--
	Culvert	--	--	--	4	0.00	546.6	--	--	--	--	--	--	--	--	--	--	--	--
	Excavation	--	--	--	2	0.00	387.5	--	--	--	--	--	--	--	--	--	--	--	--
Intermittent	Bridge/ Viaduct	--	--	--	46	54.8	0.00	61	45.2	0.00	4	0.00	0.00	2	0.00	0.00	4	0.00	0.00
	Culvert	--	--	--	1	0.00	246.0	6	0.00	1,136.2	--	--	--	2	0.00	179.9	--	--	--
	Excavation	--	--	--	--	--	--	3	0.00	406.1	1	0.00	21.9	1	0.00	118.1	1	0.00	21.9
Perennial	Bridge/ Viaduct	2	0.00	0.00	8	0.00	0.00	9	0.00	0.00	--	--	--	--	--	--	--	--	--
Total		**2**	**0.00**	**0.00**	**77**	**54.8**	**1,361.6**	**85**	**45.2**	**1,828.7**	**5**	**0.00**	**21.9**	**5**	**0.00**	**298.0**	**5**	**0.00**	**21.9**

Source: USGS, 2016; FNI, 2017
*Number of crossings was determined based on a combination of NHD and field collected data. Not all features have been field-verified. Each crossing is included by type, and includes where a single feature may be crossed multiple times within the LOD.
'--' - not present

Table 3.7-55: Estimated Wetland Impacts – Ellis County

Wetland Type	Crossing Type	Segment 2A			Segment 2B			Segment 3A			Segment 3B			Segment 3C		
		# of Crossings*	Temp	Perm	# of Crossings*	Temp	Perm	# of Crossings*	Temp	Perm	# of Crossings*	Temp	Perm	# of Crossings*	Temp	Perm
			acres			acres			acres			acres			acres	
Emergent	Bridge/Viaduct	8	0.00	0.00	--	--	--	--	--	--	--	--	--	--	--	--
	Excavation	1	0.00	<0.01	--	--	--	--	--	--	--	--	--	--	--	--
	Fill	10	0.00	1.3	--	--	--	--	--	--	--	--	--	--	--	--
Forested	Conversion	11	0.00	0.78	12	0.00	1.1	3	0.00	0.28	2	0.00	0.11	3	0.00	0.28
	Excavation	--	--	--	--	--	--	1	0.00	0.01	2	0.00	0.06	1	0.00	0.01
	Fill	--	--	--	--	--	--	--	--	--	3	0.00	0.18	--	--	--
Total		**30**	**0.00**	**2.1**	**12**	**0.00**	**1.1**	**4**	**0.00**	**0.29**	**7**	**0.00**	**0.35**	**4**	**0.00**	**0.29**

Source: USFWS, 2016; FNI, 2017
*Number of crossings was determined based on a combination of NWI and field collected data. Not all features have been field-verified. Each crossing is included by type, and includes where a single feature may be crossed multiple times within the LOD.

Table 3.7-56: Estimated Waterbody Impacts – Ellis County

Waterbody Type	Crossing Type	Segment 1			Segment 2A			Segment 2B		
		# of Crossings*	Temp	Perm	# of Crossings*	Temp	Perm	# of Crossings*	Temp	Perm
			acres			acres			acres	
Freshwater Pond	Bridge/Viaduct	2	0.00	0.00	29	0.00	0.00	21	0.00	0.00
	Excavation	--	--	--	1	0.00	0.28	3	0.00	0.52
	Fill	--	--	--	12	0.00	2.8	4	0.00	1.3
Total		**2**	**0.00**	**0.00**	**42**	**0.00**	**3.1**	**19**	**0.00**	**1.8**

Source: USGS, 2016; USFWS, 2016; FNI, 2017
*Number of crossings was determined based on a combination of NWI and field collected data. Not all features have been field-verified. Each crossing is included by type, and includes where a single feature may be crossed multiple times within the LOD

This page intentionally left blank.

USACE Projects

Estimated impacts to streams, wetlands and waterbodes of Segments 2A and 2B in Ellis County would include impacts to the USACE Project, Lake Bardwell. Segment 2A would cross a flowage easement and Segment 2B would cross fee owned land associated with Lake Bardwell. Impacts of Segment 2B (Build Alternatives D, E and F) would require Section 408 permission that TCRR shall request from the USACE. The USACE may implement avoidance measures requiring TCRR to select Segment 2A, which would not require Section 408 permission. Build Alternatives D, E and F would require Section 408 permission from the USACE Fort Worth District. Impacts to streams, wetlands and waterbodies that occur within the USACE Project are detailed in **Appendix E, Impacts to USACE Projects Technical Memorandum**.

3.7.5.2.3 Navarro County

Potential impacts to waters of the U.S. from the construction of Segments 3A, 3B or 3C within Navarro County are provided in **Tables 3.7-57** through **3.7-59.**

Table 3.7-57: Estimated Stream Impacts – Navarro County

Classification	Crossing Type	Segment 3A			Segment 3B			Segment 3C		
		# of Crossings*	Temp	Perm	# of Crossings*	Temp	Perm	# of Crossings*	Temp	Perm
			linear feet			linear feet			linear feet	
Artificial/Man-made	Bridge/Viaduct	1	0.00	0.00	7	0.00	0.00	1	0.00	0.00
	Culvert	--	--	--	1	0.00	132.4	--	--	--
	Excavation	--	--	--	1	0.00	252.3	--	--	--
Ephemeral	Bridge/Viaduct	13	0.00	0.00	--	--	--	--	--	--
	Culvert	2	0.00	235.2	--	--	--	--	--	--
	Excavation	1	0.00	42.7	--	--	--	--	--	--
Intermittent	Bridge/Viaduct	41	315.0	0.00	45	616.7	0.00	58	324.4	0.00
	Culvert	10	24.2	2,808.1	23	378.8	5,111.4	16	55.0	3,326.6
	Excavation	8	0.00	1,639.7	10	0.00	2,246.3	10	0.00	2,476.2
	Fill	1	0.00	92.6	--	--	--	1	0.00	2.7
Perennial	Bridge/Viaduct	2	0.00	0.00	--	--	--	--	--	--
	Total	**79**	**339.2**	**4,818.3**	**87**	**995.5**	**7,742.4**	**86**	**379.4**	**5,805.5**

Source: USGS, 2016; FNI, 2017
*Number of crossings was determined based on a combination of NHD and field collected data. Not all features have been field-verified. Each crossing is included by type, and includes where a single feature may be crossed multiple times within the LOD.
'--' - not present

Table 3.7-58: Estimated Wetland Impacts – Navarro County

Wetland Type	Crossing Type	Segment 3A			Segment 3B			Segment 3C		
		# of Crossings*	Temp	Perm	# of Crossings*	Temp	Perm	# of Crossings*	Temp	Perm
			acres			acres			acres	
Emergent	Bridge/Viaduct	80	8.5	0.00	5	0.00	0.00	6	0.00	0.00
	Excavation	8	0.00	2.5	--	--	--	--	--	--
	Fill	2	0.00	0.07	1	0.00	0.12	--	--	--
Forested	Conversion	6	0.00	0.32	15	0.00	4.0	10	0.00	8.0
	Excavation	1	0.00	<0.01	2	0.00	0.27	--	--	--
	Fill	--	--	--	4	0.00	0.41	--	--	--
	Total	**97**	**8.5**	**2.9**	**27**	**0.00**	**4.8**	**16**	**0.00**	**8.0**

Source: USFWS, 2016; FNI, 2017
*Number of crossings was determined based on a combination of NWI and field collected data. Not all features have been field-verified. Each crossing is included by type, and includes where a single feature may be crossed multiple times within the LOD.

Table 3.7-59: Estimated Waterbody Impacts – Navarro County

Waterbody Type	Crossing Type	Segment 3A			Segment 3B			Segment 3C		
		# of Crossings*	Temp (acres)	Perm (acres)	# of Crossings*	Temp (acres)	Perm (acres)	# of Crossings*	Temp (acres)	Perm (acres)
Freshwater Pond	Bridge/Viaduct	38	0.77	0.00	21	0.69	0.00	13	0.03	0.00
	Excavation	15	0.00	4.0	9	0.00	1.7	3	0.00	0.39
	Fill	17	0.00	4.4	20	0.00	3.0	4	0.00	0.66
Lake (Soil Conservation Service Site 138)	Bridge/Viaduct	--	--	--	1	0.00	0.00	--	--	--
Total		**70**	**0.77**	**8.4**	**27**	**0.69**	**4.7**	**16**	**0.03**	**1.1**

Source: USGS, 2016; USFWS, 2016; FNI, 2017
*Number of crossings was determined based on a combination of NWI and field collected data. Not all features have been field-verified. Each crossing is included by type, and includes where a single feature may be crossed multiple times within the LOD

3.7.5.2.4 Freestone County

Estimated impacts to waters of the U.S. from the construction of Segments 3C or 4 within Freestone County are provided in **Tables 3.7-60** through **3.7-62**. There are no mapped streams, wetlands or waterbodies within Segments 3A and 3B in Freestone County.

Table 3.7-60: Estimated Stream Impacts – Freestone County

Classification	Crossing Type	Segment 3C			Segment 4		
		# of Crossings*	Temp	Perm	# of Crossings*	Temp	Perm
			linear feet			linear feet	
Artificial/Man-made	Bridge/Viaduct	--	--	--	2	0.00	0.00
	Culvert	1	0.00	224.2	1	0.00	39.8
	Excavation	1	0.00	147.4	1	0.00	696.7
Ephemeral	Bridge/Viaduct	--	--	--	21	766.2	0.00
	Culvert	--	--	--	8	0.00	1,541.9
	Excavation	--	--	--	2	0.00	355.3
	Fill	--	--	--	4	0.00	567.2
Intermittent	Bridge/Viaduct	73	3,903.4	0.00	28	0.00	0.00
	Culvert	8	0.00	2,303.9	8	0.00	1,406.9
	Excavation	5	0.00	823.1	4	0.00	961.0
	Fill	3	0.00	910.3	1	0.00	305.6
Perennial	Bridge/Viaduct	5	0.00	0.00	2	0.00	0.00
	Total	**96**	**3,903.1**	**4,408.9**	**82**	**766.2**	**5,874.4**

Source: USGS, 2016; FNI, 2017
*Number of crossings was determined based on a combination of NHD and field collected data. Not all features have been field-verified. Each crossing is included by type, and includes where a single feature may be crossed multiple times within the LOD.
'--' - not present

Table 3.7-61: Estimated Wetland Impacts – Freestone County

Wetland Type	Crossing Type	Segment 3C			Segment 4		
		# of Crossings*	Temp	Perm	# of Crossings*	Temp	Perm
			acres			acres	
Emergent	Bridge/Viaduct	6	0.00	0.00	24	0.21	0.00
	Fill	1	0.00	0.11	4	0.00	0.26
Forested	Conversion	18	2.7	4.5	14	0.00	2.5
	Excavation	1	0.00	0.12	--	--	--
	Fill	1	0.00	0.07	2	0.00	0.17
Shrub/Scrub	Bridge/Viaduct	2	0.00	0.00	1	0.00	0.00
	Total	**29**	**2.7**	**4.8**	**45**	**0.21**	**2.9**

Source: USFWS, 2016; FNI, 2017
*Number of crossings was determined based on a combination of NWI and field collected data. Not all features have been field-verified. Each crossing is included by type, and includes where a single feature may be crossed multiple times within the LOD.

Table 3.7-62: Estimated Waterbody Impacts – Freestone County

Waterbody Type	Crossing Type	Segment 3C			Segment 4		
		# of Crossings*	Temp	Perm	# of Crossings*	Temp	Perm
			acres			acres	
Freshwater Pond	Bridge/Viaduct	13	1.1	0.00	30	0.68	0.00
	Excavation	1	0.00	0.08	9	0.00	1.3
	Fill	10	0.00	1.5	27	0.01	3.3
	Total	**26**	**1.1**	**1.6**	**66**	**0.69**	**4.6**

Source: USGS, 2016; USFWS, 2016; FNI, 2017

Table 3.7-62: Estimated Waterbody Impacts – Freestone County							
Waterbody Type	Crossing Type	Segment 3C			Segment 4		
		# of Crossings*	Temp	Perm	# of Crossings*	Temp	Perm
			acres			acres	

*Number of crossings was determined based on a combination of NWI and field collected data. Not all features have been field-verified. Each crossing is included by type, and includes where a single feature may be crossed multiple times within the LOD

3.7.5.2.5 *Limestone County*

Estimated impacts to waters of the U.S. resulting from construction of Segment 4 within Limestone County are provided in **Table 3.7-63** through **Table 3.7-65.**

Table 3.7-63: Estimated Stream Impacts – Limestone County				
Classification	Crossing Type	Segment 4		
		# of Crossings*	Temp	Perm
			Linear feet	
Artificial/Man-made	Culvert	1	0.00	784.4
Ephemeral	Bridge/Viaduct	12	0.00	0.00
	Culvert	3	0.00	1,700.9
	Excavation	1	0.00	50.3
	Fill	1	0.00	72.7
Intermittent	Bridge/Viaduct	35	0.00	0.00
	Culvert	1	0.00	162.9
	Excavation	2	0.00	401.4
Perennial	Bridge/Viaduct	2	0.00	0.00
	Total	**58**	**0.00**	**3,172.6**

Source: USGS, 2016; FNI, 2017
*Number of crossings was determined based on a combination of NHD and field collected data. Not all features have been field-verified. Each crossing is included by type, and includes where a single feature may be crossed multiple times within the LOD.

Table 3.7-64: Estimated Wetland Impacts – Limestone County				
Wetland Type	Crossing Type	Segment 4		
		# of Crossings*	Temp	Perm
			acres	
Emergent	Bridge/Viaduct	11	0.00	0.00
	Fill	3	0.00	0.13
Forested	Conversion	16	0.00	2.2
	Excavation	1	0.00	0.05
	Total	**31**	**0.00**	**2.3**

Source: USFWS, 2016; FNI, 2017
*Number of crossings was determined based on a combination of NWI and field collected data. Not all features have been field-verified. Each crossing is included by type, and includes where a single feature may be crossed multiple times within the LOD.

Table 3.7-65: Estimated Waterbody Impacts – Limestone County				
Waterbody Type	**Crossing Type**	**Segment 4**		
		# of Crossings*	**Temp**	**Perm**
			acres	
Freshwater Pond	Bridge/Viaduct	10	<0.01	0.00
	Excavation	1	0.00	0.08
	Fill	11	0.00	1.4
	Total	**23**	**<0.01**	**1.5**

Source: USGS, 2016; USFWS, 2016; FNI, 2017
*Number of crossings was determined based on a combination of NWI and field collected data. Not all features have been field-verified. Each crossing is included by type, and includes where a single feature may be crossed multiple times within the LOD.

3.7.5.2.6 Leon County

Estimated impacts to waters of the U.S. from the construction of Segments 3C or 4 within Leon County are presented in **Tables 3.7-66** through **3.7-68**.

Table 3.7-66: Estimated Stream Impacts – Leon County							
Classification	**Crossing Type**	**Segment 3C**			**Segment 4**		
		# of Crossings*	**Temp**	**Perm**	**# of Crossings***	**Temp**	**Perm**
			linear feet			**linear feet**	
Artificial/Man-made	Bridge/Viaduct	3	0.00	0.00	1	0.00	0.00
	Culvert	--	--	--	1	0.00	89.5
	Excavation	--	--	--	1	0.00	31.1
Ephemeral	Bridge/Viaduct	--	--	--	4	0.00	0.00
	Culvert	--	--	--	7	0.00	840.4
	Excavation	--	--	--	3	0.00	605.3
Intermittent	Bridge/Viaduct	58	50.4	0.00	49	1,502.7	0.00
	Culvert	7	0.00	1,419.4	8	0.00	2,073.3
	Excavation	7	0.00	697.6	5	0.00	1,272.72
	Fill	15	0.00	2,806.9	5	0.00	264.3
Perennial	Bridge/Viaduct	10	0.00	0.00	6	0.00	0.00
	Culvert	--	--	--	1	0.00	79.9
	Fill	2	0.00	373.8	--	--	--
	Total	**102**	**50.4**	**5,297.7**	**91**	**1,502.7**	**5,256.5**

Source: USGS, 2016; FNI, 2017
*Number of crossings was determined based on a combination of NHD and field collected data. Not all features have been field-verified. Each crossing is included by type, and includes where a single feature may be crossed multiple times within the LOD.
'--' - not present

Table 3.7-67: Estimated Wetland Impacts – Leon County							
Wetland Type	Crossing Type	Segment 3C			Segment 4		
		# of Crossings*	Temp	Perm	# of Crossings*	Temp	Perm
			acres			acres	
Emergent	Bridge/Viaduct	16	0.02	0.00	13	0.08	0.00
	Excavation	--	--	--	2	0.00	0.22
	Fill	--	--	--	7	0.07	0.79
Forested	Conversion	13	0.00	4.0	21	0.00	1.9
	Fill	4	0.00	0.31	2	0.00	0.08
Shrub/Scrub	Bridge/Viaduct	3	0.00	0.00	--	--	--
	Total	**36**	**0.00**	**4.3**	**45**	**0.15**	**2.8**

Source: USFWS, 2016; FNI, 2017
*Number of crossings was determined based on a combination of NWI and field collected data. Not all features have been field-verified. Each crossing is included by type, and includes where a single feature may be crossed multiple times within the LOD.

Table 3.7-68: Estimated Waterbody Impacts – Leon County							
Waterbody Type	Crossing Type	Segment 3C			Segment 4		
		# of Crossings*	Temp	Perm	# of Crossings*	Temp	Perm
			acres			acres	
Freshwater Pond	Bridge/Viaduct	9	0.00	0.00	26	0.21	0.00
	Excavation	1	0.00	0.24	6	0.00	0.39
	Fill	3	0.00	0.18	14	0.00	1.7
Lake	Bridge/Viaduct	--	--	--	2	0.00	0.00
	Total	**17**	**0.00**	**0.42**	**48**	**0.21**	**2.1**

Source: USGS, 2016; USFWS, 2016; FNI, 2017
*Number of crossings was determined based on a combination of NWI and field collected data. Not all features have been field-verified. Each crossing is included by type, and includes where a single feature may be crossed multiple times within the LOD.

3.7.5.2.7 Madison County

Estimated impacts to waters of the U.S. from construction of Segments 3C or 4 within Madison County are provided below in **Tables 3.7-69** through **3.7-71**.

Table 3.7-69: Estimated Stream Impacts – Madison County							
Classification	Crossing Type	Segment 3C			Segment 4		
		# of Crossings*	Temp	Perm	# of Crossings*	Temp	Perm
			linear feet			linear feet	
Artificial/Man-made	Bridge/Viaduct	2	0.00	0.00	1	0.00	0.00
	Culvert	1	0.00	170.7	--	--	--
Ephemeral	Bridge/Viaduct	--	--	--	16	13.9	0.00
	Culvert	--	--	--	3	0.00	960.0
	Excavation	--	--	--	2	0.00	41.8
Intermittent	Bridge/Viaduct	39	0.00	0.00	58	589.5	0.00
	Culvert	6	0.00	2,398.9	4	0.00	995.4
	Excavation	3	0.00	848.8	2	0.00	202.3
Perennial	Bridge/Viaduct	1	0.00	0.00	6	0.00	0.00
	Total	**52**	**0.00**	**3,418.4**	**92**	**603.4**	**2,199.5**

Source: USGS, 2016; FNI, 2017
*Number of crossings was determined based on a combination of NHD and field collected data. Not all features have been field-verified. Each crossing is included by type, and includes where a single feature may be crossed multiple times within the LOD.
'--' - not present

Table 3.7-70: Estimated Wetland Impacts – Madison County

Wetland Type	Crossing Type	Segment 3C			Segment 4		
		# of Crossings*	Temp	Perm	# of Crossings*	Temp	Perm
			acres			acres	
Emergent	Bridge/Viaduct	3	0.02	0.00	13	0.00	0.00
	Excavation	--	--	--	2	0.00	0.21
	Fill	3	0.00	0.44	2	0.00	0.04
Forested	Conversion	11	0.00	11.6	21	0.00	11.1
	Fill	--	--	--	1	0.00	<0.01
	Total	**17**	**0.02**	**12.0**	**39**	**0.00**	**11.7**

Source: USFWS, 2016; FNI, 2017
*Number of crossings was determined based on a combination of NWI and field collected data. Not all features have been field-verified. Each crossing is included by type, and includes where a single feature may be crossed multiple times within the LOD.

Table 3.7-71: Estimated Waterbody Impacts – Madison County

Waterbody Type	Crossing Type	Segment 3C			Segment 4		
		# of Crossings*	Temp	Perm	# of Crossings*	Temp	Perm
			acres			acres	
Freshwater Pond	Bridge/Viaduct	10	0.00	0.00	18	0.10	0.00
	Excavation	6	0.00	0.59	4	0.00	0.35
	Fill	7	0.00	1.0	5	0.00	0.59
Swamp	Bridge/Viaduct	3	0.00	0.00	--	--	--
	Fill	1	0.00	1.5	--	--	--
	Total	**27**	**0.00**	**3.1**	**27**	**0.10**	**0.94**

Source: USGS, 2016; USFWS, 2016; FNI, 2017
*Number of crossings was determined based on a combination of NWI and field collected data. Not all features have been field-verified. Each crossing is included by type, and includes where a single feature may be crossed multiple times within the LOD.

3.7.5.2.8 Grimes County

Estimated impacts to waters of the U.S. from the construction of Segments 3C, 4 and/or 5 within Grimes County are provided in **Tables 3.7-72** through **3.7-74.**

Table 3.7-72: Estimated Stream Impacts – Grimes County

Classification	Crossing Type	Segment 3C			Segment 4			Segment 5		
		# of Crossings*	Temp	Perm	# of Crossings*	Temp	Perm	# of Crossings*	Temp	Perm
			linear feet			linear feet			linear feet	
Artificial/Man-made	Bridge/Viaduct	--	--	--	--	--	--	3	2,341.6	0.00
	Culvert	--	--	--	--	--	--	3	0.00	1,781.3
	Excavation	--	--	--	--	--	--	2	0.00	262.2
Ephemeral	Bridge/Viaduct	--	--	--	13	0.00	0.00	35	2,786.5	0.00
	Culvert	--	--	--	--	--	--	16	778.2	1,806.5
	Excavation	--	--	--	--	--	--	5	0.00	588.2
	Fill	--	--	--	--	--	--	3	0.00	958.9
Intermittent	Bridge/Viaduct	11	0.00	0.00	7	0.00	0.00	86	1,595.9	0.00
	Culvert	2	0.00	170.2	2	0.00	170.2	16	0.00	3,434.2
	Excavation	4	0.00	108.1	1	0.00	108.1	15	0.00	3,038
	Fill	--	--	--	1	0.00	209.5	3	0.00	818.8
Perennial	Bridge/Viaduct	--	--	--	--	--	--	2	0.00	0.00
	Total	**17**	**0.00**	**278.3**	**24**	**0.00**	**379.7**	**189**	**7,502.2**	**12,688.1**

Source: USGS, 2016; FNI, 2017
*Number of crossings was determined based on a combination of NHD and field collected data. Not all features have been field-verified. Each crossing is included by type, and includes where a single feature may be crossed multiple times within the LOD.
'--' - not present

Table 3.7-73: Estimated Wetland Impacts – Grimes County

Wetlands Type	Crossing Type	Segment 3C			Segment 4			Segment 5		
		# of Crossings *	Temp (acres)	Perm (acres)	# of Crossings*	Temp (acres)	Perm (acres)	# of Crossings*	Temp (acres)	Perm (acres)
Emergent	Bridge/Viaduct	--	--	--	5	0.00	0.00	22	1.1	0.00
	Excavation	--	--	--	--	--	--	2	0.00	0.19
	Fill	--	--	--	--	--	--	6	2.3	0.43
Forested	Conversion	1	0.00	0.10	8	0.00	2.5	20	0.57	2.0
	Excavation	1	0.00	0.06	--	--	--	--	--	--
	Fill	--	--	--	--	--	--	4	0.22	0.18
Scrub/Shrub	Bridge/Viaduct	--	--	--	1	0.00	0.00	--	--	--
	Fill	--	--	--	--	--	--	1	0.00	0.10
Total		**2**	**0.00**	**0.16**	**14**	**0.00**	**2.5**	**55**	**4.2**	**2.9**

Source: USFWS, 2016; FNI, 2017
*Number of crossings was determined based on a combination of NWI and field collected data. Not all features have been field-verified. Each crossing is included by type, and includes where a single feature may be crossed multiple times within the LOD.

Table 3.7-74: Estimated Waterbody Impacts – Grimes County

Waterbody Type	Crossing Type	Segment 3C			Segment 4			Segment 5		
		# of Crossings*	Temp	Perm	# of Crossings*	Temp	Perm	# of Crossings*	Temp	Perm
			acres			acres			acres	
Freshwater Pond	Bridge/Viaduct	2	0.00	0.00	1	0.00	0.00	35	1.9	0.00
	Excavation	2	0.00	0.29	2	0.00	0.29	18	0.00	1.6
	Fill	2	0.00	0.60	2	0.00	0.60	36	0.45	8.0
Reservoir (Unnamed)	Excavation	--	--	--	--	--	--	1	0.00	0.01
	Fill	--	--	--	--	--	--	1	0.00	0.19
Total		**6**	**0.00**	**0.89**	**5**	**0.00**	**0.89**	**91**	**2.4**	**9.8**

Source: USGS, 2016; USFWS, 2016; FNI, 2017

*Number of crossings was determined based on a combination of NWI and field collected data. Not all features have been field-verified. Each crossing is included by type, and includes where a single feature may be crossed multiple times within the LOD.

3.7.5.2.9 Waller County

Estimated impacts to waters of the U.S. from construction of Segment 5 within Waller County are provided in **Tables 3.7-75** through **3.7-77**.

Table 3.7-75: Estimated Stream Impacts – Waller County

Classification	Crossing Type	Segment 5		
		# of Crossings*	Temp	Perm
			linear feet	
Artificial/Man-made	Bridge/Viaduct	2	0.00	0.00
Ephemeral	Culvert	1	0.00	37.7
	Excavation	1	0.00	95.1
Intermittent	Bridge/Viaduct	14	0.00	0.00
	Culvert	1	0.00	63.0
	Excavation	1	0.00	17.6
	Fill	2	0.00	531.8
Perennial	Bridge/Viaduct	2	0.00	0.00
	Total	**24**	**0.00**	**745.2**

Source: USGS, 2016; FNI, 2017
*Number of crossings was determined based on a combination of NHD and field collected data. Not all features have been field-verified. Each crossing is included by type, and includes where a single feature may be crossed multiple times within the LOD.
'--' - not present

Table 3.7-76: Estimated Wetland Impacts – Waller County

Wetland Type	Crossing Type	Segment 5		
		# of Crossings*	Temp	Perm
			acres	
Emergent	Bridge/Viaduct	4	0.00	0.00
	Excavation	2	0.00	0.01
	Fill	6	0.00	1.3
Forested	Conversion	14	0.00	4.0
	Fill	1	0.00	0.09
	Total	**27**	**0.00**	**5.4**

Source: USFWS, 2016; FNI, 2017
*Number of crossings was determined based on a combination of NWI and field collected data. Not all features have been field-verified. Each crossing is included by type, and includes where a single feature may be crossed multiple times within the LOD.

Table 3.7-77: Estimated Waterbody Impacts – Waller County

Waterbody Type	Crossing Type	Segment 5		
		# of Crossings*	Temp	Perm
			acres	
Freshwater Pond	Bridge/Viaduct	2	0.00	0.00
	Excavation	10	0.00	0.26
	Fill	4	0.00	0.27
	Total	**16**	**0.00**	**0.53**

Source: USGS, 2016; USFWS, 2016; FNI, 2017
*Number of crossings was determined based on a combination of NWI and field collected data. Not all features have been field-verified. Each crossing is included by type, and includes where a single feature may be crossed multiple times within the LOD.

3.7.5.2.10 Harris County

Estimated impacts to waters of the U.S. from construction of Segment 5 within Harris County are provided in **Tables 3.7-78** through **3.7-80**. There are no stream crossings, wetlands or waterbodies within LODs of the two Houston Terminal Station Options; therefore, none would be impacted at the Northwest Mall Terminal Station and Industrial Site Terminal Station.

Table 3.7-78: Estimated Stream Impacts – Harris County

Classification	Crossing Type	Segment 5		
		# of Crossings*	Temp	Perm
			linear feet	
Artificial/Man-made	Bridge/Viaduct	7	0.00	0.00
	Culvert	13	0.00	3,986.1
	Excavation	6	0.00	792.7
	Fill	6	0.00	4,683.5
Ephemeral	Bridge/Viaduct	3	0.00	0.00
	Culvert	1	0.00	170.6
	Excavation	1	0.00	49.2
	Fill	1	0.00	36.5
Intermittent	Bridge/Viaduct	17	3,890.0	0.00
	Culvert	1	0.00	175.9
	Excavation	2	0.00	198.6
	Fill	2	0.00	569.9
Perennial	Bridge/Viaduct	11	0.00	0.00
	Fill	1	0.00	98.6
	Total	**72**	**3,890.0**	**10,761.6**

Source: USGS, 2016; FNI, 2017
*Number of crossings was determined based on a combination of NHD and field collected data. Not all features have been field-verified. Each crossing is included by type, and includes where a single feature may be crossed multiple times within the LOD.
'--' - not present

Table 3.7-79: Estimated Wetland Impacts – Harris County

Wetland Type	Crossing Type	Segment 5			Northwest Transit Center Terminal		
		# of Crossings*	Temp	Perm	# of Crossings*	Temp	Perm
			acres			acres	
Emergent	Bridge/Viaduct	47	1.0	0.00	1	0.00	0.00
	Excavation	8	0.00	7.4	--	--	--
	Fill	25	0.00	34.8	1	0.00	<0.01
Forested	Conversion	8	0.03	0.13	--	--	--
	Fill	1	0.00	0.01	--	--	--
Other	Bridge/Viaduct	6	2.8	0.00	--	--	--
	Excavation	6	0.00	2.8	--	--	--
	Fill	9	0.63	12.8	--	--	--
Scrub/Shrub	Bridge/Viaduct	6	1.3	0.00	--	--	--
	Excavation	2	0.00	0.13	--	--	--
	Total	**118**	**5.8**	**58.1**	**2**	**0.00**	<0.01

Source: USFWS, 2016; FNI, 2017
*Number of crossings was determined based on a combination of NWI and field collected data. Not all features have been field-verified. Each crossing is included by type, and includes where a single feature may be crossed multiple times within the LOD.

Table 3.7-80: Estimated Waterbody Impacts – Harris County

Waterbody Type	Crossing Type	Segment 5			Northwest Transit Center Terminal		
		# of Crossings*	Temp	Perm	# of Crossings*	Temp	Perm
			acres			acres	
Freshwater Pond	Bridge/Viaduct	17	0.00	0.00	1	0.00	0.00
	Fill	4	0.00	0.55	1	0.00	0.04
Swamp	Excavation	1	0.00	1.7	--	--	--
	Fill	3	3.2	1.8	--	--	--
Total		**25**	**3.2**	**4.1**	**2**	**0.00**	**0.04**

Source: USGS, 2016; USFWS, 2016; FNI, 2017
*Number of crossings was determined based on a combination of NWI and field collected data. Not all features have been field-verified. Each crossing is included by type, and includes where a single feature may be crossed multiple times within the LOD.

3.7.6 Avoidance, Minimization and Mitigation Measures

In developing the Build Alternatives, TCRR identified co-location opportunities with transportation and utility corridors to minimize impacts to wetlands and waters of the U.S. Within the Build Alternatives, 53 percent of the LOD, on average, would be located adjacent to existing road, rail or utility infrastructure. Other design features include maximizing the use of viaduct to span waters of the U.S; approximately 60 percent of the Build Alternatives would be on viaduct. Impacts to wetlands would also be avoided or minimized with pier spacing that would range from 80 feet to 140 feet (as noted in **Appendix F, TCRR Conceptual Engineering Design Report**). If the width of the regulatory floodplain is less than 110 feet, the entire span would be designed and constructed with no piers in channel, and, if possible, avoid impacts to Waters of the U.S. If the width of the crossing is more than 140 feet, the minimum number of piers required to support the viaduct crossing would be placed within the feature. Bridges would also be used for larger crossings determined to exceed the capacity of culverts.

Consultation with the USACE Fort Worth and Galveston districts was initiated by TCRR to document the expected impacts, permits and mitigation needs in conjunction with this EIS process. When evaluating an application for a Clean Water Act Section 404 permit, the USACE shall evaluate the HSR system for impacts to waters of the U.S., and that the HSR system includes the following measures:

- Avoidance – taking steps to avoid impacts to waters of the U.S., including wetlands, where practicable
- Minimization – minimizing potential impacts to waters of the U.S., including wetlands
- Mitigation – providing compensation for unavoidable impacts through the restoration or creation of streams and wetlands

TCRR submitted a draft Section 408 request to the USACE Fort Worth District and Section 404 Individual Permit applications to the USACE Fort Worth and Galveston districts, including draft mitigation plans, in October 2017. This package is under review by the USACE, concurrent with this EIS, but has not been approved. TCRR shall continue to work directly with the USACE during the preparation of final design to avoid and minimize impacts to waters of the U.S. Permits as described in **Section 3.7.6.1, Compliance Measures and Permitting**, would be obtained by TCRR prior to initiating construction.

3.7.6.1 Compliance Measures and Permitting

The following Compliance Measures (CM) and permits would be required for Build Alternatives A through F for impacts to waters of the U.S., including wetlands.

WW-CM#1: Limit Impacts to 0.50 acre or Less. In compliance with the Clean Water Act and under USACE general conditions, to further minimize impacts to waters of the U.S, permanent impacts of the HSR system shall be limited by TCRR during design to 0.50 acre or less at each single and complete crossing, where practicable. In addition, permanent HSR facilities shall be placed by TCRR during design to avoid or minimize impacts to waters of the U.S., including wetlands to 0.50 acre or less.

WW-CM#2: Maintain low flow. In compliance with the Clean Water Act and under USACE general conditions, TCRR shall design and construct all crossings of waters of the U.S. to maintain low flows and avoid and/or minimize stream relocations during construction and operation of the HSR system.

WW-CM#3: Pre-construction Conditions. In compliance with the Clean Water Act and under USACE general conditions, TCRR shall return all temporary construction impacts (e.g., temporary equipment crossings or temporary disturbances in construction areas around and beneath the HSR system) to waters of the U.S., including wetlands, to pre-construction conditions. In conjunction with WW-CM#4, TCRR will provide post-construction monitoring reports to the USACE.

WW-CM#4: CWA Section 404, Individual Permit. Where avoidance of impacts to waters of the U.S., including wetlands, would not be practicable, TCRR shall obtain an Individual Permit from the appropriate USACE districts (Fort Worth and Galveston) prior to initiating construction. The decision to issue a permit rests with the USACE District Engineer and would be based on a number of considerations, including conservation, economics, aesthetics and several other factors. While the USACE would be responsible for the final decision, other natural resource agencies have an important role in the regulatory program. Assistance to the USACE on the permit process is provided by the EPA, USFWS and various state agencies. Section 404(b)(1) guidelines, published by the EPA, are the standards by which all Section 404 permit applications are evaluated. To highlight the efforts of the USACE to protect waters of the U.S., the USACE has entered into a Memorandum of Agreement with the EPA for determining the type and level of mitigation necessary to demonstrate compliance with Section 404(b)(1) Guidelines.

As previously stated, USACE is evaluating the Project under the provisions of one standard Individual Permit within each District's AOR. USACE is evaluating the overall Project, subject to its applicable authority, and will render single permit decisions within each District's AOR. Any authorization USACE renders for the Project would be conditioned such that construction of each phase of the Project that impacts jurisdictional waters will not be allowed to occur until such time that each phase of the Project is designed, submitted for review and is subsequently approved by the USACE. TCRR's permit process will continue to be informed through ongoing field visits to determine and delineate waters of the U.S., including wetlands, as well as continued coordination with the USACE, including field site visits to verify the methodology and findings. The USACE will coordinate with applicable federal and state agencies, such as EPA, TCEQ, TPWD, USFWS, etc., as part of the permit process.

TCRR, under the oversight of the USACE, shall comply with all the conditions during construction and operation required in the Section 404 permit.

WW-CM#5: Develop a Mitigation Plan. As a result of unavoidable impacts to waters of the U.S and in conjunction with **WW-CM#4: CWA Section 404, Individual Permit,** TCRR developed and submitted a draft mitigation plan with the July 2016 Section 404 submittal packet to the USACE Fort Worth and Galveston district. The draft mitigation plan includes a combination of permittee-responsible mitigation efforts (onsite and/or offsite), as defined below, and purchasing mitigation credits from mitigation banks.

- Permittee-responsible mitigation efforts may include stream/wetland enhancement and the installation of native vegetation buffers along water source edges.
- Other mitigation efforts may include replacing the loss of aquatic resource functions and values by creating, restoring, enhancing or preserving similar functions and values, preferably in the same watershed.

To facilitate the development of the mitigation plan, TCRR shall evaluate the ecological condition of jurisdictional streams and wetlands, of waters of the U.S. that would be impacted by the HSR system using the Texas Rapid Assessment Method (TXRAM) Version 2.0 in the Fort Worth District and the Hydrogeomorphic (HGM) Model in the Galveston District. The results of the assessments shall then be used for calculating the change in function and compensatory mitigation requirements associated with USACE authorized activities.[100, 101]

During the USACE review of the draft mitigation plan, TCRR shall continue to revise and refine the mitigation plan as part of the **WW-CM#4: CWA Section 404, Individual Permit.** The mitigation plan shall include sufficient detail to demonstrate measures taken to avoid, minimize and mitigate the aquatic functions that would be lost or impaired as a result of any of the Build Alternatives. Pending USACE approval, a final mitigation plan for wetlands and waters of the U.S. will be adopted by FRA as a part of the Final EIS.

WW-CM#6: Section 408 Permission. TCRR shall also submit a Section 408 request to the USACE to alter USACE Projects (the Dallas Floodway–Central Wastewater Treatment Plant, Dallas Floodway Extension-Floodway, Dallas Floodway Extension-Rochester Levee, Dallas Floodway Extension-Future Levees, Dallas Floodway Extension-Chain of Wetlands, Dallas Floodway Extension IH-45 Realignment, Dallas Floodway, Dallas Floodway-Levees, and Dallas Floodway-Sumps along the Trinity River in the Dallas County and Bardwell Lake in Ellis County). All Build Alternatives (A through F) would require Section 408 permission from the USACE Fort Worth District, while only Build Alternative D, E and F would require additional Section 408 permission for impacts to Lake Bardwell. Impacts to streams, wetlands and waterbodies that occur within the USACE Projects are detailed in **Appendix E, Impacts to USACE Projects Technical Memorandum**.

As noted in **Section 3.7.2.1**, the alteration of existing USACE projects must not impair their usefulness. The procedures for Section 408 permission are grouped into nine steps including pre-coordination, written request, required documentation, district-led agency technical review, summary of findings, division review, USACE headquarters review, notification and post-permission oversight.[102] The USACE will issue a decision on TCRR's Section 408 request after the review is complete on TCRR's Section 404, Individual Permit (**WW-CM#4: CWA Section 404, Individual Permit).**

[100] USACE. "Texas Rapid Assessment Method (TXRAM). Wetlands and Streams Modules, Version 2.0. Final." 2015. U.S. Army Corps of Engineers.
[101] USACE. "Memorandum for: All SWG Regulatory Branch Personnel, Subject: SWG-Standard Operating Procedures (SOP; Using HGM to Determine Potential Wetland Functions and the Appropriate Compensatory Mitigation for Unavoidable Wetland Impacts," 2008. U.S. Army Corps of Engineers.
[102] USACE. *Policy and Procedural Guidance for Processing Requests to Alter US Army Corps of Engineers Civil Works Projects Pursuant to 33 U.S.C. 408*. U.S. Army Corps of Engineers: Washington, D.C., 2015.

See also **WQ-CM#1: Section 401 Water Quality Certification** and **WW-CM#4: CWA Section 404, Individual Permit,** discussed further in **Section 3.3.6, Water Quality.**

3.7.6.2 Mitigation Measures

The following Mitigation Measures (MM) and permits would be required for Build Alternatives A through F for impacts to waters of the U.S., including wetlands.

WW-MM#1: Compensatory Mitigation. As a result of **WW-CM#4: CWA Section 404, Individual Permit** and **WW-CM#5: Develop a Mitigation Plan,** the USACE will determine the amount of compensatory mitigation that TCRR shall be required to implement. This determination will be based on total impacts to waters of the U.S., functional assessments of each field-verified feature and the mitigation bank's credit conversion instrument. Pending approval of the mitigation plan by the USACE and prior to construction, TCRR shall purchase wetland mitigation credits (on an acreage basis) and stream mitigation credits (on a linear footage basis).

The USACE may require TCRR to purchase wetland mitigation credits from an authorized mitigation bank. Mitigation banks that service the Study Area where impacts are estimated to occur are included in **Table 3.7-81**.

Table 3.7-81: Service Area Mitigation Banks

Bank Name	County/Segments	Credit Type/Number* Available
Rockin' K on Chambers Creek	Dallas (Segments 1, 2A, 2B); Ellis (Segments 2A, 2B, 3A, 3B); Navarro (Segments 3A, 3B, 3C)	Stream (5,818.2); Wetland (1.14)
Red Oak Umbrella	Dallas (Segments 1, 2A, 2B); Ellis (Segments 2A, 2B, 3A, 3B); Navarro (Segments 3A, 3B, 3C); Freestone (Segments 3C, 4); Leon (Segments 3C, 4)	Stream (712.9); Wetland (14.7)
Big Woods on the Trinity	Dallas (Segments 1, 2A, 2B); Ellis (Segments 2A, 2B, 3A, 3B); Navarro (Segments 3A, 3B, 3C); Freestone (Segments 3C, 4); Leon (Segments 3C, 4); Madison (Segments 3C, 4)	Wetland (177.7)
South Forks Trinity River - Ten Mile Tract	Dallas (Segment 1, 2A, 2B); Ellis (Segments 2A, 2B, 3A, 3B); Navarro (Segments 3A, 3B, 3C); Freestone (Segments 3C, 4); Madison (Segments 3C, 4); Grimes (Segments 3C, 4, 5)	Stream (Not Available); Wetland (59.3)
South Forks Trinity River	Navarro (Segment 3C); Freestone (Segment 3C); Madison (Segment 3C); Grimes (Segment 3C)	Stream (Not Available); Wetland (76.8)
Steele Creek	Navarro (Segment 3C); Freestone (Segments 3C, 4); Limestone (Segment 4); Leon (Segments 3C, 4); Madison (Segments 3C, 4); Grimes (Segments 3C, 4, 5)	Stream (Not Available); Wetland (344.2)
Mill Creek	Waller (Segment 5); Harris (Segment 5)	Stream (225.0); Wetland (9.6)
Katy Prairie Stream	Harris (Segment 5)	Stream (8,793.0)
Greens Bayou	Harris (Segment 5)	Wetland (41.1)

Source: RIBITS, 2016; FNI personal communication with the mitigation banks, 2016.
*Stream credits are provided in linear feet and wetland credits are provided in acres.

See also **WQ-MM#1 and WQ-MM#2: Section 401 BMPs** detailed in **Section 3.3.6, Water Quality.**

3.7.7 Build Alternative Comparison

The Build Alternatives comparison was completed using the LOD for each Build Alternatives. Qualitative analysis of waters of the U.S., including wetlands, is being collected by TCRR and will be assessed by the USACE during the permitting process. This analysis will be documented by the USACE separate from this EIS. **Tables 3.7-82 through 3.7-84** provide a summary of streams, waterbodies and wetlands within each Build Alternative LOD based on publicly available data and field data collected to date. Based on the data presented in the tables below:

- Build Alternative E would impact the greatest amount of streams with 52,377 linear feet of permanent impacts, and Alternative C would impact the least amount of streams with 46,110 linear feet of permanent impacts total.
- Build Alternatives C would impact the greatest amount of wetlands with 106.2 acres of permanent impacts, and Build Alternatives D would impact the least amount of wetlands with 100.9 acres of permanent impacts.
- Build Alternative A would impact the greatest amount of waterbodies with 38 acres of permanent impacts, and Build Alternative F would impact the least amount of waterbodies with 25.4 acres permanent impacts.

Build Alternative E would impact the most waters of the U.S., while Build Alternative C would have the least amount of impact on waters of the U.S.

Table 3.7-82: Estimated Impacts to Streams by Build Alternative

		Length of Potential Impacts (linear feet)																	
		ALT A			ALT B			ALT C			ALT D			ALT E			ALT F		
Type	**Crossing Type**	**# of Cross-ings***	**Temp**	**Perm**	**# of Cross-ings***	**Temp**	**Perm**	**# of Cross-ings***	**Temp**	**Perm**	**# of Cross-ings***	**Temp**	**Perm**	**# of Cross-ings***	**Temp**	**Perm**	**# of Cross-ings***	**Temp**	**Perm**
Artificial/Man-made	Bridge/ Viaduct	23	2,385.1	0.00	29	2,385.1	0.00	24	2,385.1	0.00	27	2,385.1	0.00	33	2,385.1	0.00	28	2,385.1	0.00
	Culvert	25	0.00	7,267.2	26	0.00	7,399.6	24	0.00	6,748.4	22	0.00	7,366.5	23	0.00	7,498.9	21	0.00	6,847.7
	Excava-tion	11	0.00	2,480.8	12	0.00	2,733.1	10	0.00	1,900.4	12	0.00	2,486.4	13	0.00	2,738.7	11	0.00	1,906.0
	Fill	6	0.00	4,683.5	6	0.00	4,683.5	6	0.00	4,683.5	6	0.00	4,683.2	6	0.00	4,683.5	6	0.00	4,983.5
Ephemeral	Bridge/ Viaduct	131	3,566.6	0.00	118	3,566.6	0.00	52	2,786.5	0.00	119	3,566.6	0.00	106	3,566.6	0.00	40	2,786.5	0.00
	Culvert	45	778.2	7,839.8	43	778.2	7,604.6	22	778.2	2,561.4	41	778.2	7,293.2	39	778.2	7,058.0	18	778.2	2,014.8
	Excava-tion	18	0.00	2,215.4	17	0.00	2,172.7	9	0.00	1,120.0	16	0.00	1,824.9	15	0.00	1,785.2	7	0.00	732.5
	Fill	9	0.00	1,635.3	9	0.00	1,634.3	4	0.00	995.4	9	0.00	1,635.3	9	0.00	1,635.3	4	0.00	995.4
Intermittent	Bridge/ Viaduct	394	7,964.9	0.00	396	8,266.6	0.00	415	9,835.9	0.00	409	7,955.3	0.00	411	5,257.0	0.00	430	9,826.3	0.00
	Culvert	53	24.2	11,590.5	68	378.8	14,073.7	59	55.0	13,592.7	58	24.2	12,480.7	73	378.8	14,963.9	64	55.0	14,482.9
	Excava-tion	41	0.00	7,861.3	43	0.00	8,564.1	48	0.00	8,229.9	44	0.00	8,267.4	46	0.00	8,970.2	51	0.00	8,636.0
	Fill	15	0.00	2,792.5	14	0.00	2,699.9	26	0.00	5,640.4	15	0.00	2,792.5	14	0.00	2,699.9	26	0.00	5,640.4
Perennial	Bridge/ Viaduct	55	0.00	0.00	53	0.00	0.00	53	0.00	0.00	56	0.00	0.00	54	0.00	0.00	54	0.00	0.00
	Culvert	1	0.00	79.9	1	0.00	79.9	--	--	--	1	0.00	79.9	1	0.00	79.9	--	--	--
	Excavati on	2	0.00	165.1	2	0.00	165.1	2	0.00	165.1	2	0.00	165.1	2	0.00	165.1	2	0.00	165.1
	Fill	1	0.00	98.6	1	0.00	98.6	3	0.00	472.4	1	0.00	98.6	1	0.00	98.6	3	0.00	472.4
Total Potential Stream Impacts by Build Alternative		**830**	**14,719.0**	**48,709.9**	**838**	**15,375.3**	**51,909.1**	**757**	**15,841.6**	**46,109.6**	**829**	**14,709.4**	**49,173.7**	**846**	**12,365.7**	**52,377.2**	**765**	**15,831.1**	**46,879.7**

Source: USGS, 2016; FNI, 2017

*Number of crossings was determined based on a combination of NHD and field collected data. Not all features have been field-verified. Each crossing is included by type, and includes where a single feature may be crossed multiple times within the LOD.

Note: The Northwest Transit Center Terminal Option, the Northwest Mall Terminal Option and the Industrial Site Terminal Option are not anticipated to impact streams.

Table 3.7-83: Estimated Impacts to Wetlands by Build Alternative

		Area of Potential Impacts (acres)																	
		ALT A			ALT B			ALT C			ALT D			ALT E			ALT F		
Type	**Crossing Type**	**# of Cross-ings***	**Temp**	**Perm**	**# of Cross-ings***	**Temp**	**Perm**	**# of Cross-ings***	**Temp**	**Perm**	**# of Cross-ings***	**Temp**	**Perm**	**# of Cross-ings***	**Temp**	**Perm**	**# of Cross-ings***	**Temp**	**Perm**
Emergent	Bridge/ Viaduct	235	11.2	0.00	160	2.7	0.00	120	2.4	0.00	227	11.2	0.00	152	2.7	0.00	112	2.4	0.00
	Excava-tion	27	0.00	12.6	19	0.00	10.1	15	0.00	9.7	26	0.00	12.6	18	0.00	10.1	14	0.00	9.7
	Fill	65	2.4	39.1	64	2.4	39.2	51	2.3	38.4	55	2.4	37.8	54	2.4	37.9	41	2.3	37.1
Forested	Conver-sion	164	0.65	31.8	172	0.65	35.3	131	3.4	39.5	165	0.65	32.1	173	0.65	35.6	132	3.4	39.8
	Excava-tion	8	0.00	2.0	10	0.00	2.3	8	0.00	2.1	8	0.00	2.0	10	0.00	2.3	8	0.00	2.1
	Fill	16	0.33	0.58	23	0.33	1.2	16	0.33	0.71	16	0.33	0.58	23	0.33	1.2	16	0.33	0.71
Shrub/Scrub	Bridge/ Viaduct	10	1.3	0.00	10	1.3	0.00	13	1.3	0.00	10	1.3	0.00	10	1.3	0.00	13	1.3	0.00
	Excava-tion	2	0.00	0.13	2	0.00	0.13	2	0.00	0.13	2	0.00	0.13	2	0.00	0.13	2	0.00	0.13
	Fill	1	0.00	0.10	1	0.00	0.10	1	0.00	0.10	1	0.00	0.10	1	0.00	0.10	1	0.00	0.10
Other	Bridge/ Viaduct	6	2.8	0.00	6	2.8	0.00	6	2.8	0.00	6	2.8	0.00	6	2.8	0.00	6	2.8	0.00
	Excava-tion	6	0.00	2.8	6	0.00	2.8	6	0.00	2.8	6	0.00	2.8	6	0.00	2.8	6	0.00	2.8
	Fill	9	0.63	12.8	9	0.63	12.8	9	0.63	12.8	9	0.63	12.8	9	0.63	12.8	9	0.63	12.8
Total Potential Wetland Impacts by Build Alternative		**549**	**19.3**	**101.9**	**482**	**10.8**	**103.9**	**378**	**13.2**	**106.2**	**531**	**19.3**	**100.9**	**464**	**10.8**	**102.9**	**360**	**13.2**	**105.2**

Source: USFWS, 2016 and FNI, 2017; *Number of crossings was determined based on a combination of NWI and field collected data. Not all features have been field-verified. Each crossing is included by type, and includes where a single feature may be crossed multiple times within the LOD. ; '--' – Not Present

Table 3.7-84: Estimated Impacts to Waterbodies by Build Alternative

		Area of Potential Impacts (acres)																	
		ALT A			ALT B			ALT C			ALT D			ALT E			ALT F		
Type	Crossing Type	# of Cross-ings*	T	P	# of Cross-ings*	T	P	# of Cross-ings*	T	P	# of Cross-ings*	T	P	# of Cross-ings*	T	P	# of Cross-ings*	T	P
Freshwater Pond	Bridge/ Viaduct	218	3.7	0.00	201	3.6	0.00	142	3.0	0.00	210	3.7	0.00	193	3.6	0.00	134	3.0	0.00
	Excavation	70	0.00	10.0	64	0.00	7.7	46	0.00	5.1	72	0.00	10.2	66	0.00	7.9	48	0.00	5.4
	Fill	136	0.46	24.3	139	0.46	22.9	86	0.45	16.3	128	0.46	22.8	131	0.46	21.4	78	0.45	14.8
Lake	Bridge/ Viaduct	3	0.00	0.00	4	0.00	0.00	1	0.00	0.00	3	0.00	0.00	4	0.00	0.00	1	0.00	0.00
Reservoir	Excavation	1	0.00	0.01	1	0.00	0.01	1	0.00	0.01	1	0.00	0.01	1	0.00	0.01	1	0.00	0.01
	Fill	1	0.00	0.19	1	0.00	0.19	1	0.00	0.19	1	0.00	0.19	1	0.00	0.19	1	0.00	0.19
Swamp	Bridge/ Viaduct	--	--	--	--	--	--	3	0.00	0.00	--	--	--	--	--	--	3	0.00	0.00
	Excavation	1	0.00	1.7	1	0.00	1.7	1	0.00	1.7	1	0.00	1.7	1	0.00	1.7	1	0.00	1.7
	Fill	3	3.2	1.8	3	3.2	1.8	4	3.2	3.3	3	3.2	1.8	3	3.2	1.8	4	3.2	3.3
Total Potential Open Water Impacts by Build Alternative		**433**	**7.4**	**38.0**	**414**	**7.3**	**34.3**	**285**	**6.7**	**26.6**	**419**	**7.4**	**36.7**	**400**	**7.3**	**33.0**	**271**	**6.7**	**25.4**

Source: USGS, 2016; USFWS, 2016; FNI, 2017
*Number of crossings was determined based on a combination of NHD, NWI and field collected data. Not all features have been field-verified. Each crossing is included by type, and includes where a single feature may be crossed multiple times within the LOD.
T: Temporary; P: Permanent

Table 3.7-85: Estimated Impacts to Waterbodies and Wetlands by Station Option Alternative

		Area of Potential Impacts (acres)								
		Northwest Transit Center Terminal			**Northwest Mall**			**Industrial Site**		
Wetland Type	**Crossing Type**	**# of Cross-ings***	**Temp**	**Perm**	**# of Cross-ings***	**Temp**	**Perm**	**# of Cross-ings***	**Temp**	**Perm**
Emergent	Bridge/ Viaduct	1	0.00	0.00	--	--	--	--	--	--
	Excavation	--	--	--	--	--	--	--	--	--
	Fill	1	0.00	<0.01	--	--	--	--	--	--
Forested	Conversion	--	--	--	--	--	--	--	--	--
	Excavation	--	--	--	--	--	--	--	--	--
	Fill	--	--	--	--	--	--	--	--	--
Shrub/Scrub	Bridge/ Viaduct	--	--	--	--	--	--	--	--	--
	Excavation	--	--	--	--	--	--	--	--	--
	Fill	--	--	--	--	--	--	--	--	--
Total Potential Wetland Impacts by Alternative		**2**	**0.00**	**<0.01**	--	--	--	--	--	--
Waterbody Type	**Crossing Type**	**# of Cross-ings***	**Temp**	**Perm**	**# of Cross-ings***	**Temp**	**Perm**	**# of Cross-ings***	**Temp**	**Perm**
Freshwater Pond	Bridge/ Viaduct	1	0.00	0.00	--	--	--	--	--	--
	Excavation	--	--	--	--	--	--	--	--	--
	Fill	1	0.00	0.04	--	--	--	--	--	--
Lake	Bridge/ Viaduct	--	--	--	--	--	--	--	--	--
Reservoir	Excavation	--	--	--	--	--	--	--	--	--
	Fill	--	--	--	--	--	--	--	--	--
Other	Fill	--	--	--	--	--	--	--	--	--
Swamp	Bridge/ Viaduct	--	--	--	--	--	--	--	--	--
	Excavation	--	--	--	--	--	--	--	--	--
	Fill	--	--	--	--	--	--	--	--	--
Total Potential Open Water Impacts by Alternative		**2**	**0.00**	**0.04**	--	--	--	--	--	--

Source: USFWS, 2016; FNI, 2017

*Number of crossings was determined based on a combination of NWI and field collected data. Not all features have been field-verified. Each crossing is included by type, and includes where a single feature may be crossed multiple times within the LOD.

3.8 Floodplains

3.8.1 Introduction

This section discusses floodplains and their interaction with and influence by groundwater and surface water flow. A floodplain is a low area adjoining or adjacent to the channel of a river, stream, watercourse, ocean, lake or other body of water, which is susceptible to being inundated by water from any natural source.[1] More specifically, floodplains are areas subject to wetting by flows in excess of stream channel capacity. Changes in groundwater and surface water flow can change the extent, depth or elevation of floodplains.

A discussion of floodplain management initiatives, which are decision-making processes that protect the natural resources and function of floodplains while reducing flood losses,[2] is also included in this section. A summary of subwatersheds (8-digit HUCs) rather than county boundaries is provided because the flow of water does not necessarily coincide or follow political boundaries (see also **Section 3.3.3.2, Water Quality; Appendix D, Surface Water Mapbook**). Counties and segments are referenced to better describe these subwatersheds and their relationship to the Build Alternatives.

This section also addresses the related topics of surface water hydrology, geohydrology and channel stability. Surface water hydrology is the study of the movement, distribution and quality of surface waters. Geohydrology is defined as the area of geology that involves the distribution and movement of groundwater in the soil and rocks of the Earth's crust, commonly in aquifers. Channels or stream banks can be affected by changes in surface water hydrology. Stable channels can continue to pass design flows, but are also not subject to substantial erosion.[3]

3.8.2 Regulatory Context

A number of federal, state and local laws, regulations and orders pertain to floodplains, surface water hydrology, geohydrology and channel stability. See also the Section 404 of the Clean Water Act and Section 408 discussion in **Section 3.7, Waters of the U.S**.

Federal

FRA's updated *Procedures for Considering Environmental Impacts* states that this EIS shall assess impacts of the Build Alternatives on floodplains.[4] This document requires acknowledgment in NEPA documents that a proposed action would occur within a base floodplain, defined as the limits of a floodplain determined by using the Department of Housing and Urban Development floodplain maps or best available data. An EIS is required to discuss alternatives located in the base floodplain; the risks associated with those Build Alternatives; impacts on natural and beneficial floodplain values; and the adequacy of the proposed methods to minimize harm.

---

[1] Blanchard, B. Wayne, "Guide to Emergency Management and Related Terms, Definitions, Concepts, Acronyms, Organizations, Programs, Guidance, Executive Orders and Legislation*,"* FEMA*,* October 22, 2008.
[2] FEMA, "Floodplain Management Definition," September 30, 2015. Accessed January 2016, https://www.fema.gov/floodplain-management-definition.
[3] Charlton, Ro, "Fundamentals of Fluvial Geomorphology," 2008.
[4] FRA, "Procedures for Considering Environmental Impacts," issued 1999, 64 C.F.R. 28545 et seq.

Additional regulations and policies that guide the assessment of impacts to floodplains are as follows:

Rivers and Harbors Appropriations Act of 1899

The USACE, under Section 408 of the Rivers and Harbors Appropriations Act of 1899 (33 U.S.C. § 408), maintains it is "unlawful for any person or persons to build upon, alter, deface work built by the U.S. to prevent floods unless [the Secretary of the Army] grants permission." If the Project includes levee crossings, the Section 408 approval process may apply in areas where a new alignment would cross a levee and cannot use an existing crossing.

Department of Transportation Order 5650.2

The USDOT Order 5650.2 (Floodplain Management and Protection) establishes policies and procedures for transportation projects regarding floodplain impacts. Federal and state transportation agencies are expected to avoid and minimize, where practicable or reasonable, adverse impacts to floodplains.[5] These agencies are also required to restore and preserve natural and beneficial floodplain functions that are adversely impacted by transportation projects. The USDOT Order also prohibits or restricts significant encroachment of floodplains (floodplain development) that may increase the probability that there would be a loss of human life; likely future damage or interruption of service to, or loss of a vital transportation facility, or a notably adverse impact to natural and beneficial floodplain functions.[6] Encroachment, defined for the purposes of floodplain management, includes new construction, improvements, fill and other activities within the regulated floodplain boundary.[7]

USDOT Order 5650.2 requires that there is an opportunity for public review and comment for any action that is proposed within the base floodplain elevation area or Special Flood Hazard Areas, areas prone to flooding for which communities have established floodplain regulations and development restrictions. This opportunity for public involvement should include public hearing presentations that identify unavoidable floodplain encroachments, measures taken to minimize floodplain impacts and planned mitigation.[8]

National Flood Insurance Act

This section addresses both the National Flood Insurance Act of 1968, as amended, and the related Flood Disaster Protection Act of 1973, as amended. FEMA defines floodplains as "Any land area susceptible to being inundated by flood waters from any source" (44 C.F.R. §59.1). The National Flood Insurance Program was established pursuant to the National Flood Insurance Act of 1968[6], as amended (42 U.S.C. § 4001), and the Flood Disaster Protection Act of 1973, as amended (42 U.S.C. § 4001), to encourage sound floodplain management programs at the state and local levels. To provide a national standard without regional discrimination, the 100-year flood has been adopted by FEMA as the "flood having a one percent chance of being equaled or exceeded in any given year" (44 C.F.R. § 59.1). Regulations promulgated by the act (44 C.F.R. §§ 59 to 80) also contain the basic policies and procedures to regulate floodplain management and analyze, identify and map floodplains for flood insurance purposes.

[5] USDOT, "Floodplain Management and Protection DOT 5650.2," 1979.
[6] USDOT, "Floodplains, Planning and Environment/NEPA," January 2016, http://www.fta.dot.gov/12347_2237.html.
[7] FEMA, "Encroachments," 2016, https://www.fema.gov/encroachments
[8] Ibid.

The National Flood Insurance Program allows property owners in participating communities to purchase flood insurance. It also requires participating state and local governments to adopt and enforce floodplain management ordinances that reduce future flood damages. These ordinances must meet or exceed federal standards in order to receive future federal financial assistance.

The National Flood Insurance Program also requires participating communities to restrict development in areas prone to flooding and require that construction of new or substantially improved buildings will minimize or prevent flood damage.[9] The National Flood Insurance Program regulatory standards are minimum requirements for floodplain management.[10] Any state or community can adopt more comprehensive and restrictive floodplain management regulations to protect life and property from flooding. Within Texas, the TWDB is tasked as a state agency responsible for coordinating the National Flood Insurance Program.[11, 12]

Executive Order 11988

Federal agencies are regulated under EO 11988, *Floodplain Management*.[13] This EO requires that federal agencies avoid adverse impacts on floodplains to the extent possible, determine if reasonable alternatives exist that avoid impacts to floodplains, and avoid situations that would support floodplain development if a practicable alternative exists.

Executive Order 13690

Federal agencies are also regulated under EO 13690, *Establishing a Federal Flood Risk Management Standard and a Process for Further Soliciting and Considering Stakeholder Input*, as of January 30, 2015.[14] This EO expands management from the current base flood level to a higher vertical elevation and corresponding horizontal floodplain to address current and future flood risk. EO 13690 requires federal agencies to use one of three techniques when establishing flood elevation or hazard areas or siting, designing or constructing facilities.[15] These techniques include using best available science to address flooding; adopting two to three feet of elevation or freeboard above the base regulatory floodplain, or adopting a conservative flood elevation associated with flooding with an annual chance of 0.2 percent. Freeboard is a factor of safety usually expressed in feet above a flood level for floodplain protection.[16]

Implementations plans from federal agencies, including the USDOT, are currently pending. The discussion of regulatory context and environmental consequences in this section will be updated if this guidance becomes available prior to issuance of the Final EIS.

---

[9] FEMA, "Unit 2: The National Flood Insurance Program," 2007, https://www.fema.gov/pdf/floodplain/nfip_sg_unit_2.pdf.
[10] 44 C.F.R. Part 60, Criteria for Land Management and Use, 2002.
[11] State of Texas, "State of Texas Hazard Mitigation Plan: 2013 Update," 2013.
[12] Ibid.
[13] 44 C.F.R. Part 9, Floodplain Management and Protection of Wetlands, 2003.
[14] The White House, Executive Order–Establishing a Federal Flood Risk Management Standard and a Process for Further Soliciting and Considering Stakeholder Input, January 30, 2015. Accessed June 2016, https://www.whitehouse.gov/the-press-office/2015/01/30/executive-order-establishing-federal-flood-risk-management-standard-and- .
[15] FEMA, Federal Flood Risk Mangement Standard (FFRMS), November 19, 2015. Accessed February 2016, https://www.fema.gov/federal-flood-risk-management-standard-ffrms.
[16] FEMA, Freeboard. Accessed June 2016, http://www.fema.gov/freeboard.

Federal Highway Administration Hydraulic Engineering

FHWA Hydraulic Engineering Circular (HEC) No. 20 defines qualitative and quantitative methods to evaluate channel stability[17] and HEC-18 defines procedures used to estimate scour depth at piers and abutments of proposed structures.[18] TxDOT relies upon these methodologies and design manuals for hydraulic structures and stormwater management to protect existing and planned infrastructure, as well as maintain a stable stream channel.[19] TxDOT also requires evaluation of channel stability during the NEPA process. Although the Project is not regulated by TxDOT or FHWA, the guidance would apply if the rail crosses roads regulated by the FHWA and TxDOT. These design manuals are also commonly used nationwide for design and analysis of transportation projects, including bridges. TCRR has indicated that they would follow the latest FHWA HEC-20 and HEC-18 procedures.

State

Hazard Mitigation Planning

The Texas Division of Emergency Management (TDEM) issues the Texas Hazard Mitigation Plan every three years, which is also provided to FEMA.[20] The plan addresses natural hazards including flooding. In addition to identifying strategies to prevent flooding and mitigate future damages, the TWDB serves as the National Flood Insurance Program State Coordinator acting as a liaison between the federal National Flood Insurance Program and local communities.[21]

TxDOT Hydraulic Design Manual

Texas roadway projects funded by TxDOT and built within TxDOT ROW are designed according to TxDOT hydrologic and hydraulic design criteria.[22] The Hydraulic Design Manual (HDM)[23] provides guidance on selecting the appropriate method for runoff computations, on how to analyze bridge and culvert openings with respect to hydraulic considerations, and how to size detention storage. Although the Project is not regulated by TxDOT, the manual serves as an industry design standard for linear transportation projects. Therefore, TCRR elected to rely on this guidance for the concept design and final design of the Build Alternatives.

Local

Groundwater Conservation Districts

In Texas, Groundwater Management Areas were created to provide for the conservation, preservation, protection and recharge of groundwater, which has a direct influence on floodplain management; prevent waste of groundwater and further prevent subsidence per the Texas Water Code §35.001.[24]

---

[17] FHWA, Hydraulic Engineering Circular No. 20 - *Stream Stability at Highway Structures, Third Edition,* March 2001, http://isddc.dot.gov/OLPFiles/FHWA/010591.pdf.
[18] FHWA, Hydraulic Engineering Circular No. 18 – *Evaluting Scour at Bridges, Fourth Edition,* May 2001, http://isddc.dot.gov/OLPFiles/FHWA/010590.pdf.
[19] TxDOT, "Sediment Control," July 2002, http://ftp.dot.state.tx.us/pub/txdot-info/env/storm/5.0sedimentationcontrol.pdf.
[20] State of Texas, "State of Texas Hazard Mitigation Plan: 2013 Update," 2013.
[21] Ibid.
[22] TxDOT, *Hydraulic Design Manual,* TxDOT Manual System, August 31, 2015, http://onlinemanuals.txdot.gov/txdotmanuals/hyd/manual_notice.htm.
[23] Ibid.
[24] TWDB, "Groundwater Management Areas," *Groundwater,* 2016. Accessed January 2016, http://www.twdb.texas.gov/groundwater/management_areas/index.asp.

Groundwater Management Areas are geologic areas suitable for groundwater management.[25] After the Groundwater Management Areas were established, GCDs were developed to administer regulations developed for groundwater management within the Groundwater Management Areas.

The primary power of a GCD is its regulatory authority to require registration and permitting of all water wells within its geographic boundary.[26] To protect aquifers, GCDs establish a desired future condition for its service area (such as availability) and regulate new water wells and groundwater withdrawal rates to protect desired future conditions. **Table 3.8-1** provides a summary of the status of individual GCDs. The boundaries of the GCDs are illustrated in **Section 3.3.4.2.2, Water Quality**.

Table 3.8-1: Groundwater Conservation Districts

Name	General Location	Segments	Status of Regulations
Prairielands GCD	Ellis	1, 2A, 2B, 3A, 3B, 3C	Established in 2009. The area is facing critical groundwater declines. The Management Plan was adopted in 2012. The Prairielands GCD requires well registration.
Mid-East Texas GCD	Freestone, Leon, and Madison counties	3A, 3B, 3C, 4	Established in 2002. The Mid-East Texas GCD's Management Plan was adopted in 2009. The Mid-East GCD requires registration of exempt wells (domestic and livestock) and permitting of non-exempt wells (public water supply, industrial/commercial and irrigation).
Bluebonnet GCD	Grimes, Harris, Madison and Waller counties	3C, 4, 5	Established in 2002. The Bluebonnet GCD's Management Plan was adopted on January 10, 2010. This GCD has established regulations for the registration and operation of wells for public water supply, industrial uses and transportation.

Source: Bluebonnet GCD, 2016

Floodplain Development Permit

A floodplain development permit is required for all development within the Special Flood Hazard Areas of communities that participate in the National Flood Insurance Program.[27] Dallas, Ellis, Freestone, Grimes, Harris, Leon, Limestone, Madison, Navarro and Waller counties participate in the National Flood Insurance Program.[28] To obtain a permit, local development codes require hydrologic evaluations and drainage studies (modeling) to determine the effect on peak water surface elevation (including floodplains) and water quality as a result of a proposed development.

In addition to federal and state regulations, the City of Dallas, Harris County and the City of Houston have developed ordinances that take precedence over any less restrictive conflicting laws, ordinances, codes or official determinations.[29, 30, 31] Other ordinances for site development and construction may also prohibit development in floodplains. See **Table 3.8-2** for a list of local floodplain regulators.

---

[25] Texas A & M University, "Groundwater Conservation Districts," *Texas Water,* 2014. Accessed January 2016, http://texaswater.tamu.edu/groundwater/groundwater-conservation-districts.

[26] Texas Commission on Water Quality, "Texas Groundwater Conservation Districts (January 2016)," *Groundwater*, January 2016. Accessed January 2016, http://www.tceq.texas.gov/assets/public/permitting/watersupply/groundwater/maps/gcdmap.pdf.

[27] 44 C.F.R. Part 2, Criteria for Land Management and Use, 2002.

[28] FEMA, "What is a Special Flood Hazard Area (SFHA)?," *FloodSmart.* January 21, 2016. Accessed February 2016, https://www.floodsmart.gov/floodsmart/pages/faqs/what-is-a-special-flood-hazard-area.jspp.

[29] City of Dallas, "Floodplain and Escarpment Zone Regulations Article V Division 51A-5.100," Dallas, Texas: City of Dallas, n.d. City of Houston. "Rules and Regulations for Chapter 19, Guidelines Houston City Code: Floodplain," City of Houston, February 1, 2009.

[30] Harris County, "Regulations of Harris County, Texas for Floodplain Management," Houston, Texas: Harris County Public Infrastructure Department Engineering Division, 2011.

[31] City of Houston, "Rules and Regulations for Chapter 19, Guidelines Houston City Code: Floodplain," City of Houston, February 1, 2009.

Table 3.8-2: Floodplain Regulators

Name	General Location	Status of Regulations
Flood Control Division: Trinity Watershed Management Flood Control	City of Dallas	The floodplain administrator/director is responsible for administering the federal flood insurance program. A Trinity River Corridor Development Certificate is required for development within the floodplain of the Trinity River Corridor.
Dallas County Public Works	Dallas County	The floodplain administrator is responsible for administering the floodplain regulations. Regulations apply to all unincorporated areas of Dallas County.
Ellis County Department of Development	Ellis County	The floodplain administrator/director is responsible for administering the floodplain regulations.
Navarro County Planning and Development Office	Navarro County City of Corsicana	The floodplain administrator/director is responsible for administering the floodplain regulations.
Other Local City/County Offices	City of Buffalo; City of Ennis; Freestone County; Grimes County; Leon County; City of Leona; Limestone County; Madison County; Waller County	The local floodplain administrator/director is responsible for administering the floodplain regulations.
Public Works: Planning and Development Services Division	City of Houston	The City Engineer is responsible for the permitting/inspection process including floodplain management.
Harris County Flood Control District	Harris County	The floodplain administrator is responsible for administering the floodplain regulations. Regulations apply to all unincorporated areas of Harris County.

Sources: City of Dallas, n.d.; City of Houston, 2009; County Information Resources Agency, n.d.; Ellis County, n.d; Harris County, 2011; and FEMA, 2015

Fill elevations and first floor elevations within the one percent annual exceedance probability floodplain, often referred to as the 100-year floodplain, of the Trinity River in Dallas must be constructed at a minimum of one foot above the design flood. In addition, encroachment into the floodway is prohibited unless FEMA issues a Conditional Letter of Map Revision.[32] A Trinity River Corridor Development Certificate is required for any floodplain alteration within the Trinity River Corridor.[33]

The City of Houston requires that structures constructed in the Special Flood Hazard Areas shall be elevated to at least the minimum flood protection elevation measured at the lowest floor, which is equal to the base flood elevation plus 12 inches.[34] Development that is dangerous to health, safety or property during flooding or that would cause excessive increases in flood heights or velocities within the Special Flood Hazard Areas are restricted or prohibited.[35]

In addition, within the regulatory floodplain, a development permit is required for construction within a floodway, which is the channel of a river or other watercourse and the adjacent lands that must be reserved in order to discharge the base flood without cumulatively increasing the water surface

[32] City of Dallas, "Floodplain and Escarpment Zone Regulations Article V Division 51A-5.100," Dallas, Texas: City of Dallas, n.d.
[33] Ibid.
[34] City of Houston. "Rules and Regulations for Chapter 19, Guidelines Houston City Code: Floodplain," February 1, 2009.
[35] City of Dallas, "Floodplain and Escarpment Zone Regulations Article V Division 51A-5.100," n.d.

elevation more than a designated height in Dallas, Harris County, and Houston.[36] Structures constructed within a floodway must be elevated to 18 inches or more above the base flood elevation.[37]

Drainage Criteria Manuals

Drainage criteria manuals are published by counties and some cities to clearly define their requirements for hydrologic modeling inputs, allowable peak flow computation methods, and detention requirements due to new development and the corresponding increases in runoff that occur. Generally speaking, there are different requirements and analysis methods that apply to smaller development areas (e.g., <200 acres) and larger development areas (e.g., >200 acres). Detention facilities are intended to mitigate increases in peak flows and changes in the timing of runoff associated with urbanization so that surrounding properties and the receiving body of water are not adversely impacted by increases in peak flows or water surface elevations.[1] The civil engineering industry's standard of care for detention analysis is the 100-year rainfall event. In addition, the 100-year rainfall event is used by FEMA to define the level of flooding risk within communities that participate in the National Flood Insurance Program.[2] See Table 3.8.3 for a list of local drainage criteria manuals applicable to the Build Alternatives.

Table 3.8-3: Drainage Criteria Manuals

Name	General Location	Detention Requirements
Drainage Design Manual, City of Dallas Public Works	Dallas County	New detention facilities must be designed to detain a 100-year event and assure that the discharge flows are at a non-erosive rate. Basins with upstream detention areas and with drainage areas of 130 acres or less can be designed using the Modified Rational Method while basins with drainage areas greater than 130 acres should be designed using the unit Hydrograph Method. Additional general design criteria for outflow structures, embankments, slopes, erosion control elements and detention volume are also defined.
City of Lancaster Storm Water Design Manual	Dallas County	New detention facilities must be designed to detain a 100-year rainfall event while assuring that the outfall structure does not increase peak discharge for the 1-year or 100-year rainfall event. General design criteria for outflow structures, embankments, slopes, erosion control elements and detention volume are also defined.
City of Wilmer, Texas Drainage Ordinance	Dallas County	New detention facilities must be designed to detain a 100-year rainfall event. Basins with drainage areas of 200 acres or less can be designed using the Rational Method, while basins with drainage areas greater than 130 acres must be designed using the unit Hydrograph Method. Additional general design criteria for outflow structures, embankments, slopes, erosion control elements and detention volume are also defined.[38]

[36] Ibid.; Harris County, "Regulations of Harris County, Texas for Floodplain Management," Houston, Texas: Harris County Public Infrastructure Department Engineering Division, 2011. City of Houston, "Rules and Regulations for Chapter 19, Guidelines Houston City Code: Floodplain," City of Houston, February 1, 2009.

[37] Ibid.

[1] Drainage Criteria Manual for Chambers County Texas, Chapter 7.0 Detention Analysis. August 9, 2005. Accessed October 10, 2016. http://www.co.chambers.tx.us/users/roads/Drainage_Criteria_Manual.pdf

[2] Ibid.

[38] Methods defined within City of Wilmer, Drainage ordinance No. 08-0918 available at: www.cityofwilmer.net/uploads/Drainage_Ordinance_No.08-0918.pdf

Table 3.8-3: Drainage Criteria Manuals

Name	General Location	Detention Requirements
City of Palmer, Texas Engineering Design Manual	Ellis County	Drainage facilities must be designed and constructed at locations and of such size and dimensions to adequately serve the development and the contributing drainage area above the development. General design criteria for outflow structures, embankments, slopes, erosion control elements and detention volume are also defined.
Waller County Subdivision and Development Regulations – Drainage Criteria Manual	Waller County	All new development must maintain zero net increase in stormwater runoff rates and no negative impacts. New detention facilities must be designed to detain at a minimum to accommodate a 100-year rainfall event, with stable slopes (4:1), a minimum of 30-foot access and maintenance berms around the entire perimeter, and include erosion control elements as necessary to ensure a stable, low maintenance facility. This manual also provides two methods to define the required detention volume depending on project area (Coefficient Method and Small Watershed Method). Design criteria for minimum allowable freeboard between the projected 100-year water surface elevation and the top of the berm and maximum allowable outflow rate are also defined.
City of Houston Department of Public Works and Engineering Stormwater Design Requirements	Harris County	Detention volume for development areas is calculated on the basis of the changes to the impervious cover associated with the project development and existing conditions at the site. Impervious cover includes all structures, foundations, driveways, parking areas, patios, walkways, etc. that exist or will exist on the property.
Harris County Flood Control District Policy and Criteria Manual	Harris County	Design new detention facilities to detain the 10% and 1% exceedance probability, 24-hour storm events for proposed watershed conditions. This manual also provides three methods to define the required detention volume depending on project area (Method 1<50 acres, Method 2 > 50 acres but less than <640 acres, Method 3 > 640 acres). Design criteria for inflow determination, maximum allowable outflow rate, and tailwater condition downstream of the discharge location are also defined.

Source: AECOM, 2017

Harris-Galveston Subsidence District

The Harris-Galveston Subsidence District is a special purpose district created by the Texas Legislature in 1975 to provide for the regulation of groundwater withdrawal throughout Harris and Galveston counties for the purpose of preventing land subsidence, which is the movement of a land surface as a result of geologic or man-made causes, which can lead to increased flooding.[39] The district regulates the withdrawal of groundwater to control subsidence and coordinates with regional ground and surface water suppliers, interacts with other state and local regulatory bodies, analyzes predictions on water usage; enforces disincentives to those who rely too heavily on groundwater; and commits to practicing and promoting water conservation. The Harris-Galveston Subsidence District enforces a permitting and registration requirement for all new wells before the well may be drilled or operated. Specific requirements are dependent on the Regulatory Area, or location within the district. In Regulatory Area One, permittees may obtain up to 10 percent of water demand from groundwater. This number increases to 20 percent in Regulatory Area Two. In Regulatory Area Three, permittees may obtain up to 20 percent of water demand from groundwater or they must operate under a certified Groundwater Reduction Plan and obtain up to 70 percent of water from groundwater.

[39] Harris-Galveston Subsidence District website (http://hgsubsidence.org/), Accessed July 20, 2016.

3.8.3 Methodology

The methodologies used to assess existing conditions and potential impacts to floodplains and the interconnected geohydrology, surface water hydrology and channel stability in the Study Area are discussed below. The floodplain Study Area is defined as the LOD for each of the Build Alternatives and Houston Terminal Station options for direct impacts and the Study Area includes subwatersheds intersected by the Build Alternatives for indirect impacts.

3.8.3.1 Floodplains

A flood is any relatively high streamflow event that overtops the natural or artificial banks in a reach of a stream segment. The extent and depth of flooding are important features of Flood Insurance Rate Maps (FIRM) under the National Flood Insurance Program. A FIRM generally shows an area's base flood elevations, flood zones which describe types of flooding and floodplain boundaries. FEMA FIRM and Digital Flood Insurance Rate Map (DFIRM) data were used to identify flood zones and the amount of floodplain in the floodplain Study Area, with exception of Freestone and Madison counties because FEMA digital floodplain data was not readily available.[40] Flood Hazard Boundary Maps from the U.S. Department of Housing and Urban Development were digitized for Freestone County (1978) and Madison County (1991).

The conceptual design and hydrologic and hydraulic analysis provided by TCRR was qualitatively evaluated for general compliance with floodplain regulations and general engineering standards.[41] This analysis was limited to FEMA digital floodplain data and supplemented by conceptual design criteria to avoid impacts to crossings without FEMA digitized data.

3.8.3.2 Geohydrology

Groundwater and surface water are physically connected by the hydrologic cycle and are functionally interdependent.[42] The exchange of water between groundwater and surface water is controlled by the differences in elevation between the two waters and geology. Groundwater may augment streams, or surface flows from streams may augment aquifers. Floodplains are the physical extent of surface water during flood events which increase surface water runoff and thus may increase inflows to groundwater.

To assess geohydrology within the floodplain Study Area, GIS data for existing wells and reservoirs (**Appendix D, Natural Resources Mapbook**) and aquifers (**Section 3.3.4.2.2, Water Quality**) was collected. Wellhead protection zones, aquifer recharge areas and recovery zones and locations of aquifers were also identified (**Section 3.3, Water Quality**). The general condition of major and minor aquifers was reviewed to identify areas with greater vulnerability to adverse effects from increased stormwater runoff; changes in topography and local hydrology and drainage due to construction, new impervious area, relocation of channels and modifications to existing stormwater facilities including culverts; areas that may be vulnerable to spills associated with construction and operations due to alluvial soils, outcrops of permeable rock or proximity to streams directly influencing aquifers; and shallow groundwater areas that would be affected by dewatering during construction.

[40] FEMA 2014 (digitized from US. Department of Housing and Urban Development 1978 and 1991.
[41] TCRR, "*Texas Central Partners Texas High Speed Rail Final Draft Conceptual Engineering Report-FDCERv7*," September 15, 2017.
[42] Winter, Thomas C., et al., "Ground Water and Surface Water: A Single Resource," U.S. Geologic Service, 1998.

3.8.3.3 Surface Water Hydrology

Precipitation and stormwater runoff discharge to Texas rivers, streams and reservoirs, and provide water supply.[43] Man-made hydrologic alterations can alter stream flow, as well as groundwater and surface water interactions, which may change the extent or elevation of water surfaces during normal, low and high flow events; affect riparian vegetation; and result in conditions that change the stability of channels and the channel's morphology or shape, all of which may affect the storage capacity of floodplains.

GIS data on topography, subwatersheds, streams, lakes and reservoirs within the Study Area was collected. General information on hydrology, including flood control structures and streamflow gages, was also collected. The general condition of subwatersheds in the floodplain Study Area was also reviewed to identify areas with greater vulnerability to adverse effects from increased stormwater runoff and changes in topography, including existing floodplains and floodways, highly erodible soils and areas with flat topography.

As stated above, TCRR also elected to rely on TxDOT's HDM[44] during the concept design and final design of the Build Alternatives to compute hydrologic runoff data, analyze bridge and culvert openings with respect to hydraulic considerations, and how to size detention storage.

3.8.3.4 Channel Stability

A channel consists of the bed and banks that confine the surface flow of a stream.[45] Alluvial streams continually adjust their bed and banks; hydrologic alterations can intensify this process and result in sediment deposit, bank erosion, lowering of the steam bed and shifts in the channel locations.[46] Eroded material is then transported by surface water flow through waterbodies. Changes in surface flow and channel dimensions affect the rate or extent of sedimentation and erosion within the contributing stream channels, which in turn affect floodplain storage capacity.

Infrastructure over alluvial streams, including bridges and viaducts, can be undermined by natural processes, as well as hydrologic alterations. The stability of channels and infrastructure near bridge crossings is controlled by geomorphic or physical characteristics of the stream and the hydraulic factors associated with bridges or viaducts. Geomorphic characteristics include stream size, flow, channel substrate, the location of the channel in the subwatershed, manmade features within the drainage (including levees) and riparian vegetation. Hydraulic factors include the alignment, shape and form of the channel, the magnitude and frequency of flood events and flow restrictions. The introduction or modification of existing culverts can change flow within streams and the streambed elevation and stability and result in deeper (incised) or raised (aggraded) streambeds.[47]

In addition to hydraulic factors, soil data, including highly erodible soils, was collected to assess the floodplain Study Area and identify areas that may be vulnerable to channel erosion or sedimentation during construction and operation.

---

[43] Winter, Thomas C., et al., "Ground Water and Surface Water: A Single Resource," U.S. Geologic Service, 1998.
[44] Ibid.
[45] FHWA, "Stream Stability at Highway Structures, Third Edition," March 2001. Accessed January 2016. http://isddc.dot.gov/OLPFiles/FHWA/010591.pdf.
[46] Ibid.
[47] Castro, Janine, "Geomorphologic Impacts of Culvert Replacement and Removal: Avoiding Channel Incision. Portland," Oregon: U.S. Fish and Wildlife Service, 2003.

3.8.4 Affected Environment

3.8.4.1 Floodplains

Floodplains are delineated on FIRM by elevation and characterized by the type of flood hazard zones. Land areas that are at high risk for flooding area called Special Flood Hazard Areas,[48] are identified on FIRM with the following designations:

- Zones A, 1 percent annual chance of flooding or 26 percent chance of flooding over the life of a 30-year mortgage
- Zone AE, one percent AEP flood where base flood elevations are provided
- Zone AO, river or stream flood hazards areas or areas with a one percent or greater chance of shallow flooding[49]

The Special Flood Hazard Areas for a one percent annual exceedance probability flood is also referred to as a 100-year flood and represents the base flood elevation for regulatory purposes. Flood Insurance Rate Map Zones B and X (shaded) are areas of moderate flood hazard usually between the limits of the 1 percent annual exceedance probability flood and the 0.2 percent annual exceedance probability flood.[50] The 0.2 percent annual exceedance probability flood is also called the 500-year flood. Areas of minimal flood hazard are labeled as Zones C or X (unshaded) on the FIRM and typically above the 0.2 percent annual chance flood. These areas are outside the Special Flood Hazard Areas and higher in land surface elevation of the 0.2 percent chance annual flood area.[51] Flood zones identified as “A”, “AE”, “AO” and “X” are illustrated in **Appendix D**, **Natural Resources Mapbook**.

Based on the FEMA FIRM and DFIRM, approximately 46 to 47.5 acres, ranging from Build Alternatives A and B to F, respectively, would be located within the 500-year floodplain (Zone X – shaded). Additionally, the amount of the LOD that would be located within the 100-year floodplain (Zones A, AE and AO) ranges from 565 acres under Build Alternative B to 611 acres under Build Alternative D. The remainder of the LOD would be located within areas of minimal flood hazard (Zone X – unshaded). The estimated total acreages of 500-year floodplains (Zone X – shaded) and 100-year floodplains (Zones A, AE and AO) for each Build Alternative Segment and county within the LOD is provided in **Table 3.8-4.**

One of the Houston Terminal Station options (Industrial Site Terminal) would have 0.1 acre located within the 500-year floodplain (Zone X – shaded) in Harris County within the Buffalo-San Jacinto watershed. The remaining two Houston Terminal Station options (Northwest Mall and Northwest Transit Center) would not be located within a designated FEMA floodplain.

---

[48] FEMA, "What is a Special Flood Hazard Area (SFHA)?" January 21, 2016. Accessed February 2016, https://www.floodsmart.gov/floodsmart/pages/faqs/what-is-a-special-flood-hazard-area.jsp.
[49] State of Texas, "State of Texas Hazard Mitigation Plan: 2013 Update," 2013.
[50] Ibid.
[51] Blanchard, B. Wayne, “Guide to Emergency Management and Related Terms, Definitions, Concepts, Acronyms, Organizations, Programs, Guidance, Executive Orders and Legislation,” FEMA, October 22, 2008.

Table 3.8-4: Floodplain by Basin and Build Alternative Segment within the Floodplain Study Area

	Area (acres) of Intersected Floodplain														
	ALT A		ALT B		ALT C		ALT D		ALT E		ALT F		Houston Terminal Industrial Site		
	100-Year	500-Year	100-Year	500-Year	100-Year	500-Year	100-Year	500-Year	100-Year	500-Year	100-Year	500-Year	100-Year	500-Year	
Upper Trinity															
Segment 1	179	3.5	179	3.5	179	3.5	179	3.5	179	3.5	179	3.5	--	--	Dallas
Segment 1	1	0.5	1	0.5	1	0.5	1	0.5	1	0.5	1	0.5	--	--	Ellis
Segment 2A	24	1	24	1	24	1	--	--	--	--	--	--	--	--	Ellis
Segment 2B	--	--	--	--	--	--	24	1.5	24	1.5	24	1.5	--	--	Ellis
Chambers															
Segment 2A	26	0	26	0	26	0	--	--	--	--	--	--	--	--	Ellis
Segment 2B	--	--	--	--	--	--	31	0	31	0	31	0	--	--	Ellis
Segment 3A	21	0	--	--	--	--	21	0	--	--	--	--	--	--	Navarro
Segment 3B	--	--	22	0	--	--	--	--	22	0	--	--	--	--	Navarro
Segment 3C	--	--	--	--	21	0	--	--	--	--	21	0	--	--	Navarro
Richland															
Segment 3A	76	0	--	--	--	--	76	0	--	--	--	--	--	--	Navarro
Segment 3B	--	--	34	0	--	--	--	--	34	0	--	--	--	--	Navarro
Segment 3C	--	--	--	--	103	0	--	--	--	--	103	0	--	--	Navarro
Lower Trinity-Tehuacana															
Segment 3C	--	--	--	--	60	0	--	--	--	--	60	0	--	--	Freestone and Leon
Segment 4	40	0	40	0	--	--	40	0	40	0	--	--	--	--	Freestone
Lower Trinity-Kickapoo															
Segment 3C	--	--	--	--	91	1	--	--	--	--	91	1	--	--	Leon, Madison and Grimes
Segment 4	93	0	93	0	--	--	93	0	93	0	--	--	--	--	Leon, Madison,

Table 3.8-4: Floodplain by Basin and Build Alternative Segment within the Floodplain Study Area

	Area (acres) of Intersected Floodplain														
	ALT A		ALT B		ALT C		ALT D		ALT E		ALT F		Houston Terminal Industrial Site		
	100-Year	500-Year	100-Year	500-Year	100-Year	500-Year	100-Year	500-Year	100-Year	500-Year	100-Year	500-Year	100-Year	500-Year	
															and Grimes
Segment 5	6	0	6	0	6	0	6	0	6	0	6	0	--	--	Grimes
Navasota															
Segment 4	50	0	50	0	--	--	50	0	50	0	--	--	--	--	Freestone, Limestone and Leon
Segment 5	11	0	11	0	11	0	11	0	11	0	11	0	--	--	Grimes
West Fork San Jacinto															
Segment 5	10	0	10	0	10	0	10	0	10	0	10	0	--	--	Grimes
Spring															
Segment 5	56	9	56	9	56	9	56	9	56	9	56	9	--	--	Grimes. Waller and Harris
Buffalo-San Jacinto															
Segment 5	13	32	13	32	13	32	13	32	13	32	13	32	--	--	Harris
Segment 5: Industrial Site Terminal Option	--	--	--	--	--	--	--	--	--	--	--	0	0	0.1	Harris
Total Acreage	**606**	**46**	**565**	**46**	**601**	**47**	**611**	**46.5**	**570**	**46.5**	**606**	**47.5**	**0**	**0.1**	

Source: FEMA 2014 (digitized from US. Department of Housing and Urban Development 1978 and 1991)

3.8.4.2 Geohydrology

The general characteristics of the aquifers are summarized in **Section 3.3, Water Quality**. The Trinity River Major Aquifer, Carrizo-Wilcox Major Aquifer and Gulf Coast Aquifer have experienced significant declines in groundwater levels due to heavy pumping.[52] The Woodbine Minor Aquifer, Nacatoch Minor Aquifer and Queen City Aquifer have also been extensively pumped and suffer groundwater level declines.[53] Many of the management strategies in these basins focus on transition to surface water. Within the Gulf Coast Major Aquifer, the composite layers of sand and clay vary dramatically. This aquifer is vulnerable to subsidence of the land surface due to pumping.[54] Portions of the Gulf Coast Aquifer underlie the Study Area within Regulatory Area Three of the HGSD.

Minor aquifers in the floodplain Study Area would be heavily influenced by the introduction of surface runoff, changes in floodplains and new water demands including the Woodbine Minor Aquifer, Nacatoch Minor Aquifer, Queen City Aquifer, Sparta Aquifer and Yegua Jackson Minor Aquifer.

3.8.4.3 Hydrology

The individual characteristics of the subwatersheds within the floodplain Study Area are described in **Section 3.3, Water Quality**. This discussion focuses upon precipitation patterns and water storage.

3.8.4.3.1 Precipitation and River Flow

Precipitation in this area varies with seasonal rainfall. Although there is little seasonal variation in central Texas, the patterns transition to a strongly seasonal variation in east Texas.[55] The yearly average rainfall by county and basin within the floodplain Study Area is provided in **Table 3.8-5**.[56] The amount and seasonal variation of rainfall does not directly correlate to the volume of flow exhibited along main stem rivers in central Texas, as large reservoirs control the release of water. The average flow for main stems of rivers in central Texas is typically high in the summer due to releases from manmade water storage. A discussion on the hydrologic characteristics of large river basins is provided below.

[52] George, Ph.D., P.G., Peter G., Robert E. Mace, Ph.D., P.G. and Rima Petrossian, P.G. "Aquifers of Texas," Austin, TX: Texas Water Development Board, 2011.
[53] Ibid.
[54] Bureau of Economic Geology, "Aquifers of Texas," 2004, http://www.beg.utexas.edu/UTopia/images/pagesizemaps/aquifer.pdf.
[55] Guillen, George Ph.D., Wrast, Jenny M.S., Ramirez, Dianna M.S., "Ecological Overlay for the Trinity River for Support of Development of Instream Environmental Flow Recommendations," Environmental Institute of Houston, University of Houston Clear Lake, and Trinity River Authority, 2009, http://www.tceq.state.tx.us/assets/public/permitting/watersupply/water_rights/eflows/trinitybiologicaloverlay.pdf.
[56] County pages of the Texas Almanac, Texas State Historical Association. Accessed June 2016, http://texasalmanac.com/.

Table 3.8-5: Yearly Average Rainfall

County	Basin	Average Yearly Rainfall (inches)
Dallas	Upper Trinity	37.57
Ellis	Upper Trinity, Chambers	39.12
Navarro	Chambers, Richland	39.78
Freestone	Lower Trinity-Tehuacana, Navasota	43.12
Limestone	Navasota	40.34
Leon	Lower Trinity-Tehuacana, Navasota; Lower Trinity-Kickapoo	42.29
Madison	Navasota; Lower Trinity-Kickapoo	45.12
Grimes	Navasota; Lower Trinity-Kickapoo; West Fork San Jacinto; Spring	43.51
Waller	Spring	45.53
Harris	Spring, Buffalo-San Jacinto	56.81

Source: Texas State Historical Association, 2016

3.8.4.3.2 Trinity River Basin

As shown in **Appendix D, Natural Resources Mapbook**, the Trinity River Basin is located entirely within Texas and covers an area of 17,913 square miles.[57] The headwaters are located northwest of Dallas at the confluence of the Elm and West forks, and the river flows 500 miles to Trinity Bay, which then drains into the Gulf of Mexico.[58, 59, 60] The basin has an average flow volume of 5,727,000 acre-feet per year.[61] With the exception of the stretch of the Trinity River downstream of Lake Livingston (one of the basin's major reservoirs), flows within most streams, including the Trinity River upstream of Lake Livingston, are relatively low each year during the summer. Precipitation consists of an average annual rainfall of 27 (upper basin) to 52 inches (lower basin).

The Trinity River Basin contains 32 major reservoirs, of which 23 are monitored water supply reservoirs and 13 are used for flood control.[62, 63, 64] The monitored water supply reservoirs have a current storage of 7,784,959 acre-feet, with all but one water supply reservoir storing greater than 10,000 acre-feet.[65] In addition to the major reservoirs, there are hundreds of smaller reservoirs constructed by the NRCS. These smaller, NRCS reservoirs reduce flood peaks by temporarily storing floodwaters; they do not provide a steady base flow to the downstream channel unless the water surface elevation in the reservoir is above the elevation of the lowest ungated outlet. The terrain of this basin varies from hilly and rolling hills in the upper basin to nearly level plains and rolling hills in the central basin to very flat conditions in the lower basin.[66]

---

[57] TWDB, "River Basins." Accessed June 2016, http://www.twdb.texas.gov/surfacewater/rivers/river_basins/index.asp.
[58] TCEQ Water Availability Division, "Basins with Adopted Environmental Flow Standards (map)," September 1, 2015, Accessed June 2016, http://www.tceq.texas.gov/assets/public/comm_exec/images/enviro-flows-LG-map09022015.jpg.
[59] TWDB, "River Basins." Accessed June 2016, http://www.twdb.texas.gov/surfacewater/rivers/river_basins/index.asp.
[60] TWDB, "Trinity River Basin." Accessed June 2016, http://www.twdb.texas.gov/surfacewater/rivers/river_basins/trinity/index.asp.
[61] TWDB, "River Basins." Accessed June 2016, http://www.twdb.texas.gov/surfacewater/rivers/river_basins/index.asp.
[62] TWDB, "Trinity River Basin – reservoir pages." Accessed June 2016, http://www.twdb.texas.gov/surfacewater/rivers/river_basins/trinity/index.asp.
[63] TWDB Water Data for Texas, "Trinity River Basin Reservoirs." Accessed June 2016, http://www.waterdatafortexas.org/reservoirs/basin/trinity.
[64] TWDB, "Lakes in Trinity River Basin." Accessed June 2016, http://www.twdb.texas.gov/surfacewater/rivers/river_basins/trinity/index.asp.
[65] TWDB Water Data for Texas, "Trinity River Basin Reservoirs." Accessed June 2016, http://www.waterdatafortexas.org/reservoirs/basin/trinity.
[66] Land, Larry F., et al. "Water Quality in the Trinity River Basin, Texas, 1992-1995," *Circulars,* 1998. Accessed January 2016, http://pubs.usgs.gov/circ/circ1171/circ1171.pdf.

Lake Limestone is located at the headwaters of the Navasota River and is owned and operated by the Brazos River Authority for water supply and recreational purposes (**Appendix D, Natural Resources Mapbook; Section 3.3.4.2.2, Water Quality**).[67] Lake Livingston is located approximately six miles southwest of Livingston, in Walker, Polk, Trinity and San Jacinto counties, and is fed from the main stem of the Trinity River.[68] It is owned and operated by the Trinity River Authority under contract with the City of Houston for flood control, municipal and industrial water supply, irrigation and recreation purposes.[69]

The Richland-Chambers Reservoir is located below the Upper Trinity Watershed at the intersection of the Chambers Creek and Richland Creek and extends into Navarro and Freestone counties (**Appendix D, Natural Resources Mapbook; Section 3.3.4.2.2, Water Quality**).[70] The Richland-Chambers Reservoir is owned and operated by Tarrant Regional Water District and used for water supply, flood control, irrigation and recreation purposes.[71]

Bardwell Lake and Dam is located approximately 5 miles south of the City of Ennis in Ennis County on Waxahachie Creek 5 miles north of its confluence with Chambers Creek (**Appendix D, Natural Resources Mapbook; Section 3.3.4.2.2, Water Quality**).[72] This reservoir is owned and operated by the USACE for municipal water supply, flood control and recreation.

3.8.4.3.3 Brazos River Basin

The Brazos River Basin covers an area of 45,573 square miles, of which 42,865 square miles are located within Texas.[73] The river extends 840 miles from Stonewall County southeast to the Gulf of Mexico.[74,75,76] The basin has an average flow volume of 6,074,000 acre-feet per year, the largest average annual flow volume of any river in Texas.[77] The middle and lower portions of the Brazos River, which includes the Navasota River, experiences infrequent, high-magnitude flows in the floodplain that have the potential to transport sediment, erode banks and cause flooding.[78]

The Brazos River Basin contains 42 major reservoirs, of which 27 are monitored water supply reservoirs and 11 are used for flood control.[79, 80] The monitored water supply reservoirs have a current storage of 5,539,125 acre-feet, with 24 of the reservoirs storing greater than 10,000 acre-feet.[81]

[67] TWDB, "Lake Limestone (Brazos River Basin)." Accessed January 2016, https://www.twdb.texas.gov/surfacewater/rivers/reservoirs/limestone/index.asp.
[68] U.S. Geologic Survey, "Environmental Setting and Hydrologic Conditions in the Trinity River Basin." Accessed January 2016, http://pubs.usgs.gov/circ/circ1171/html/envhyd.htm.
[69] TWDB, "Lake Livingston (Trinity River Basin)." Accessed June 2016, http://www.twdb.texas.gov/surfacewater/rivers/reservoirs/livingston/index.asp.
[70] TWDB, "Richland-Chambers Dam and Reservoir (Trinity River Basin)." Accessed January 2016, http://www.twdb.texas.gov/surfacewater/rivers/reservoirs/richland_chambers/index.asp.
[71] Ibid.
[72] TWDB, "Bardwell Lake (Trinity River Basin)." Accessed 2016, https://www.twdb.texas.gov/surfacewater/rivers/reservoirs/bardwell/index.asp.
[73] TWDB, "River Basins." Accessed June 2016, http://www.twdb.texas.gov/surfacewater/rivers/river_basins/index.asp.
[74] TCEQ Water Availability Division, "Basins with Adopted Environmental Flow Standards (map)," September 1, 2015. Accessed June 2016, http://www.tceq.texas.gov/assets/public/comm_exec/images/enviro-flows-LG-map09022015.jpg.
[75] TWDB, "River Basins." Accessed June 2016, http://www.twdb.texas.gov/surfacewater/rivers/river_basins/index.asp.
[76] TWDB, "Brazos River Basin." Accessed January 2016, http://www.twdb.texas.gov/surfacewater/rivers/river_basins/brazos/index.aspp.
[77] Ibid.
[78] TWDB, "Technical Study Summaries: Middle and Lower Brazos River." Accessed Janaury 2016, http://www.twdb.texas.gov/surfacewater/flows/instream/middle_lower_brazos/doc/BrazosHydroSummarySheet.pdf.
[79] TWDB, "Brazos River Basin – reservoir pages." Accessed June 2016, http://www.twdb.texas.gov/surfacewater/rivers/river_basins/brazos/index.asp.

3.8.4.3.4 San Jacinto River Basin

The San Jacinto River Basin covers an area of 3,936 square miles situated between the Trinity and Brazos River basins, mainly within Montgomery and Harris counties near Houston, and is one of the smallest river basins in Texas.[82, 83] The river headwaters are located in Walker County, and it flows southeast to Galveston Bay.[84] The West Fork of the San Jacinto River originates near Lake Conroe and flows south into Lake Houston. The East Fork flows south into Lake Houston and then into Galveston Bay. The basin has an average flow volume of 1,365,000 acre-feet per year.[85] The topographic variation within the basin is minor, with the landscape formed by coastal processes. Major streams within the basin include the East and West forks of the San Jacinto River, Spring Creek and Luce and Buffalo bayous.

The basin is highly modified within the Houston Metropolitan Area and receives a significant amount of urban runoff.[86] The magnitude and frequency of some components of the river's hydrology may be influenced by past dam construction, water diversions and increased urban and wastewater loading.[87]

The San Jacinto River Basin contains 6 major reservoirs, of which 2 are water supply reservoirs and 2 are used for both water supply and flood control.[88] Two of the major large water supply reservoirs – Lake Conroe in the north and Lake Houston in the south – are located in this subwatershed.[89] None of the San Jacinto River Basin's major reservoirs intersect the floodplain Study Area.

3.8.4.4 Channel Stability

General information on soils and geology is provided in **Section 3.20, Soils and Geology**. Highly-erodible soils, including sands and loams, may cause or contribute to loss of channel stability resulting in erosion and sedimentation which can further affect floodplains. These features are identified in **Appendix D, Mineral and Utility Resources Mapbook**.

3.8.5 Environmental Consequences

3.8.5.1 No Build Alternative

Under the No Build Alternative, the HSR system would not be constructed. There would be no direct impacts to floodplains, geohydrology, surface water hydrology, and channel stability because construction would not occur in or near existing water bodies or floodplains under the Build Alternatives. Potential impacts could still occur under the No Build Alternative because new infrastructure (roads, housing developments, and businesses) would continue to be constructed due to natural growth in the area that could increase the amount of impervious cover and consequently alter

[80] TWDB Water Data for Texas, "Brazos River Basin Reservoirs." Accessed June 2016, http://www.waterdatafortexas.org/reservoirs/basin/brazos.
[81] Ibid.
[82] TCEQ Water Availability Division, "Basins with Adopted Environmental Flow Standards (map)," September 1, 2015. Accessed June 2016, http://www.tceq.texas.gov/assets/public/comm_exec/images/enviro-flows-LG-map09022015.jpg.
[83] TWDB, "River Basins." Accessed June 2016, http://www.twdb.texas.gov/surfacewater/rivers/river_basins/index.asp.
[84] TWDB, "San Jacinto River Basin." Accessed January 2016, http://www.twdb.texas.gov/surfacewater/rivers/river_basins/sanjacinto/index.asp.
[85] Ibid.
[86] Texas Commission on Environmental Quality, "San Jacinto River Basin Narrative Summary," 2016. Accessed January 2016, https://www.tceq.texas.gov/assets/public/compliance/monops/water/02twqmar/basin10.pdf.
[87] AECOM, "Characterization of the San Jacinto Watershed," 2012.
[88] TWDB, "Lakes in San Jacinto River Basin." Accessed June 2016, http://www.twdb.texas.gov/surfacewater/rivers/river_basins/sanjacinto/index.asp.
[89] AECOM, "Characterization of the San Jacinto Watershed," Houston, Texas, 2012. Bluebonnet GCD, "Regulations," 2016. Accessed January 2016, http://www.bluebonnetgroundwater.org/regulations/.

the floodplain, surface water hydrology, and geohydrology, as well as impact channel stability. However, the No Build Alternative would not contribute to these impacts.

3.8.5.2 Build Alternatives

3.8.5.2.1 Floodplains

Construction of the Build Alternatives would traverse mapped Zone A, Zone AE, and Zone X floodplains, as denoted on the **Appendix D, Natural Resources Mapbook**. During the planning and conceptual engineering of the Build Alternatives, the alignments were designed to avoid and minimize crossings of mapped stream channels (see also **Section 3.7, Waters of the U.S.**). However, the Build Alternatives would still impact regulatory floodplains, as summarized in **Table 3.8.6**. During construction the footprint of the LOD additional workspace area, laydown yards and construction workspace would have a temporary impact to the floodplains. While the HSR track and supporting facilities (e.g., permanent roads, parking areas, access/maintenance areas, terminals and non-vegetated embankments) would result in a permanent impact to the floodplain throughout the operation of the HSR system. The fewest permanent impacts to Zone A, Zone AE, and Zone X floodplains would be Build Alternative B, with 612 acres, while the largest permanent impacts would be under Build Alternative D, with 658.3 acres. Additionally, temporary impacts by the Build Alternatives would range from 60 acres (under Build Alternatives C and F) to 83 acres (under Build Alternatives A and D) of Zone A, Zone AE, and Zone X floodplains.

One of the Houston Terminal Stations options (Industrial Site Terminal) would have 0.1 acre of permanent impact. The other two Houston Terminal Station options are not presented in **Table 3.8.6** because they would not be located within an existing floodplain and, therefore, would have neither permanent nor temporary impacts.

The Build Alternatives would also include bridge/viaduct stream crossings ranging from 283, under Build Alternative C, to 307 bridge/viaduct stream crossings under Build Alternative D,[90] as shown in **Table 3.8.7**. The Houston Terminal Station options are not presented in **Table 3.8.7** because they do not have identified bridge/viaduct stream crossings.

[90] TCRR, "*Texas Central Partners Texas High Speed Rail Final Draft Conceptual Engineering Report-FDCERv7*," September 15, 2017.

Table 3.8-6: Floodplain Impacts by Build Alternative within the Floodplain Study Area

		Acres Impacted of Zone A, Zone AE, and Zone X Combined													
Segment	**County**	**ALT A**		**ALT B**		**ALT C**		**ALT D**		**ALT E**		**ALT F**		**Houston Terminal Industrial Site**	
		Perm.	**Temp.**	**Perm.**	**Temp.**	**Perm.**	**Temp.**	**Perm.**	**Temp.**	**Perm.**	**Temp.**	**Perm.**	**Temp.**	**Perm.**	**Temp.**
Segment 1	Dallas and Ellis	157	27	157	27	157	27	157	27	157	27	157	27	--	--
Segment 2A	Ellis	51	0	51	0	51	0	--	--	--	--	--	--	--	--
Segment 2B	Ellis	--	--	--	--	--	--	56	0.3	56	0.3	56	0.3	--	--
Segment 3A	Ellis and Navarro	95	2	--	--	--	--	95	2	--	--	--	--	--	--
Segment 3B	Ellis and Navarro	--	--	56	0	--	--	--	--	56	0	--	--	--	--
Segment 3C	Ellis, Navarro, Freestone, Leon, Madison, and Grimes	--	--	--	--	270	5	--	--	--	--	270	5	--	--
Segment 4	Freestone, Limestone, Leon, Madison, and Grimes	158	26	158	26	--	--	158	26	158	26	--	--	--	--
Segment 5	Grimes, Waller, and Harris	109	28	109	28	109	28	109	28	109	28	109	28	--	--
Segment 5: Industrial Site Terminal Option	Harris	--	--	--	--	--	--	--	--	--	--	--	--	0	0.1
	Total	570	83	531	81	587	60	575	83.3	536	81.3	592	60.3		
	Total by Alternative	653		612		647		658.3		617.3		652.3			

Table 3.8-7: Floodplain Bridge/Viaduct Crossings within the Floodplain Study Area

Build Alternative Segment	County	Number of Stream Crossings								
		ALT A			ALT B			ALT C		
		FEMA Zone AE	FEMA Zone A	Non-FEMA Stream Crossings	FEMA Zone AE	FEMA Zone A	Non-FEMA Stream Crossings	FEMA Zone AE	FEMA Zone A	Non-FEMA Stream Crossings
Segment 1	Dallas	11	1	9	11	1	9	11	1	9
Segment 2A	Ellis	8	12	17	8	12	17	8	12	17
Segment 2B	Ellis	--	--	--	--	--	--	--	--	--
Segment 3A	Ellis and Navarro	0	17	23	--	--	--	--	--	--
Segment 3B	Ellis and Navarro				0	15	17	--	--	--
Segment 3C	Ellis, Navarro, Freestone, Leon, Madison, Grimes	--	--	--	--	--	--	3	25	109
Segment 4	Freestone, Limestone, Leon, Madison, Grimes	0	24	103	0	24	103	--	--	--
Segment 5	Grimes, Waller and Harris	14	13	80	14	13	80	14	13	80
Total by Build Alternative		**33**	**67**	**232**	**33**	**65**	**226**	**36**	**51**	**215**

Source: TCRR, "*Texas Central Partners Texas High Speed Rail Final Draft Conceptual Engineering Report-FDCERv7*," September 15, 2017.

Table 3.8-7: Floodplain Bridge/Viaduct Crossings within the Floodplain Study Area

Build Alternative Segment	County	Number of Stream Crossings								
		ALT D			ALT E			ALT F		
		FEMA Zone AE	FEMA Zone A	Non-FEMA Stream Crossings	FEMA Zone AE	FEMA Zone A	Non-FEMA Stream Crossings	FEMA Zone AE	FEMA Zone A	Non-FEMA Stream Crossings
Segment 1	Dallas and Ellis	12	0	3	12	0	3	12	0	3
Segment 2A	Ellis	--	--	--	--	--	--	--	--	--
Segment 2B	Ellis	6	15	14	6	15	14	6	15	14
Segment 3A	Ellis and Navarro	0	17	18	--	--	--	--	--	--
Segment 3B	Ellis and Navarro	--	--	--	0	15	16	--	--	--
Segment 3C	Ellis, Navarro, Freestone, Leon, Madison, and Grimes	--	--	--	--	--	--	3	25	104
Segment 4	Freestone, Limestone, Leon, Madison, and Grimes	0	24	96	0	24	96	--	--	--
Segment 5	Grimes, Waller, and Harris	14	13	75	14	13	75	14	13	75
Total		**32**	**69**	**206**	**32**	**67**	**204**	**35**	**53**	**196**
Total by Build Alternative		**307**			**303**			**284**		

Source: TCRR, "*Texas Central Partners Texas High Speed Rail Final Draft Conceptual Engineering Report-FDCERv7*," September 15, 2017..

As shown in **Table 3.8.7**, the Build Alternatives with the fewest crossings would include 86 crossings over FEMA Zone A or Zone AE identified floodplains under Build Alternative C, while the most numerous crossings would be 101 crossings under Build Alternative D. Based on the conceptual design of the Build Alternatives, all of the identified FEMA floodplain crossings would be fully spanned with a viaduct segment and include a minimum of three feet of freeboard above the base flood elevation (if Zone AE) or above the modeled water surface elevation to be completed during final design (if Zone A). The viaduct design for the HSR system would minimize fill within the floodplain by minimizing pier placement within floodplains. Pier spacing would range from 80 feet to 140 feet, with a typical pier spacing of 110 feet. If the width of the regulatory floodplain is less than 110 feet, the entire channel span including freeboard would be designed and constructed with no piers in the floodplain and, if possible, avoid all potential impacts to waters of the U.S. (**Section 3.7, Waters of the U.S**.). If the width of the crossing would be greater than 140 feet, the minimum number of piers required to support the viaduct crossing would be placed within the floodplain; however, the piers would not displace enough of the flow volume to cause a new flood risk.[91] By incorporating this design into the construction of the Build Alternatives, TCRR would ensure compliance with applicable FEMA regulations, including EO 11988, EO 13690 and Federal Flood Risk Management Standard.[92, 93, 94] Prior to construction, TCRR would obtain a Floodplain Development Permit for any impacts within FEMA floodplain boundaries from FEMA or local floodplain administrators/directors detailed in **Table 3.8-2**, as applicable.[95, 96, 97, 98]

Per the preliminary drainage analysis and conceptual engineering analysis, other stream crossings that do not have FEMA designated floodplains or FEMA-digitized data would range from 196 crossings under Build Alternative F, to 207 crossings under Build Alternative A (including Freestone and Madison counties). These stream crossings would be spanned with viaducts in a similar manner as the FEMA-digitized crossings (see **Appendix F, TCRR Conceptual Engineering Design Report**). Proposed low chord elevations, or the lowest part of the structure, at crossings without FEMA data were developed through conceptual design hydraulic analysis performed by TCRR. These elevations would offer protection well above the 100-year water surface elevation with an additional 3 feet of freeboard to protect against increased flooding risk from future development within the watershed unrelated to the Build Alternatives. Adding additional freeboard above the 100-year level would ensure compliance with EO 11988, EO 13690, and Federal Flood Risk Management Standard.

Each bridge/viaduct crossing would need to comply with local permitting requirements per the floodplain regulations identified in **Tables 3.8-2 and 3.8-3**. Each bridge/viaduct crossing would be hydraulically modeled during final design by the TCRR to:

[91] Personal email communication between Monica Wedo (AECOM) and Cory Stull (FNI), June 6, 2016.
[92] The White House, Executive Order–Establishing a Federal Flood Risk Management Standard and a Process for Further Soliciting and Considering Stakeholder Input*,* January 30, 2015. Accessed June 2016, https://www.whitehouse.gov/the-press-office/2015/01/30/executive-order-establishing-federal-flood-risk-management-standard-and- .
[93] 44 C.F.R. Part 9, Floodplain Management and Protection of Wetlands, 2003.
[94] Ibid.
[95] 44 C.F.R. Part 2, Criteria for Land Management and Use, 2002.
[96] City of Dallas, "Floodplain and Escarpment Zone Regulations Article V Division 51A-5.100*,"* Dallas, Texas: City of Dallas, n.d. City of Houston. "Rules and Regulations for Chapter 19, Guidelines Houston City Code: Floodplain*,"* City of Houston, February 1, 2009.
[97] Harris County, "Regulations of Harris County, Texas for Floodplain Management," Houston, Texas: Harris County Public Infrastructure Department Engineering Division, 2011.
[98] City of Houston, "Rules and Regulations for Chapter 19, Guidelines Houston City Code: Floodplain," City of Houston, February 1, 2009.

- Ensure the minimum low chord viaduct crossings would be at least three feet above the FEMA floodplain elevation and/or the modeled floodplain elevation
- Determine pier depth
- Ensure no adverse impact as a result of piers
- Assess scour envelopes due to bridge and viaduct pier placement. TCRR has indicated that they would follow the latest FHWA HEC-18 procedures

During construction, adverse effects on floodplains, defined as a raise in floodplain elevation, would be minimized by siting the majority of construction staging and access areas and temporary fill outside of floodplains, as discussed in **Section 3.8.6, Mitigation**. Therefore, significant encroachment of a regulatory floodplain during construction would not occur. For construction in areas that would be located within floodplains, erosion and sedimentation controls would be implemented by TCRR and/or its construction contractor and regulated under TPDES Permit No. TXR150000, which is a general permit in Texas for the discharge of stormwater during construction (see **Appendix F, TCRR Conceptual Engineering Design Report**). Erosion and sedimentation control would include a variety of water quality controls, discussed in **Section 3.3, Water Quality**.

The design of the Build Alternatives would minimize potential increases to the floodplain elevations by retaining existing water surface elevations where feasible to avoid impacting the available flood storage and minimizing fill in sensitive areas. Many regulatory floodplains and unregulated stream segments would be fully spanned and potential impacts avoided. Compliance and mitigation measures, including temporary detention, would be used to offset effects on floodplains from piers and construction within the floodplains. Consequently, impacts to floodplains would not be significant.

3.8.5.2.2 Geohydrology

Any construction below the ground surface would locally disturb the uppermost soil layer into which rainwater infiltration occurs. The addition of impervious cover, both temporary and permanent, would alter the infiltration rate into the subsurface within the LOD. Construction could also encounter groundwater, particularly in the southern part of the floodplain Study Area, including Grimes, Montgomery and Harris counties where the water table ranges from about 10 to 30 feet below ground surface. If groundwater is encountered, it is typically removed and disposed of in compliance with water quality standards, as discussed in **Section 3.3, Water Quality**.[99]

The viaduct sections of the Build Alternatives would be supported by piers, which could be either drilled, driven or cast-in-place. Other subsurface construction, such as excavation for earthen embankment foundations, may be required. Pier construction and other subsurface construction methods have not been determined by TCRR. These methods would be selected by TCRR based on local conditions determined by currently available geotechnical data and future geotechnical investigations performed during final design of the preferred alternative.

It is anticipated that the water needs of the Build Alternatives, including the stations, would be supplied by local, existing public water supplies, and TCRR would not directly access groundwater. Use of existing

[99] U.S. Geological Survey, Prepared in Cooperation with the Harris-Galveston Coastal Subsidence District, "Estimated Depth to the Water Table and Estimated Rate of Recharge in Outcrops of the Chicot and Evangeline Aquifers Near Houston, Texas, Water-Resources Investigations Report 96-4018," 1996.

public suppliers would require an expansion to supply water to the Bardwell MOW in Ellis County, as discussed in **Section 3.9, Utilities and Energy**.

Projects that pump groundwater in Harris County must comply with the HGSD regulations, and, in some areas, require the end user to submit Groundwater Reduction Plans that outline a conversion path to reduce reliance on groundwater. It is anticipated that TCRR would obtain its water supply from the City of Houston and groundwater withdrawal would not be necessary. The City of Houston is in compliance with HGSD regulations; therefore, the impacts of the Build Alternatives on ground subsidence from groundwater pumping would not be significant.

TCRR would implement temporary and permanent erosion, sediment and water quality controls, as discussed in **Section 3.3, Water Quality**, during the construction period and long-term operations to minimize changes to geohydrology. Impacts to geohydrology as a result of the Build Alternatives would be not significant with the implementation of best management practices and design features detailed in **Section 3.8.6, Avoidance, Minimization and Mitigation**.

3.8.5.2.3 Hydrology

Cross-Drainage Patterns

HSR track on embankment (raised edge) would impede the natural flow path of runoff by channelizing flow along the embankment and redirecting the natural flow path. This change to the natural flow path would permanently modify the hydrology of the area, which could increase the peak flowrate and total volume of runoff for a given flow path in a given subwatershed. Cross-drainage structures, or features that allow flowing stormwater to pass through a constructed embankment instead of collecting on one side, would minimize the impact of these artificially channelized flows. The runoff from a natural stream or depression that intersects the constructed embankment would be able to pass under the embankment to a natural or manmade drainage feature on the other side. Cross-drainage structures include the use of cross culverts, bridge class culverts, or bridge spans. As summarized in **Table 3.8-8,** cross-drainage locations using culvert or bridge class culverts (BCC) would range from 95 cross-drainage locations under Build Alternative C to 111 under Build Alternative D.

Per the TCRR stream crossing design approach (see **Appendix F, TCRR Conceptual Engineering Design Report**), cross culverts would be aligned perpendicular (i.e., 90 degree angle) or as close to perpendicular as possible to the HSR track. If a cross culvert cannot meet this design criteria due to other constraints, up to a 30 degree angle (skew) from the normal direction of the rail alignment would be implemented. For roadway crossings, the cross culverts would be aligned to have a skew angle less than 45 degrees from the normal direction of the rail alignment.

Table 3.8-8: Culvert or BCC Cross-Drainage Locations within the Floodplain Study Area

				Number Locations Per Build Alternative					
Segment	**County**	**100-Year Flow Rate Low (cfs)**	**100-Year Flow Rate High (cfs)**	**ALT A**	**ALT B**	**ALT C**	**ALT D**	**ALT E**	**ALT F**
Segment 1	Dallas and Ellis	90	1,100	3	3	3	3	3	3
Segment 2A	Ellis	94	393	9	9	9	--	--	--
Segment 2B	Ellis	84	398	--	--	--	11	11	11
Segment 3A	Ellis and Navarro	80	1,305	21	--	--	21	--	--
Segment 3B	Ellis and Navarro	133	1,849	--	12	--	--	12	--
Segment 3C	Ellis, Navarro, Freestone, Leon, Madison, and Grimes	60	1,1540	--	--	38	--	--	38
Segment 4	Freestone, Limestone, Leon, Madison and Grimes	69	884	31	31	--	31	31	--
Segment 5	Grimes, Waller, and Harris	20	3,482	45	45	45	45	45	45
			Total by Build Alternative	**109**	**100**	**95**	**111**	**102**	**97**

Source: FNI, August 2016

Lake Bardwell and Dam is owned and operated by the USACE.[100] The USACE holds flowage easements, or the right to occasionally flood private land in connection with operation of the reservoir, up to an elevation of 439 feet above mean sea level, and regulates all construction below this level around the lake. Only structures that do not reduce flood storage capacity and are not meant for human habitation maybe constructed on the flowage easements and must have prior written approval of the USACE District Engineer. Section 408 permission applications for construction must include detailed design plans including a map showing the location of the construction activities and the supporting analysis to prove that the Bardwell Lake storage capacity would not be reduced by project implementation. Segments 2A and 2B would cross flowage easements (approximately 2,650 feet and 3,300 feet, respectively) maintained by the USACE. Additionally, Segment 2B would be located on USACE property at Lake Bardwell and Dam. Construction on a federally authorized and constructed flood control project would require Section 408 requests for construction permission from the USACE, discussed in **Section 3.7.6, Waters of the U.S.**

As shown in **Table 3.8-7**, Build Alternative D would have the largest number of proposed bridge/viaduct sections (307) while Build Alternative C would have the least (283). Similarly, as shown in **Table 3.8-8**, Build Alternative D would have the largest number of proposed culvert and bridge cross culvert cross-drainage locations (111) while Build Alternative C would have the least (95).

Impervious Cover and Detention

Construction of the Build Alternatives would use temporary access roads and temporary staging areas that would result in short-term placement of impervious cover (surfaces that cannot infiltrate rainfall). The increase in impervious cover would increase stormwater runoff peak flow rates and total runoff volumes during a rainfall event. Removal of vegetation during construction would also increase the velocity of storm water runoff until new vegetation is reestablished. Upon completion of construction, all temporary staging areas and other temporary impervious cover would be removed and these areas would be revegetated to pre-construction conditions.

The placement of HSR track and supporting facilities (e.g., permanent roads, parking areas, access/maintenance areas, terminals, and non-vegetated embankments) would result in a permanent increase in impervious cover and an increase in ground compaction in those areas during operations. This increase in impervious cover and ground compaction would result in reduced or no infiltration, increased stormwater runoff peak flow rates and total runoff volumes during rainfall events and alteration of existing drainage patterns. In addition, construction of stations and other infrastructure in highly urbanized areas would contribute additional volumes of stormwater runoff to existing stormwater drainage systems. Increasing stormwater runoff flow rates and volume would increase the risk of flooding in areas that are lacking stormwater infrastructure or in areas where existing infrastructure cannot support an increase. Therefore, TCRR would be required by local jurisdictions (described in **Tables 3.8-2 and 3.8-3**) to incorporate design features into the Build Alternatives to minimize the effects of increases in impervious cover and ground compaction during construction and operations.

Using typical section types, including roadway improvements for grade separations, impervious cover per linear foot was calculated by TCRR for each Build Alternative. This data was used to estimate

[100] USACE, "Guidelines for Property Adjacent to Public Land," January 17, 2013, http://www.swf-wc.usace.army.mil/bardwell/Realestate/Adjland.asp.

increases in peak flow rate and total runoff volume between pre-construction and post-construction conditions per industry-standard hydrologic runoff computation methodologies, as discussed in **Section 3.8.3.3** (and noted in **Appendix F, TCRR Conceptual Engineering Design Report**). TCRR used this analysis to preliminarily design temporary and permanent drainage infrastructure, including detention basins. These design features are provided in **Section 3.8.6**.

Per TCRR's conceptual design (see **Appendix F, TCRR Conceptual Engineering Design Report**), permanent detention basins would be located adjacent to the railway in coordination with access roadway and rail-side ditches. The detention basins would be located close to natural streams or existing storm drain trunk lines that could serve as outfalls. Estimates on the volume, placement and depth of each detention basin were prepared by TCRR. TCRR designed the proposed detention volume for each drainage area to be sized to prevent an increase of post-construction peak flows over pre-construction peak flows by storing the newly-generated and additional volumes of runoff. TCRR's peak flow design criteria included the 100-year, 24-hour rainfall event (1 percent chance each year). The design parameters used by TCRR to calculate the required detention basin volumes were determined according to the TxDOT's HDM.

At this stage of preliminary design, TCRR limited the depth of the detention basins to 4 feet or less (3 feet of water storage and 1 foot of available freeboard) to accommodate both shallow groundwater tables and outfall requirements. During final design, upon completion of geotechnical investigations for each basin, TCRR may design deeper basins to reduce overall footprint. TCRR preliminarily designed the detention basins to provide the maximum pond depth storage for each stream/channel crossing based upon the peak runoff volume estimates and included an additional 30-foot construction and maintenance buffer along the outside edge of the basin. The detention basin design includes gravity outfall structures, or structures that would release water based solely upon the difference in water surface elevation between the inside of the basin and the downstream receiving waterbody with no gates or other measures used to control flow out of the basin. To convey water from the HSR track or facilities towards the detention basins, TCRR would install rail-side ditches (swales) to capture both on-site drainage and a portion of off-site drainage that flows towards the rail alignment. The ditches would not be designed to provide additional detention.

Impacts on hydrology would be temporary and permanent. Detention and cross-drainage, as well as temporary and permanent storm water controls, would be incorporated into the final design of all Build Alternatives to ensure compliance with TCEQ's TPDES program, as discussed in **Section 3.3, Water Quality**; therefore, the effects on hydrology for all Build Alternatives would be not significant.

3.8.5.2.4 Channel Stability

Portions of the floodplain Study Area with highly-erodible soils, high-channel velocities and proximity to existing structures and infrastructure, including outfalls, intakes and roads, would be evaluated by TCRR for channel stability in compliance with HEC-20 or similar during final design and included in the final design package. This manual is also applicable to rail crossings over waterbodies, as the use of raised embankments and piers are common between both road and rail crossings over waterbodies, and TCRR has indicated that they would follow HEC-20 procedures. **Table 3.8-9 below** provides lengths of stream segments within the floodplain Study Area by Build Alternative Segment that lie within areas defined as having highly erodible soils. Segments 1, 2A and 2B are not included in **Table 3.8-9** because the soils in this portion of the floodplain Study Area are not highly erosive. The total length of waterbodies within the floodplain and with highly erodible soils would range by Build Alternatives from 33,668 feet (Build

Alternatives A and D) to 35,221 feet (Build Alternatives B and E). Build Alternatives C and F would have the least (32,129 feet) permanent impacts, while Build Alternatives B and E (34,351feet) would have the greatest permanent impacts.

In addition to the cross-drainage design criteria in **Section 3.8.5.4**, during final design, TCRR would evaluate the effect of construction over stream crossings to avoid increased aggradation or degradation of existing channels, as well as potential damage to existing infrastructure that crosses or parallels the number of channels listed in **Table 3.8-10**. If these stream crossings would not be fully spanned by a viaduct segment and piers would be required, then a scour analysis would be completed by TCRR and erosion protection would be included in the final design plans. As previously stated, TCRR has indicated that they would follow the latest FHWA HEC-18 procedures for design criteria of scour velocities at viaducts.[101, 102] Design features, including adequate pier depth, stream armoring, vegetation and flow deflectors, would be incorporated as necessary by TCRR into the final design plans. With inclusion of these design criteria and design features, adverse effect on channel stability would not be significant.

[101] TxDOT, "Manual Notice 2012-1." Accessed June 2016, http://onlinemanuals.txdot.gov/txdotmanuals/geo/scour.htm.
[102] TxDOT, "Manual Notice 2016-1." Accessed June 2016, http://onlinemanuals.txdot.gov/txdotmanuals/hyd/bridge_hydraulic_considerations.htm.

Table 3.8-9: Streams Located in Highly Erodible Soils by Build Alternative within the Floodplain Study Area

		Length of Impact (ft)											
Segment	**County**	**ALT A**		**ALT B**		**ALT C**		**ALT D**		**ALT E**		**ALT F**	
		Perm.	**Temp.**	**Perm.**	**Temp.**	**Perm.**	**Temp.**	**Perm.**	**Temp.**	**Perm.**	**Temp.**	**Perm.**	**Temp.**
Segment 1	Dallas and Ellis	--	--	--	--	--	--	--	--	--	--	--	--
Segment 2A	Ellis	--	--	--	--	--	--	--	--	--	--	--	--
Segment 2B	Ellis	--	--	--	--	--	--	--	--	--	--	--	--
Segment 3A	Ellis and Navarro	460	--	--	--	--	--	460	--	--	--	--	--
Segment 3B	Ellis and Navarro	--	--	2,013	--	--	--	--	--	2,013	--	--	--
Segment 3C	Ellis, Navarro, Freestone, Leon, Madison and Grimes	--	--	--	--	11,222	1,070	--	--	--	--	11,222	1,070
Segment 4	Freestone, Limestone, Leon, Madison and Grimes	11,431	--	11,431	--	--	--	11,431	--	11,431	--	--	--
Segment 5	Grimes, Waller, and Harris	20,907	870	20,907	870	20,907	870	20,907	870	20,907	870	20,907	870
	Total	32,798	870	34,351	870	32,129	1,940	32,798	870	34,351	870	32,129	1,940
Total by Build Alternative		33,668		35,221		34,069		33,668		35,221		34,069	

Source: NRCS. SSURGO data by County, 2013 and 2015
Perm. = Permanent Impact
Temp. = Temporary Impact

Table 3.8-10: Number of Stream Crossings Within the Floodplain Study Area Having Highly Erodible Soils

Build Alternative Segment	ALT A	ALT B	ALT C	ALT D	ALT E	ALT F
Segment 1	NA	NA	NA	NA	NA	NA
Segment 2A	NA	NA	NA	NA	NA	NA
Segment 2B	NA	NA	NA	NA	NA	NA
Segment 3A	5	--	--	5	--	--
Segment 3B	--	5	--	--	5	--
Segment 3C	--	--	39	--	--	39
Segment 4	43	43	--	43	43	--
Segment 5	42	42	42	42	42	42
Total	**90**	**90**	**81**	**90**	**90**	**81**

Source: NRCS. SSURGO data by County, 2013 and 2015

3.8.6 Avoidance, Minimization and Mitigation

During the conceptual design of the Build Alternatives, TCRR followed the following design guidelines to avoid or minimize impacts to floodplain elevations, surface water hydrology, geohydrology, and channel stability:

- Avoided and minimized crossings of mapped stream channels
- Where crossing a regulatory floodplains or an unregulated stream segments would be necessary, fully spanned the stream channel where possible
- Avoided and minimized pier placement for bridge/viaduct sections within floodplains; based on the conceptual design of the Build Alternatives, all of the identified FEMA floodplain crossings would be fully spanned with a viaduct segment and
- Included a minimum of three feet of freeboard above the base flood elevation (if Zone AE) or above the modeled water surface elevation to be completed during final design (if Zone A).
- Designed low chord elevations of proposed bridge/viaduct sections with an additional three feet of freeboard above the modeled water surface elevation to protect against increased flooding risk from future development
- Used culverts and bridge-culvert crossings to maintain cross-drainage patterns and floodplain elevations
- Minimized siting construction staging and access areas and temporary fill within a floodplain and sensitive areas
- Minimized permanent fill within a floodplain and sensitive area

During final engineering design, TCRR would continue to analyze scour envelopes and channel stability for adequate design of pier depth, stream armoring, vegetation, and flow deflectors. Additionally, during construction, TCRR would construct temporary channels or coffer dams to reroute flows around work areas. During operations, TCRR would obtain water supply from local, existing public water supplies where feasible.

Design features to be further employed by TCRR in the detailed design to minimize the effects of additional impervious areas include but are not limited to:

- Maintain existing off-site cross-drainage patterns, where practicable.

- Capture, detain, and convey newly-generated LOD runoff resulting from impervious areas at pre-construction flows by designing stormwater drainage infrastructure to support the increase in runoff.

Additionally, during conceptual design, TCRR offset impacts to flooding upstream or downstream of the rail line by complying with drainage design criteria from local authorities listed in **Table 3.8-2**.

3.8.6.1 Compliance Measures

The following Compliance Measures (CM) and permits for floodplains, geohydrology, hydrology, and channel stability would be required for Build Alternatives A through F.

FP-CM#1: Floodplain Development Permit. During final design, TCRR shall obtain floodplain development permits from the local floodplain administrators/directors, listed in **Table 3.8-2,** and comply with local floodplain regulations, as required by the floodplain development permits.

FP-CM#2: Construction Floodplain Best Management Practices. During construction within floodplains, TCRR and its construction contractor shall implement erosion and sedimentation controls in accordance with TPDES Permit No. TXR150000.[103] TCRR and its construction contractor shall conduct periodic site inspections and maintenance when best management practices are in place to identify and address areas requiring maintenance. TCRR shall maintain records of all inspections as part of the Storm Water Pollution Prevention Plan (SWPPP). Additional inspections shall be conducted throughout construction by the local regulating authorities listed in **Tables 3.8-2 and 3.8-3**.

To minimize disruption of natural flow patterns and to maintain floodplain benefits, TCRR and its construction contractor shall construct temporary channels or coffer dams to reroute flows around work areas. At the conclusion of construction, vegetation would be replanted by TCRR and its construction contractor, in accordance with TCEQ Clean Water Act Section 401 water quality certification standards (see **Section 3.7.6, Waters of the U.S.**). TCRR and its construction contractor shall complete restoration in accordance with the TCEQ approved permitted design plans and specifications. Restoration shall be inspected for compliance by TCEQ prior to the completion of construction.

For all stream crossings temporarily impacted during construction, the following best management practices would be implemented by TCRR and its construction contractor and enforced by the local regulating authorities, listed in **Tables 3.8-2 and 3.8-3**, which issue site development permits.

- Maintain the passage of normal or high downstream flows to the maximum extent practicable.
- Temporary fills would consist of materials that would not be eroded by expected high flows.
- Temporary fills would be removed in their entirety and the affected area returned to pre-construction elevation as soon as practicable after construction.
- The areas affected by temporary fill would be revegetated as soon as practicable after construction.
- Access roads would be constructed so that the length of each road crossing minimizes any adverse effects on Waters of the U.S. (e.g., the shortest crossing distance would be used) and would be as near as possible to pre-construction contours and elevations.

[103] TxDOT, "Manual Notice 2016-1." Accessed June 2016, http://onlinemanuals.txdot.gov/txdotmanuals/hyd/bridge_hydraulic_considerations.htm.

- During construction, a combination of temporary and permanent detention basins, notched weirs, swales and vegetative strips would be used to limit off-site stormwater runoff.

FP-CM#3: Operational Floodplain Best Management Practices. During final design, TCRR shall incorporate permanent floodplain controls including swales, vegetative strips, and soil stabilization measures in combination with detention ponds to reduce peak flow rates to pre-construction conditions for the 25-year and 100-year rainfall events.

FP-CM#4 Operational SWPPP: Specific post-construction control measures required by the local regulating authorities, defined in **Tables 3.8-2 and 3.8-3,** would be documented in the post-construction SWPPP and enforced by TCEQ and the EPA, as discussed in **Section 3.3, Water Quality**, to ensure compliance with the Clean Water Act and Texas Water Code.[104]

3.8.7 Build Alternatives Comparison

A comparative summary of the of Build Alternatives for impacts to 100-year and 500-year floodplain, crossings of FEMA Zone AE and A by viaducts, the anticipated number of culverts or cross-drainage locations and anticipated number of stream crossings through highly erodible soils is included in **Table 3.8-11.** Two of the Houston Terminal Station options (Northwest Mall and Northwest Transit Center) station options are not presented in **Table 3.8-11** or discussed in the summary below because they would not be located within an existing floodplain and would neither require stream crossings nor have permanent or temporary floodplain impacts.

Table 3.8-11: Impacts by Build Alternative within the Floodplain Study Area

	ALT A	ALT B	ALT C	ALT D	ALT E	ALT F
	Size of Floodplain (acre)					
Impacts to 100-Year Floodplain	606	565	601	611	570	606
Impacts to 500-Year Floodplain	46	46	47	46.5	46.5	47.5
Total Acres of Intersected Floodplain	**653**	**611**	**648**	**658**	**617**	**653**
Permanent Impacts to 100-Year and 500-Year Floodplains	570	531	588	575	536	593
Temporary Impacts to 100-Year and 500-Year Floodplains	83	81	60	83	81	60
Total Acres of Impacted Floodplain	**653**	**612**	**648**	**658**	**617**	**653**
	Length of Streams with Highly Erodible Soils (feet)					
Impacts to Streams	33,668	35,221	34,069	33,668	35,221	34,069
	Number of Crossings					
Bridge/Viaduct Crossings at FEMA Zone AE Crossings	33	33	36	32	32	35
Bridge/Viaduct Crossings at FEMA Zone A Crossings	66	64	50	69	67	53
Bridge/Viaduct Crossings at Non-FEMA Stream Crossings	207	205	197	206	204	196
Total Number of Bridge/Viaduct Crossings	**306**	**302**	**283**	**307**	**303**	**284**
Culverts or BCC Cross-Drainage Locations	109	100	95	111	102	97
Stream Crossings Having Highly Erodible Soils	90	90	81	90	90	81

Source: AECOM, 2017

Based on **Table 3.8-11**, the following is a summary of the impacts by Build Alternative within the floodplain Study Area:

[104] Water Quality Control, *Texas Water Code*, Title II, Subtitle D, Chapter 26, http://www.statutes.legis.state.tx.us/Docs/WA/htm/WA.26.htm.

- Alternative D would impact the most acreage of floodplains at 658 acres of 100-year and 500-year floodplain combined with 575 of these acres identified as permanent impact, while Alternative B would impact the least acreage of floodplains at 611 acres of 100-year and 500-year floodplain combined with 531 of these acres identified as permanent impact.

- The third Houston Terminal Station option (Industrial Site Terminal) would have 0.1 acres of permanent impact located within the 500-year floodplain (Zone X – shaded) in Harris County.

- Alternative D would require the most bridges/viaducts installed at 307 combined crossings of FEMA Zone AE, Zone A, and Non-FEMA streams, while Alternative C would require the least bridges/viaducts installed at 283 combined crossings of FEMA Zone AE, Zone A, and Non-FEMA streams.

- Alternative D would require the most culverts or BCC to maintain cross-drainage patterns across embankment sections at 111. Alternative C would require the least culverts or BCC to maintain cross-drainage patterns at 95.

- Alternatives B and E would have the greatest stream length through highly erodible soils at 35,221 feet each, 870 feet of this total would be identified as temporary impacts. Alternatives A and D would have the least stream length through highly erodible soils at 33,668 feet each, 870 feet of this total would be identified as temporary impacts.

- Alternative A, B, D, and E would have the most number of stream crossings through highly erodible soils at 90 crossings each. Alternatives C and F would have the least number of stream crossings through highly erodible soils at 81 crossings each.

This page intentionally left blank.

3.9 Utilities and Energy

3.9.1 Introduction

The purpose of this section is to identify the major utilities in the Study Area and assess the energy demand of constructing and operating the HSR system. Identification of the major utilities aids in the assessment of potential conflicts with utilities during construction to avoid interruptions to service. The evaluation of major utilities also determines if they can accommodate the energy demands of the HSR system.

3.9.2 Regulatory Context

Federal

FRA's *Procedures for Considering Environmental Impacts* requires the evaluation of the production and consumption of energy. These include assessing impacts of any irreversible or irretrievable commitments of energy resources likely to be involved in the Project and any potential energy conservation, especially those likely to reduce the use of petroleum/gasoline or natural gas. The FRA Procedures do not specifically address utilities such as water, wastewater and energy transmission systems.[1]

State

__Public Utility Regulatory Act (Texas Utilities Code, Title 16, Title II)__

The purpose of this act is to establish a comprehensive and adequate regulatory system for public utilities to assure rates, operations and services that are just and reasonable to the consumers and to the utilities. The act covers consumer protections, rate setting, measurement and payment, reliability measures and construction and safety standards. This act grants the Texas Public Utility Commission authority to regulate the state's electric and telecommunication utilities, implements respective legislation and offers customer assistance in resolving consumer complaints under the Act.

__Texas Local Government Code §§ 214.214__

Texas Local Government Code §§ 214.214 codifies the state's compliance with National Fire Protection Association 70 in response to the National Electrical Code. National Fire Protection Association 70 codifies the requirements for safe electrical installations into a single, standardized source. National Fire Protection Association 70 is the benchmark for safe electrical design, installation and inspection to protect people and property from electrical hazards.

__Texas Health and Safety Code (Texas Statutes Title 9)__

Title 9 Safety, Subtitle A, Chapter 752, Public Safety, establishes regulations for high voltage overhead lines.

[1] FRA. Procedures for Considering Environmental Impacts. Notice of Updated Environmental Assessment Procedures. May 26, 1999.

3.9.3 Methodology

3.9.3.1 Data Collection

The evaluation of the utilities uses a Study Area defined by the boundaries of the LOD, while the Study Area for energy demand is defined by the service area of the energy providers. The utility and energy data are derived from the following sources:

- Platts utility information for aboveground and below ground major utility pipelines/electrical lines as well as electrical providers
- Texas Water Development Board regional plans for water demand
- City of Dallas, City of College Station, City of Navasota and City of Houston water utility for wastewater treatment plant capacity
- U.S. Energy Information Administration data on Texas energy use, electrical generation, crude oil and natural gas, and fuel consumption
- ERCOT statewide data for electrical demand and electrical generation
- RRC data for oil/gas wells

Additionally, municipal long-range plans were reviewed to identify projected needs and specific strategies for utility and energy allocation.

- The 2014 Long Range Water Supply Plan[2] resulted in a list of 14 strategies to provide raw water to the City of Dallas. These strategies range from conservation and reuse to creating new reservoirs. None of these planned reservoirs would be in the vicinity of the Build Alternatives. The Build Alternatives would cross two raw water pipelines - one proposed in Ellis County and the Integrated Pipeline currently under construction in Ellis and Navarro counties. The Integrated Pipeline would bring water from Lake Palestine to Dallas, as well as the Richland Chambers and Cedar Creek reservoirs. The integrated pipeline is being developed in agreement with the Tarrant Regional Water District.
- The Integrated Water Supply Plan[3] is an integration of planning conducted over many years by Tarrant Regional Water District and its customers, and it identifies the new water supplies with the largest potential benefit for water supply reliability. The Integrated Water Supply Plan considers new opportunities, technologies, and strategies for the next 50 years that would maximize reliability and minimize the effect on customer rates.
- The City of Houston Water Conservation Plan[4] (effective September 2014 through May 2019) provides water conservation goals and progress intended to preserve long-term water supplies for the City of Houston and its region
- The North Harris County Water Conservation Plan[5] identifies principles, practices, and standards for conservation and the efficient use of available water supplies and water distribution system capacity
- The Texas Regional Water Plans[6] consists of 16 prioritized water management projects by region that map out how to conserve water supplies, meet future water supply needs and respond to future droughts in the regions

[2] Dallas Water Utilities, “2014 Dallas Long Range Water Supply Plan to 2070 and Beyond,” December 2015.
[3] Tarrant Regional Water District, “Integrated Water Supply Plan,” 2013.
[4] City of Houston, “Water Conservation Plan,” April 2015.
[5] Harris County, “North Harris County Water Conservation Plan,” 2013.
[6] Texas Water Development Board, “Texas Regional Water Plans,” 2015.

- The 2017 State Water Plan "Water for Texas"[7] is a regional water plan developed every five years for statewide water supply planning. TWDB compiles key information gathered by the regional water planning agencies and provides recommendations to the Texas Legislature for legislative priorities related to the planning and construction of reservoirs and state water plan financing.

The type, size and location of the existing major utilities located within, adjacent or parallel to the LOD were identified by TCRR during conceptual engineering.[8] TCRR used the following criteria to identify the major utilities in the Study Area (see **Appendix F, TCRR Conceptual Engineering Design Report**):

- Water and wastewater – 18-inch diameter and larger
- Storm drain – 36-inch diameter and larger
- Crude oil and natural gas pipelines – 12-inch diameter and larger with high pressure at 500 pounds per square inch
- Electrical transmission lines – 69 kV and above
- Communication and fiber trunk lines – 24-inch and larger
- Oil and gas wells

A 50-foot buffer was added to the oil and gas well locations to account for potential mapping errors in the Texas Railroad Commission data.

TCRR provided water and wastewater demand projections for the stations, TMFs and MOWs. This data was reviewed and compared to capacity in the respective counties in the Study Area.

3.9.3.2 Energy Consumption

Given that energy service provider boundaries cover large areas within central and east Texas, data was collected at a regional and statewide level to define current energy demand and capacity. The construction schedule, provided by TCRR, was used to determine the construction period energy demand. The equipment and workforce schedules were then used to calculate construction-period energy usage. [9] TCRR also provided operational power consumption for train traction energy and energy consumption for stations and other facilities. Train traction power energy consumption was estimated by TCRR using a traction power load flow simulation. Energy demand for station operations and MOWs was estimated by TCRR and was developed using representative square foot energy consumption at similar facilities in Japan. The operational power consumption is summarized in **Table 3.9-13**, and includes power losses from transmission and transformers. Losses were estimated using the ERCOT annual average of 5 percent of power transmitted derived from 1996 to 2013 EIA data, as explained in **Train Operation Emissions** of **Section 3.2.3.2, Air Quality**. The daily power consumption was then multiplied by 365 days per year, the assumed operational schedule, to estimate annual consumption. Current electricity consumption rates from ERCOT were compared with the expected energy consumption of the Build Alternatives.

[7] Texas Water Development board, "2017 State Water Plan "Water for Texas," 2017.
[8] Utilities within the study area are identified in general accordance with recommended practices and procedures described in American Society of Civil Engineers Publication 38-02 (Standard Guideline for the Collection and Depiction of Existing Utility Data)
[9] For the purposes of this analysis, mobilization was assumed to occur from January 2018 to March 2018. Regional building demolition and land grubbing for the embankment, elevated (viaduct), and retained-fill segments was anticipated to begin in March 2018 and conclude in December 2019. The major construction activities were anticipated to occur between 2018 and 2021, with construction of the TMFs, MOWs and stations completed during 2020 and 2021. Demobilization and finishing would occur from September 2021 to December 2021.

Energy is commonly measured in terms of British Thermal Units (BTU) and is the unit of measure used to quantify energy consumption during construction and operation. A BTU is defined as the amount of heat required to raise the temperature of 1 pound of water by 1 degree Fahrenheit. For transportation activities, energy usage is predominantly influenced by the amount of fuel used. The average BTU content of fuel is the heat value (or energy content) per volume of fuel as determined from tests of fuel samples. For example, a gallon of gasoline produces approximately 114,500 BTU.[10] However, the BTU value of gasoline varies from season to season and from batch to batch. Energy consumption, particularly electricity is commonly measured using the unit of measure of Watts, and consumption over a period of time is typically measured as megawatt-hours (1 million Watts consumed in one hour, or MWh). To compare electric energy consumption to other (e.g. vehicle) energy consumption, the conversion factor of 3,412,141.5 BTUs per MWh was used.

Construction energy (fuel) refers to the one-time energy involved in building the HSR system, typically through the burning of fuel for operating construction equipment and vehicles, as well as delivering construction materials. Construction energy (fuel) was determined based on specific schedule and equipment data estimated by TCRR (see **Appendix F, TCRR Conceptual Engineering Design Report**). These data were used to estimate the anticipated construction energy consumption based on the following assumptions:

- Total equipment working hours from the air quality analysis in **Section 3.2, Air Quality** was used as the basis of construction energy
- Each equipment working hour was assumed to use one-tenth of gallon of fuel as an average for the total length of the Build Alternative
- The total fuel use was then multiplied by 114,500 to calculate the total BTU of construction energy

Operational energy (electricity) refers to the energy consumed during operations. Electrical demand was calculated in terms of megawatts, then converted to BTUs where necessary, and compared to current estimates of peak demand and supply capacity within the electrical grid(s). Operational energy was then compared to the energy (fuel) consumed by the traveling public under the No Build Alternative. This energy is a function of traffic characteristics, such as volume, speed, distance traveled, vehicle mix and thermal value of the fuel being used. The approximate distance from Dallas to Houston is 240 miles, and is the same if a person travels by automobile on IH-45 or flies commercially between the airports in these cities.

To determine the operational benefit of the Build Alternatives on fuel and energy savings, the VMT that would have occurred in the absence of the Build Alternatives was calculated. Using ridership information provided by TCRR[11], it was estimated to be 2,552,520,000 VMT. This is discussed in detail in the air quality **Section 3.2.3.2.2** under the subsection **Reduction in Vehicle Miles Traveled**. Because IH-45 is the principle and practical route used for Dallas-Houston travel, a city center-to-city center distance of 239 miles was assumed for the trip distance, or a round trip total of 478 miles. Because automobile and light truck travel is the predominant mode of passenger transportation between Dallas and Houston, energy (fuel) saved was converted to a BTU equivalent.[12] This information was used along with

[10] EPA 1995. Office of Mobile Sources. Fuel Economy Impact Analysis of Reformulated Gasoline. August.
[11] TCRR, "*Texas Central Partners Texas High Speed Rail Final Draft Conceptual Engineering Report-FDCERv7*," September 15, 2017.
[12] National Highway Traffic Safety Administration 2009. Corporate Average Fuel Economy Standards for Model Year 2012-2016 Passenger Cars and Light Trucks. http://www.nhtsa.gov/Laws+&+Regulations/CAFE+-+Fuel+Economy/Model+Years+2012-2016:+Final+Rule. Website accessed June 17, 2016.

the 2014 average Corporate Average Fuel Economy (CAFE) standard for passenger vehicles, promulgated by DOT and EPA, to calculate fuel and energy savings shown in **Table 3.9-17**. Energy that would be used during the manufacturing of the train vehicles or with changes in the demand for automobiles or airplanes, are not included in this analysis because the net change in energy use would be relatively small compared to the operational energy consumed by the HSR trains or saved by reducing passenger vehicle use over the long-term.

3.9.4 Affected Environment

3.9.4.1 Utility Crossings

The utilities crossing analysis focuses on major utilities such as large diameter water/wastewater lines, large diameter natural gas pipelines, large diameter petroleum/crude oil pipelines and high voltage electrical transmission lines. Major utilities located within the Study Area are grouped by county, segment and utility owner in **Table 3.9-1**, and shown in **Appendix D, Mineral and Utility Resources Mapbook**.

Table 3.9-1: Summary of Utility Crossings

Type	Number Crossed	Owner
Dallas County Segment 1		
Communication Line (OH)	2	AT&T Texas
Communication Line (UG)	1	AT&T Texas
Electric Transmission	15	ONCOR
Natural Gas	1	Atmos Energy Corp
Natural Gas	1	Gulf South Pipeline Company
Sanitary	15	City of Dallas
Sanitary	1	City of Lancaster
Stormwater	14	City of Dallas
Water	2	City of Dallas
Ellis County Segment 2A		
Communication Line (OH)	1	AT&T Texas
Communication Line (UG)	2	AT&T Texas
Crude Oil	1	Sunoco Pipeline LP
Electric Transmission	8	ONCOR
Natural Gas	3	Energy Transfer Company
Natural Gas	1	EMS USA INC
Natural Gas	3	Atmos Energy Corp
Water	2	Tarrant Regional Water District
Ellis County Segment 2B		
Communication (OH)	1	AT&T Texas
Communication (UG)	2	AT&T Texas

Table 3.9-1: Summary of Utility Crossings

Type	Number Crossed	Owner
Crude Oil	1	Sunoco Pipeline LP
Electric Transmission	10	ONCOR
Natural Gas	3	Energy Transfer Company
Natural Gas	1	EMS USA INC
Natural Gas	3	Atmos Energy Corp
Water	2	Tarrant Regional Water District
Navarro County Segment 3A		
Communication Line (UG)	1	AT&T Texas
Crude Oil	1	Sunoco Pipeline LP
Electric Transmission	6	ONCOR
Empty/Unknown	1	Magellan Pipeline Company
Gasoline/Jet Fuel/Diesel	1	Magellan Pipeline Company
Natural Gas	1	Enbridge Pipelines
Natural Gas Liquids	1	ONEOK Arbuckle Pipeline LLC
Natural Gas Liquids	1	Energy Transfer Company
Navarro County Segment 3B		
Crude Oil	1	Sunoco Pipeline LP
Electric Transmission	10	ONCOR
Empty/Unknown	1	Magellan Pipeline Company
Gasoline/Jet Fuel/Diesel	1	Magellan Pipeline Company
Natural Gas	1	Enbridge Pipelines
Natural Gas Liquids	1	ONEOK Arbuckle Pipeline LLC
Natural Gas Liquids	1	Energy Transfer Company
Navarro County Segment 3C		
Crude Oil	2	Sunoco Pipeline LLC
Electric Transmission	6	ONCOR
Empty	1	Magellan Pipeline Company
Gasoline/Jet Fuel/Diesel	1	Magellan Pipeline Company
Natural Gas	1	Enbridge Pipelines
Natural Gas Liquids	1	Energy Transfer Company
Communication (UG)	1	AT&T Texas
Limestone County Segment 4		
Natural Gas	2	Trend Gathering & Treating LLC
Natural Gas	1	Enbridge Pipelines
Freestone County Segment 3A		

Table 3.9-1: Summary of Utility Crossings

Type	Number Crossed	Owner
None	--	--
Freestone County Segment 3B		
None	--	--
Freestone County Segment 3C		
Crude Oil	5	Enterprise Crude Pipeline LLC
Crude Oil	2	Sunoco Pipeline LLC
Electric Transmission	4	ONCOR
Gasoline/Jet Fuel/Diesel	1	Magellan Pipeline Company
Liquefied Petroleum Gas	1	ONEOK NGL Pipeline LLC
Natural Gas	2	Anadarko Gathering Company LLC
Natural Gas	2	Atmos Pipeline
Natural Gas	4	Enbridge Pipelines
Natural Gas	2	Energy Transfer Company
Natural Gas	1	Linn Operating Inc
Natural Gas	1	Pinnacle Gas Treating LLC
Natural Gas	1	Trend Gathering & Treating LLC
Natural Gas Liquids	1	ONEOK Arbuckle Pipeline LLC
Freestone County Segment 4		
Communication Line (UG)	1	AT&T Texas
Crude Oil	3	Sunoco Pipeline LP
Electric Transmission	3	ONCOR
Liquefied Petroleum Gas	1	ONEOK NGL Pipeline LLC
Natural Gas	2	Atmos Pipeline
Natural Gas	2	Energy Transfer Company
Natural Gas Liquids	1	DCP Midstream LP
Leon County Segment 3C		
Electric Transmission	2	ONCOR
Gasoline/Jet Fuel/Diesel	1	Magellan Pipeline Company LP
Natural Gas	1	Enbridge Pipelines LP
Natural Gas	1	Energy Transfer Company
Natural Gas Liquids	1	DCP Midstream LP
Leon County Segment 4		
Communication Line (OH)	1	AT&T Texas
Communication Line (UG)	7	AT&T Texas
Electric Transmission	9	ONCOR

Table 3.9-1: Summary of Utility Crossings

Type	Number Crossed	Owner
Natural Gas	3	Enbridge Pipelines LP
Natural Gas	2	Trend Gathering & Treating LLC
Natural Gas	1	Energy Transfer Company
Madison County Segment 3C		
Electric Transmission	1	Entergy Texas
Natural Gas	1	Atmos Pipeline
Madison County Segment 4		
Electric Transmission	2	Mid-South Synergy
Natural Gas	1	Atmos Pipeline
Grimes County Segment 3C		
Electric Transmission	1	Mid-South Synergy
Grimes County Segment 4		
Crude Oil *	1	Enterprise Pipelines LP
Grimes County Segment 5		
Crude Oil	1	Magellan Pipeline Company LP
Electric Transmission	3	Entergy Texas
Electric Transmission	2	Unknown
Electric Transmission	2	Centerpoint Energy
Natural Gas	2	Energy Transfer Company
Natural Gas	2	Kinder Morgan Tejas Pipeline LLC
Natural Gas	2	Copano Gulf Coast LLC
Refined Products	1	Sunoco Pipeline LP
Y-Grade Products	2	Enterprise Products Operating LLC
Waller County Segment 5		
Communication Line (UG)*	8	AT&T Texas
Crude Oil	1	Blackhawk Pipeline LP
Electric Transmission	2	CenterPoint Energy
Electric Transmission	1	San Bernard Electric Co-op
Natural Gas	1	Texas Eastern Transmission LP
Harris County Segment 5		
Communication Line (OH)	8	AT&T Texas
Communication Line (UG)*	35	AT&T Texas
Crude Oil	1	Enterprise Crude Pipeline LLC
Crude Oil	2	Magellan Pipeline Company LP
Crude Oil	1	Genesis Pipeline Texas LP

Table 3.9-1: Summary of Utility Crossings		
Type	**Number Crossed**	**Owner**
Electric Transmission	16	CenterPoint Energy
Natural Gas	1	Netco Pipeline
Natural Gas*	2	Kinder Morgan Tejas Pipeline LLC
Natural Gas	2	Transcontinental Gas PL CO LLC
Natural Gas*	2	Houston Pipeline Company LP
Natural Gas	2	Natural Gas Pipeline Co or America LLC
Natural Gas	1	Gulf South Pipeline Company LP
Natural Gas	2	Tennessee Gas Pipeline CO LLC
Natural Gas	1	Trunkline Gas Company LLC
Natural Gas	1	Southcross Gulf Coast Trans LTD
Natural Gas Liquids	1	Enterprise Products Operating LLC
Sanitary	4	City of Houston
Stormwater	2	City of Houston
Water*	9	City of Houston
Industrial Site Terminal Option Segment 5		
Communication (UG)	1	AT&T Texas
Northwest Mall Terminal Option Segment 5		
Communication (UG)	3	AT&T Texas
Sanitary	1	City of Houston
Segment 5: Northwest Transit Terminal Station Option		
Communication (OH)	1	AT&T Texas
Communication (UG)	12	AT&T Texas
Electric Transmission	2	Centerpoint Energy
Sanitary	2	City of Houston
Stormwater	2	City of Houston
Water	2	City of Houston
Total (All Utilities)	**364**	--

Source: AECOM, 2017
Note: OH – Overhead; UG – Underground
* Denotes that the utility will both be crossed and paralleled

The utilities analysis also included those utilities that run parallel to the Study Area. Similarly, they are grouped by county, segment and utility owner in **Table 3.9-2**, and shown in **Appendix D, Mineral and Utility Resources Mapbook**.

Table 3.9-2: Summary of Parallel Utilities

Type	Number Parallels	Owner
Dallas County Segment 1		
Sanitary	4	City of Dallas
Stormwater	5	City of Dallas
Water	7	City of Dallas
Ellis County Segment 2A		
Crude Oil	2	Sunoco Pipeline LP
Ellis County Segment 2B		
Electric Transmission	3	ONCOR
Natural Gas	3	Energy Transfer Company
Ellis County Segment 3A		
Electric Transmission	1	ONCOR
Ellis County Segment 3B		
Electric Transmission	2	ONCOR
Ellis County Segment 3C		
Electric Transmission	1	ONCOR
Navarro County Segment 3A		
Electric Transmission	5	ONCOR
Navarro County Segment 3B		
Crude Oil	1	Sunoco Pipeline LP
Electric Transmission	1	ONCOR
Navarro County Segment 3C		
Crude Oil	4	Enterprise Crude Oil LLC
Crude Oil	4	Enterprise Crude Pipeline LLC
Crude Oil	1	Sunoco Pipeline LLC
Electric Transmission	7	ONCOR
Freestone County Segment 3C		
Crude Oil	6	Enterprise Crude Pipeline LLC
Crude Oil	1	Sunoco Pipeline LLC
Electric Transmission	1	ONCOR
Gasoline/Jet Fuel/Diesel	1	Magellan Pipeline Company
Freestone County Segment 4		
Crude Oil	1	Sunoco Pipeline LP
Electric Transmission	5	ONCOR
Natural Gas	2	Energy Transfer Company
Leon County Segment 4		

Table 3.9-2: Summary of Parallel Utilities		
Type	**Number Parallels**	**Owner**
Natural Gas	1	Enbridge Pipelines LP
Natural Gas	1	Trend Gathering & Treating LLC
Madison County Segment 4		
Electric Transmission	7	Centerpoint Energy
Grimes County Segment 4		
Crude Oil*	1	Enterprise Crude Pipeline LLC
Grimes County Segment 5		
Crude Oil	1	Magellan Pipeline Company LP
Electric Transmission	8	Centerpoint Energy
Waller County Segment 5		
Communication Line (UG)*	3	AT&T Texas
Harris County Segment 5		
Communication Line (UG)*	6	AT&T Texas
Natural Gas	2	Atmos
Stormwater	2	City of Houston
Wastewater	1	City of Houston
Water*	3	City of Houston
Northwest Transit Center Terminal Option		
Stormwater	3	City of Houston
Wastewater	2	City of Houston
Water	3	City of Houston
Total (All Utilities)	**122**	--

Source: AECOM, 2017; Note: OH – Overhead; UG – Underground
* Denotes that the utility will be both crossed and paralleled

3.9.4.1.1 Water Demand

According to the 2016 Texas Water Development Board Region C, G and H Water Plans, the counties in the Study Area are forecasted to have growing unmet water demand in the coming years. Shortages were determined by comparing currently connected water supplies (without considering future connection of already developed supplies) with expected demand, as shown in **Table 3.9-3**.[13, 14, 15]

Table 3.9-3: Current and Expected Water Demand and Shortages			
County	**2010/2011 Use [ac-ft/year]**	**2040 Expected Demand [ac-ft/year]**	**2040 Expected Shortage [acre-feet /year]**
Dallas	525,143	674,672	159,703
Ellis	36,349	58,626	14,495

[13] TWDB, "2016 Region C Water Plan for Texas Water Development Board, Volume 1 Main Report," December 2015.
[14] TWDB, "2016 Brazos G Regional Water Plan for Texas Water Development Board," December. 2015.
[15] TWDB, "2016 Region H Water Planning Group for Texas Water Development Board," November 2015.

Navarro	13,991	28,015	17,838
Limestone	32,473	45,404	17,533
Freestone	43,095	35,121	4,431
Leon	5,866	7,481	222
Madison	4,312	5,323	526
Grimes	20,362	41,609	19,053
Waller	29,148	33,130	97
Harris	897,891	1,419,046	272,972

Source: TPWD, 2015
Note: acre-feet is equivalent to 325,851 gallons.

As seen in the table above, potable water demand is anticipated to increase for all 10 counties in the Study Area between year 2010 and 2040. The largest anticipated shortages of potable water are expected in Dallas and Harris counties due to the forecasted population increases in these areas. Relatively minor shortages of potable water are predicted for Leon, Madison and Waller counties.

There are a number of wholesale water providers that could supply water to the stations, TMFs and MOW facilities. The major wholesale providers and their contracted supply through 2020[16, 17, 18, 19, 20] for each of the HSR facilities are listed in **Table 3.9-4**. Water supplies to the urban and suburban communities are almost entirely derived from surface water rights. Rural water supplies are derived from a variety of rivers, lakes, streams, ponds, reservoirs, springs and wells.

Table 3.9-4: Wholesale Water Providers

County	Project Facility (Segment)	Water Provider	Contracted Volume Through 2020 [acre-feet]
Dallas	Dallas Terminal and TMF (1)	Dallas Water Utilities	497,526
Ellis	Bardwell MOW (2A, 2B)	None	n/a
Freestone	Fairfield MOW (3C)	South Freestone WSC	285
Leon	Centerville MOW (3C)	Southeast WSC	180
Freestone	Wortham MOW (4)	Pleasant Grove WSC	157
Leon	Jewett MOW (4)	Concord Robbins WSC	213
Grimes	Brazos Valley Station (4)	Anderson Water Company	12.9
Grimes	Bedias MOW (5)	Wickson Creek SUD	1,710
Waller	Houston MOW (5)	G & W WSC	450
Harris	Houston Terminal and TMF (5)	City of Houston	740,678

Sources: TPWD, 2015; and South Freestone WSC, 2016
Note: acre-feet is equivalent to 325,851 gallons.
WSC – Water Supply Corporation
SUD – Special Utility District

As noted in **Table 3.9-4**, no water supply service would be located near the Bardwell MOW facility, which would be located on Segment 2A or 2B.

3.9.4.1.2 Wastewater Capacity

The HSR system, specifically stations, TMFs and MOW facilities, would produce wastewater in the counties listed in **Table 3.9-5**. The following table summarizes the capacities of the wastewater systems

[16] TWDB, "2016 Region C Water Plan for Texas Water Development Board, Volume 1 Main Report," December 2015.
[17] South Freestone WSC. Personal Communication. 6/21/2016. Permitted groundwater withdrawals.
[18] TWDB, "2016 Region H Water Planning Group for Texas Water Development Board," November 2015.
[19] TWDB, "2016 Brazos G Regional Water Plan for Texas Water Development Board," December. 2015.
[20] Bluebonnet Water Conservation District. Personal Communication. 6/21/2016. Permitted groundwater withdrawals.

in the vicinities of the stations and facilities.[21, 22, 23] Generally, on-site sewage systems (e.g., septic tanks) are used in rural and low-density locations of the Study Area; therefore, there are no wastewater treatment plants in some of the counties in the Study Area.

Table 3.9-5: Wastewater Treatment Capacity

County	Facility (Segment)	Agency	WWTP Name	Capacity
Dallas	Dallas Terminal and TMF (1)	Dallas Water Utilities	Central WWTP	150 MGD
Ellis	Bardwell MOW (2A, 2B)	None	N/A	N/A
Freestone	Fairfield MOW (3C)	None	N/A	N/A
Leon	Centerville MOW (3C)	None	N/A	N/A
Freestone	Wortham MOW (4)	None	N/A	N/A
Leon	Jewett MOW (4)	None	N/A	N/A
Brazos	Brazos Valley Station (4)	City of College Station	Carter's Creek WWTP	9.5 MGD
Brazos	Brazos Valley Station (4)	City of College Station	Lick Creek WWTP	2.0 MGD
Grimes	Bedias MOW (5)	None	N/A	N/A
Waller	Houston MOW (5)	None	N/A	N/A
Harris	Houston Terminal and TMF	City of Houston Public Works	69th Street WWTP	200 MGD

Sources: City of Dallas, 2016; City of College Station, 2016 and City of Houston, 2016
Notes: WWTP – wastewater treatment plant; mgd – million gallons per day; NA – Not Applicable

The wastewater treatment plant that would serve the Dallas Terminal Station option has a capacity of 150 million gallons per day (mgd). The Central Wastewater Treatment Plant has a permit to expand to a future capacity of 200 mgd. The most recent available data indicates that the average annual flow for 2014 was 88 mgd, or approximately 60 percent of existing plant capacity.[24]

As noted in **Table 3.9-5**, due to their location in rural areas, none of the MOW facilities would be in proximity to existing wastewater services.

The closest wastewater treatment plant to the Brazos Valley Station would be in College Station. The two WWTPs in College Station have a capacity of 11.5 mgd. From the most recent available data, the College Station system treats approximately 7 mgd, or 61 percent of the existing plant capacity.[25]

The City of Houston Public Works 69th Street Wastewater Treatment Plant would serve the Houston Terminal Station options; it has a capacity of 200 mgd. Information about average daily flows at individual wastewater treatment plants in Houston is not publically available, but the City of Houston system, whose capacity is 565 mgd, treats a daily average flow of 225 mgd, representing 40 percent of the existing plant capacity.[26]

3.9.4.2 Energy

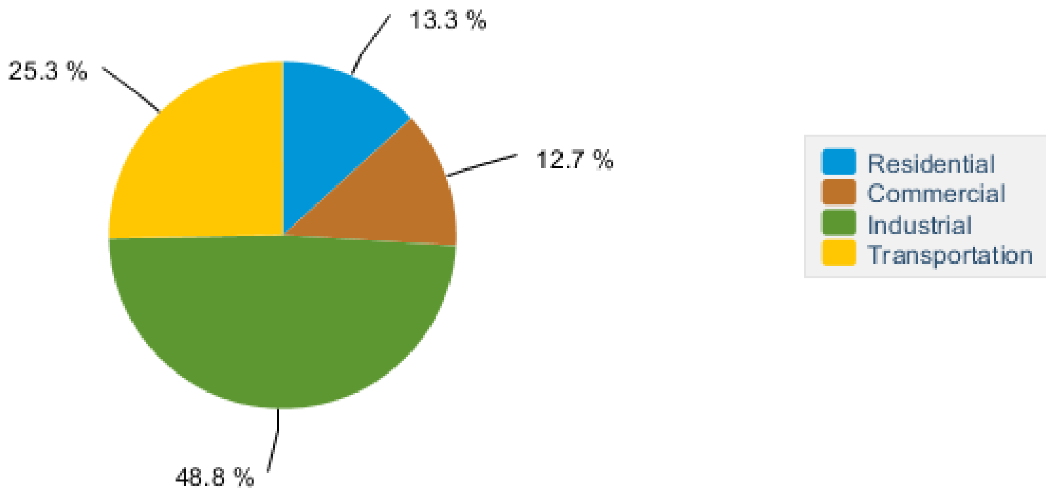
Texas leads the nation in energy production, primarily from crude oil and natural gas, but is also rapidly developing its wind and solar energy resources. Texas also leads the nation in energy consumption, accounting for more than one-eighth of the U.S. total. The state's industrial sector accounts for the

[21] City of Dallas, "City of Dallas Water Conservation Plan 2014. "https://savedallaswater.com/pdf/wcp.pdf. Website accessed March 6, 2016
[22] City of College Station Wastewater (Sewer) Services. http://www.cstx.gov/index.aspx?page=818 . Website accessed March 23, 2016.
[23] City of Houston 2016. Wastewater Facilities & Maintenance Section. 69th Street Wastewater Treatment Plant details. https://www.publicworks.houstontx.gov/pud/wwtms.html. Website accessed February 22, 2016
[24] NCTCOG 2015. North Central Texas Water Quality Management Plan Update. May.
[25] City of College Station, Wastewater (Sewer) Services, http://www.cstx.gov/index.aspx?page=818. Website accessed October 2016.
[26] City of Houston 2016. Wastewater Facilities & Maintenance Section. https://www.publicworks.houstontx.gov/pud/wwtms.html. Website accessed February 22, 2016.

largest share of energy use, due the number and size of petroleum refining and chemical manufacturing facilities. The transportation sector accounts for the second largest share of energy use, due in part because of the distances across the state and large number of registered vehicles. Because of its varied climate, heating and cooling needs are also high in Texas.[27] **Figure 3.9-1** illustrates Texas's energy use by sector in 2013.

[27] EIA 2016a. U.S. Energy Information Administration. Independent Statistics & Analysis. Texas Summary. https://www.eia.gov/state/print.cfm?sid=TX. Website accessed April 25, 2016.

Figure 3.9-1: Texas Energy Consumption by End Use in 2013



Source: EIA, 2016

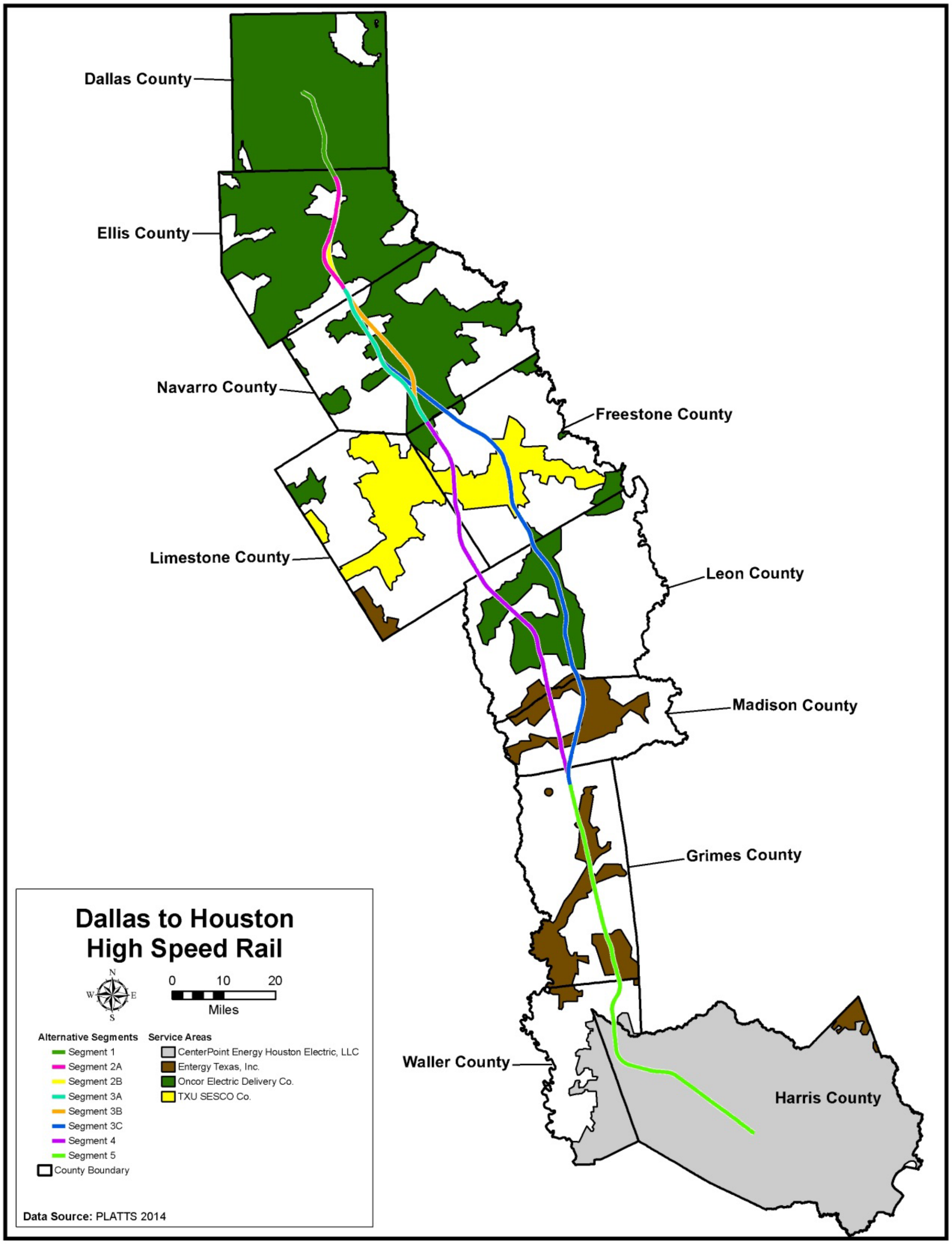
3.9.4.2.1 Electricity

Electrical Providers

As seen on **Figure 3.9-2**, the Study Area is served by four major utility service providers—Oncor Electric Delivery, TXU Sesco, Entergy Texas and CenterPoint Energy. Oncor Electric Delivery is Texas' largest distribution and transmission system, delivering power to more than 3.2 million homes and businesses and operating approximately 120,000 miles of transmission and distribution lines.[28] Oncor Electric's service territory in the study area includes Dallas, Ellis, Navarro, Freestone, Limestone, and Leon counties.

[28] Energy Future Holdings 2016. Oncor Electric Delivery overview. https://www.energyfutureholdings.com/about-us/. Website accessed June 9, 2016.

Figure 3.9-2: Major Electric Utility Providers



Source: AECOM, 2017

TXU SESCO delivers electricity across Texas to 1.7 million residential and business customers.[29] TXU SESCO's service area is comparable to Oncor Electric, but is limited to Freestone and Limestone counties in the Study Area.

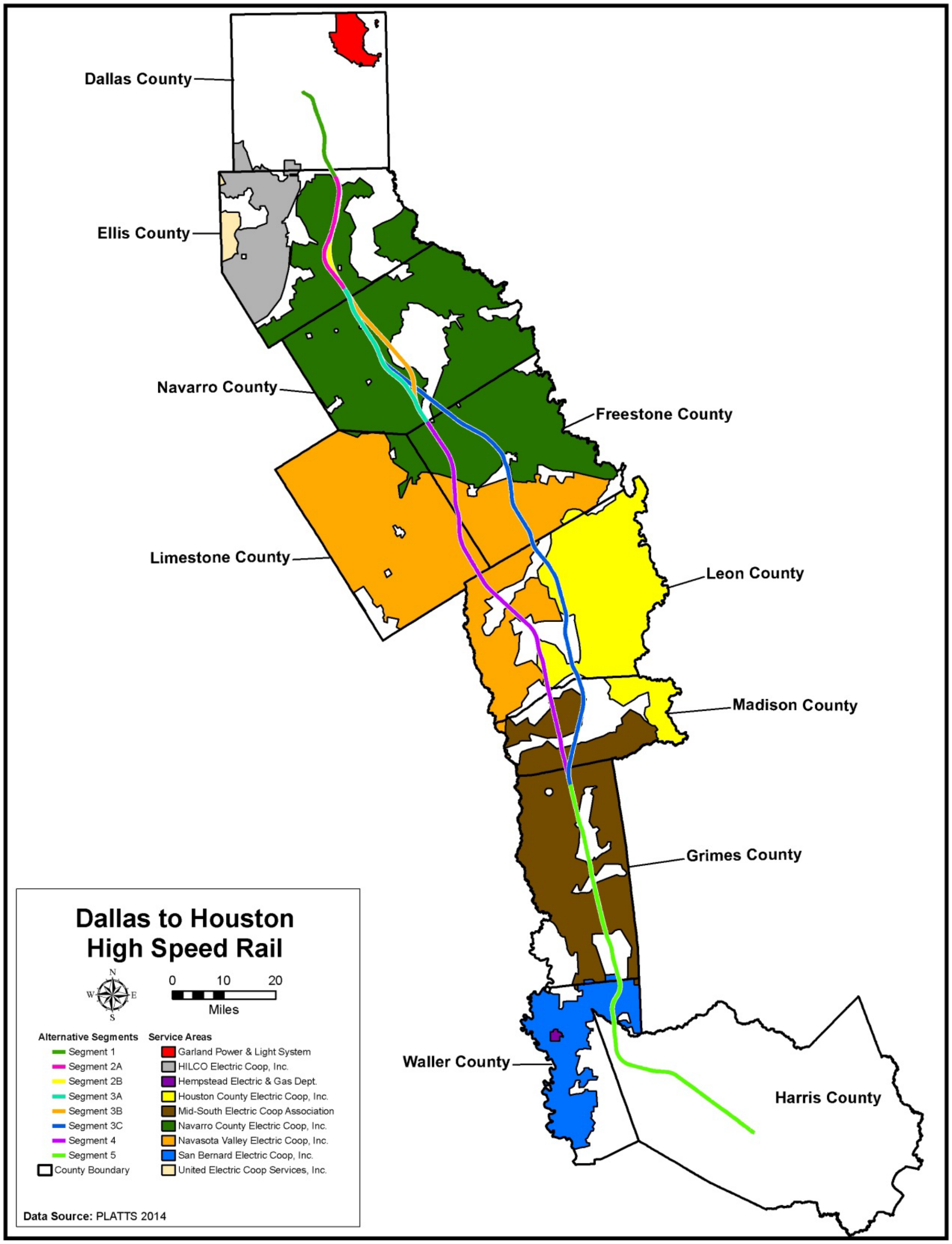
Entergy Texas delivers electricity to 434,000 customers across 27 counties and 15,320 square miles in central and eastern Texas.[30] Entergy Texas' service area is smaller than Oncor Electric, and includes Limestone, Leon, Madison, Grimes, Waller and Harris counties in the Study Area.

CenterPoint Energy's service area is much smaller than Oncor Electric. CenterPoint Energy delivers energy for 85 electric retailers in a 5,000 square-mile area serving more than 2.3 million customers in the Houston metropolitan area.[31] CenterPoint Energy's service territory in the Study Area is Harris County.

In addition to the four major utility service providers, there are nine smaller service providers across the Study Area, as seen on **Figure 3.9-3**. These include Garland Power & Light System, HILCO Electric Coop, Inc., Hempstead Electric & Gas Department, Houston County Electric Coop, Inc., Mid-South Electric Coop Association, Navarro County Electric Coop, Inc., Navasota Valley Electric Coop, Inc., San Bernard Electric Coop, Inc. and United Electric Coop Services, Inc. Many of these smaller service providers are members of the Brazos Electric Cooperative. Brazos Electric Cooperative is Texas' largest generation and transmission cooperative whose members' service territory extends across 68 counties from the Texas Panhandle to Houston. Brazos Electric is the wholesale power supplier for its 16 member-owner distribution cooperatives and one municipal system.[32]

[29] Energy Future Holdings 2016. TXU SESCO overview. https://www.energyfutureholdings.com/about-us/. Website accessed June 9, 2016.
[30] Entergy Texas 2016. Entergy overview. http://www.entergy-texas.com/about_entergy/. Website accessed June 9, 2016.
[31] CenterPoint 2016. CenterPoint Energy Overview. http://www.centerpointenergy.com/en-us/residential/services/electric-utility?sa=ho. Website accessed April 19, 2016.
[32] Brazos Electric 2016. Brazos Valley Electric Cooperative Overview. http://www.brazoselectric.com/. Website accessed April 19, 2016.

Figure 3.9-3: Smaller Electric Utility Providers



Source: AECOM, 2017

ERCOT manages about 90 percent of the state's electric load, connecting more than 43,000 miles of transmission lines and 550 generation units. ERCOT is subject to oversight by the Texas Public Utility Commission and the Texas Legislature. ERCOT's members include consumers, cooperatives, generators, power marketers, retail electric providers, major electric utilities (transmission and distribution providers), and municipal-owned electric utilities.[33]

Electrical Demand
The ERCOT 2014 *Report on Existing and Potential Electric System Constraints and Needs* analyzed existing and potential constraints in the electrical transmission system for Texas consumers. The DFW Metroplex is a major load center in Texas and experiences persistent electrical load growth. Demand in all customer classes has been steadily increasing over the last 10 years. Four electrical transmission line actions have been identified to address the growth. The Houston metropolitan area is the other major load center in Texas, serving more than 25 percent of the entire load in the ERCOT System. In recent years the Houston area has seen persistent electrical load growth but also a lack of new electrical generation development. Demand in all customer classes has been increasing since 2009, and the rate of growth for commercial and residential classes has been increasing since 2010. On the other hand, only 1,800 megawatts (MW) of new generation has been added in the Houston area over the last 10 years (2004-2013), while 3,800 MW of older generation was retired over the same time period.[34]

The ERCOT *2014 Regional Transmission Plan Report Appendix D and E* examined current net system load factors based on hourly demand and net system load factors based on 15-minute demand. For the year 2014, the annual hourly demand was 58.4 percent of capacity, while the 15-minute demand was 58.3 percent of capacity. This indicates that sufficient electrical power is generated and supplied in the ERCOT system to support the current population of Texas.

The ERCOT *2014 Regional Transmission Plan Report* addresses region-wide reliability and economic transmission needs for years 2015 through 2020. ERCOT's transmission system is divided into eight different weather zones to represent the different climate-related weather patterns observed in the ERCOT Region (see **Figure 3.9-4**). The ERCOT weather zones in the Study Area include north central, east and coast. ERCOT used two demand forecast sources for electric reliability. The first demand forecast used annual electric load data, while the second demand forecast used the ERCOT-developed 90th percentile weather zone electrical load data.[35] Both forecasts assumed that summer peak is deemed to be critical due to the high air conditioner load that exists during summer afternoons in Texas. **Table 3.9-6** shows the results of the 90th percentile weather zone electrical load data forecast, which shows steady growth in the north central, east, and coast areas from 2015 through 2020.[36]

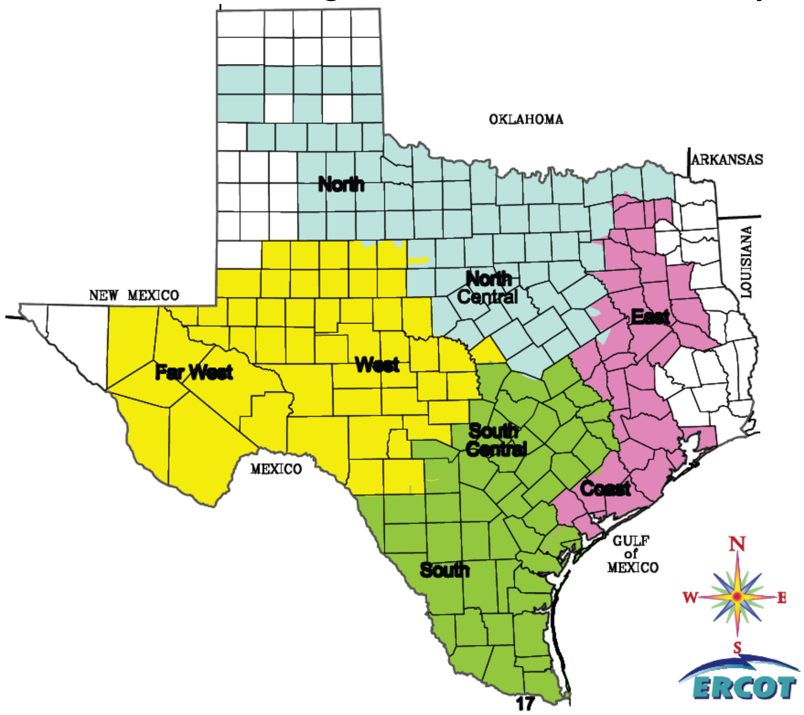
Table 3.9-6: ERCOT 90th Percentile Weather Zone Load Forecast (MW)

Year	Coast	East	Far West	North	North Central	South Central	South	West	ERCOT Non-Coincidental Peak
2015	2,3048	2,343	2,589	1,589	25,917	11,882	6,346	1,945	75,659
2017	2,3419	2,356	2,824	1,570	26,629	12,049	6,721	1,983	77,553
2019	2,3853	2,369	3,056	1,551	27,322	12,210	7,087	2,022	79,470
2020	2,4054	2,376	3,172	1,541	27,664	12,289	7,271	2,041	80,408

Source: ERCOT 2014
Note: MW – megawatts

[33] ERCOT 2016. ERCOT Overview. http://www.ercot.com/about. Website accessed April 19, 2016.
[34] ERCOT 2014. Report on Existing and Potential Electric System Constraints and Needs. December.
[35] ERCOT uses a 90th percentile or 90/10 forecast (as opposed to a 50/50 forecast based on average weather conditions) in order to achieve a transmission system that is sufficient to meet future loads 9 out of 10 years. The ERCOT 90/10 load forecast is developed using the ERCOT Long-Term Hourly Peak Demand and Energy Forecast with a 90th percentile temperature assumption.
[36] ERCOT 2014. Long-Term System Assessment for the ERCOT Region. December.

Figure 3.9-4: ERCOT 2014 Regional Transmission Plan Study Regions



Source: ERCOT 2014

The 2014 *Long-Term System Assessment for the ERCOT Region* studied the short-term need for increased transmission and generation capacity throughout Texas. It provides a long-term view of system reliability needs. Most of the short-term needs for electrical system improvements to the high voltage system noted in this analysis were located in and around the DFW Metroplex. Short-term electrical system improvements are also anticipated in the Houston metropolitan area due to high industrial growth. As seen in **Table 3.9-7,** a substantial amount of electrical capacity is forecasted to be added in Texas to accommodate anticipated growth. In contrast, a much smaller amount of equipment retirements is forecasted over the same 11-year period.[37] The net added capacity, which subtracts the retired capacity, provides a peak capacity of 20,410 MW that would provide an additional 489,840 megawatt hours (MWh) daily, or 178,791,600 MWh annually, under constant generation.

Table 3.9-7: Expected Electricity Growth

	2018	2021	2024	2027	2029
Annual Capacity Additions (MW)	1,350	5,790	4,780	5,940	3,500
Cumulative Capacity Additions (MW)	1,350	7,140	11,920	17,860	21,360
Equipment Retirements (MW)	955	2,086	2,379	2,453	950
Net Added Capacity	395	5,054	9,541	15,407	20,410

Source: ERCOT, 2014

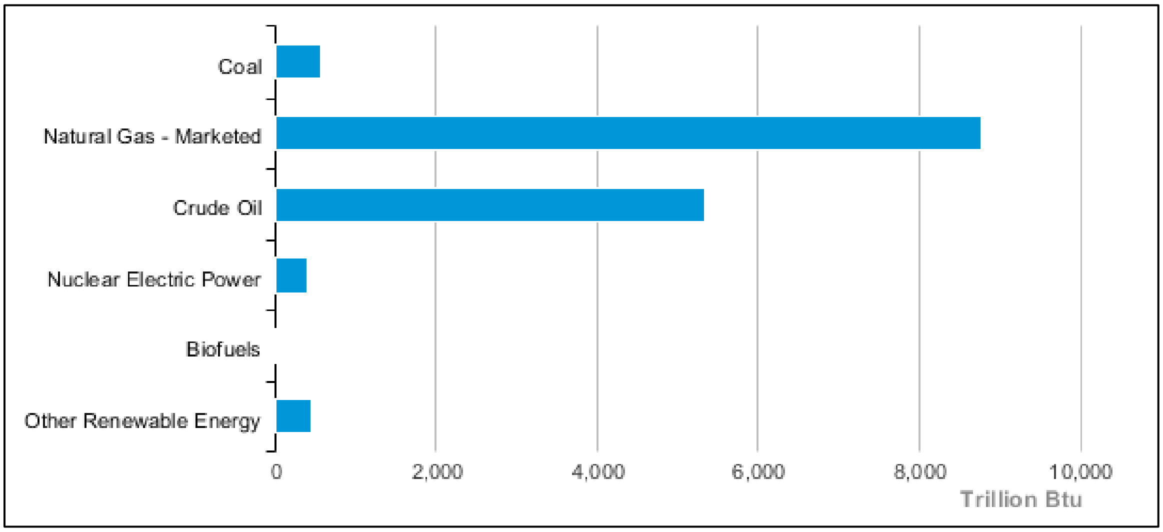
Electric Generation

Texas produces more electricity than any other state, and generates almost twice as much as the second highest-producing state. More than two-thirds of the electricity is generated by independent power

[37] ERCOT, "Long-Term System Assessment for the ERCOT Region," December 2014

producers and industrial generators. **Figure 3.9-5** illustrates Texas' electricity generation estimates by type in 2013.

Figure 3.9-5: Texas Electricity Generation Estimates in 2013



Source: EIA, 2016

3.9.4.2.2 *Fuel*

Crude Oil and Natural Gas

Texas leads the nation in crude oil reserves and production, and the state has almost one-third of all reserves in the U.S. Although crude oil reserves can be found in several geologic basins throughout Texas, including in the Study Area, the largest oil fields are found in west Texas. In 2014, crude oil production exceeded 3.1 million barrels per day. Texas also leads the nation in crude oil refining capacity, with 27 refineries that can process more than 5.1 million barrels of oil per day. Additionally, Texas leads the nation in total oil consumption and in 2014 was fifth in per capita consumption.[38]

Similar to crude oil, Texas leads the nation in natural gas production, and the state has more than one-fourth of all reserves in the U.S. Similar to crude oil, natural gas can be found in several geologic basins throughout Texas, including in the Study Area, but the largest natural gas fields are found in north and south Texas. In 2014, natural gas production reached 7.95 trillion cubic feet. As discussed in **Section 3.9.4** above, there are numerous natural gas pipelines in the Study Area. Texas exports natural gas to markets across the U.S. and Mexico via intrastate and interstate pipelines. Additionally, Texas leads the nation in natural gas consumption, accounting for about one-seventh of total usage in the U.S. The amount of natural gas used for electrical generation in Texas is greater than in any other state and is more than one-sixth of the U.S. total.[39]

Of the 10 counties in the Study Area, only Dallas, Ellis and Waller counties do not have oil and gas activities within or adjacent to the Study Area. Much the rural property between the cities of Dallas and Houston is leased to oil and gas companies for exploration and extraction. Numerous oil and gas wells,

[38] EIA 2016a. U.S. Energy Information Administration. Independent Statistics & Analysis. Texas Summary. https://www.eia.gov/state/print.cfm?sid=TX. Website accessed April 25, 2016.
[39] EIA 2016a. U.S. Energy Information Administration. Independent Statistics & Analysis. Texas Summary. https://www.eia.gov/state/print.cfm?sid=TX. Website accessed April 25, 2016.

and their associated well pads and access roads, were identified within and adjacent to the Study Area, as listed in **Table 3.9-8**. As described in **Section 3.9.3, Methodology**, a 50-foot buffer was added to account for potential mapping errors in the Texas Railroad Commission data.

Table 3.9-8: Oil and Gas Wells within the Study Area

County/Segment	# Vertical Wells in LOD	# Vertical Wells in 50 foot Buffer	# Horizontal Wells in LOD	Total Horizontal Length in LOD
Navarro County				
Segment 3A	2	-	2	7.3
Segment 3B	-	1	-	0
Segment 3C	5	-	-	0
Freestone County				
Segment 3A	-	-	-	-
Segment 3B	-	-	-	-
Segment 3C	3	3	1	675.9
Segment 4	-	-	-	-
Limestone County				
Segment 4	7	4	2	692.5
Leon County				
Segment 3C	2	1	-	851.9
Segment 4	8	1	3	317.6
Madison County				
Segment 3C	1	2	1	502.6
Segment 4	3	1	3	69.3
Grimes County				
Segment 3C	-	-	-	68.2
Segment 4	-	-	-	44.0
Segment 5	3	2	4	1214.8
Harris County				
Segment 5	3	-	1	46.3
Segment 5 Northwest Transit Center	1	-	-	-
Total	**38**	**15**	**22**	**4,490.4**

Source: AECOM, 2017;
Note: No oil/gas wells are located in Dallas, Ellis or Waller counties

Fuel Consumption

The *State Transportation Statistics 2015*, which is published by the USDOT Bureau of Transportation Statistics, presents a statistical profile of transportation across a wide variety of characteristics. A summary of each state's transportation infrastructure, safety, freight movement, passenger travel, VMT, economy and finance, as well as energy and the environment, is presented. Fuel consumption rates for vehicle and airline passengers in Texas are shown in **Table 3.9-9**.[40]

Table 3.9-9: Transportation Energy Consumption by Source for 2013

	Distillate Fuel (diesel)	Jet Fuel	Motor Gasoline*	Residential Fuel	Other**	Total Petroleum	Per Capita
Texas	749.2	386.7	1,498.4	118.3	15.4	2,767.9	104.4
U.S.	5,909.6	2,968.6	16,034.9	581.2	197.3	25,691.4	81.2

Source: U.S.DOT, 2015
Notes: All data is in trillion British thermal units, except for per capita data which is in million British thermal units.

[40] U.S.DOT, Bureau of Transportation Statistics, "State Transportation Statistics 2015," 2015

Table 3.9-9: Transportation Energy Consumption by Source for 2013							
	Distillate Fuel (diesel)	Jet Fuel	Motor Gasoline*	Residential Fuel	Other**	Total Petroleum	Per Capita

* Includes ethanol blended into motor gasoline.
** "Other" category is the sum of aviation gasoline, liquefied petroleum gas, and lubricants.

Automobile and light truck travel is the predominant mode of passenger transportation in the Study Area. Additionally, the Study Area is a major corridor for the movement of goods and services by truck and freight rail between the cities of Dallas and Houston. Generally, the demand for fuel consumption for transportation mirrors the growth of the state's population and economic output. Therefore, as Texas has grown, so has its use of fuel.

3.9.5 Environmental Consequences

3.9.5.1 No Build Alternative

Under the No Build Alternative, the HSR system would not be built. There would be no direct impacts to existing utilities because no construction activities would take place. There would be no additional service demand placed on these utilities. However, economic and population growth would continue, resulting in additional demand for fuel. Fuel consumption from vehicular and aviation travel between Dallas and Houston would increase in response to anticipated population growth and, therefore, no fuel savings would occur.

3.9.5.2 Build Alternatives

3.9.5.2.1 Utilities

Electric Utility Modifications

Table 3.9-10 illustrates three types of electrical utility modifications that would be required, including new connections to HSR facilities and vertical adjustments to existing pole lines. TCRR identified potential locations for these modifications for the Build Alternatives (see **Appendix F, TCRR Conceptual Engineering Design Report**). However, the utility provider would have ultimate decision-making authority over the size and location of the improvement. For example, the provider could choose to combine the needs of the HSR system with other planned or authorized projects. Due to the unknown location of these modifications, an environmental assessment of these areas is not included at the project-level. These potential impacts are discussed at the cumulative-level in **Chapter 4.0, Indirect and Cumulative Impacts**.

TCRR would be responsible for obtaining the necessary authorization from each provider to provide service to the HSR system. This authorization process would also include the environmental clearance of the modified area, if not already assessed in this EIS. TCRR would communicate its intent to electrical utility providers regarding the potential electrical transmission line realignments identified in the table above, conduct coordination to identify opportunities to avoid conflicts and agreements would be completed before construction of the Build Alternatives could begin. The utility providers would be responsible for undertaking any potential relocations, pole adjustments and/or new connections. The effects of any new electrical utility connections cannot be determined at this time due the speculative nature of their location and length. The location of these modifications would be determined by the utility provider. The utility provider may choose to include these modifications into any existing plans to modify their system infrastructure. As the owner of the utility, the provider would manage and lead the environmental process associated with the modifications to provide the connections to TCRR's infrastructure. This process includes a routing analysis that requires environmental impact assessment, as well as a public involvement process, and is coordinated through the Texas Public Utility Commission. These potential actions by the utility providers are discussed further in **Chapter 4.0, Indirect and Cumulative Impacts**.

Table 3.9-10 shows the number and type of the anticipated electrical transmission line realignments. The nine electric transmission lines that are noted in the No Impact column of the table would be parallel to the Build Alternatives, but would not require realignment or modifications.

Table 3.9-10: Electric Transmission Line Impacts

County/Segment	Pole Realignment	No Impact	TPSS Connections
Dallas County			
Segment 1	15	--	1
Ellis County			
Segment 2A	8	--	1
Segment 2B	13	--	1
Segment 3A	1	--	-
Segment 3B	2	--	-
Navarro County			
Segment 3A	10	1	2
Segment 3B	11	--	1
Segment 3C	11	2	2
Freestone County			
Segment 3A	--	--	-
Segment 3B	--	--	-
Segment 3C	5		2
Segment 4	6	2	1
Leon County			
Segment 3C	2	--	1
Segment 4	9	--	2
Madison County			
Segment 3C	1	--	1
Segment 4	7	2	-
Grimes County			
Segment 3C	1	--	-
Segment 5	13	2	2
Waller County			
Segment 5	3	--	-
Harris County			
Segment 5	16	--	-
Harris County -Segment 5: Industrial Site Terminal Option	--	--	-
Harris County- Segment 5: Northwest Mall Terminal Option	--	--	--
Harris County- Segment 5: Northwest Transit Center Terminal Option	2	--	-
Total	**136**	**9**	**17**

Source: AECOM, 2017

Build Alternatives C and F would require ten new electrical connections required at the TPSSs, and Build Alternatives B and E would require the least amount of new connections, with eight each. Pole adjustments, or raising the transmission line, could be required under all Build Alternative to accommodate vertical clearances for the HSR ROW. Estimates of pole adjustments range from 75 under Build Alternative C to 95 under Build Alternative E.

Existing Utility Crossings

While overhead utilities lines are visible and can be verified prior to construction activities, below ground utility exploration would need to be performed by the TCRR and/or its construction contractor prior to the start of construction to determine the exact locations and depths. Additionally, abandoned or unknown utility lines could be discovered during construction activities. For the purposes of this analysis, all utility conflicts would require utility realignment or protective action. Protective actions include activities during construction (e.g., shoring) and/or operations (e.g., encasement).

Where the Build Alternatives would cross underground utilities, realignment may be necessary to provide adequate protection and/or depth. Where the Build Alternatives would cross overhead utilities, realignment or reconstruction would be expected to provide the required vertical clearance over the HSR system to accommodate utility infrastructure. Utilities within the Study Area would be either realigned outside the restricted access areas of the HSR ROW or modified (e.g., encased in a pipe sturdy enough to withstand the weight of the HSR system and allow for maintenance access) to avoid conflict.

Because of utility realignments and protective actions, construction of the Build Alternatives would result in scheduled and/or accidental interruptions of utility services. Final design and phasing of construction activities would minimize interruptions.

Realignment of a utility may also necessitate additional land or easement acquisition, temporary facilities during realignment and reimbursement or penalties for disruption of service. The final utility crossing decisions would be determined on a case-by-case basis between TCRR and the utility provider during final design. Utility realignment and/or protection methods, for construction or post-construction purposes, typically would not negatively impact the effectiveness of the utility infrastructure. Therefore, construction conflicts with utility crossings would be not significant.

Tables 3.9-11 through **3.9-13** summarize the potential utility crossings by type (e.g., water, wastewater and communication underground) and proposed rail configuration (e.g., below grade, on embankment or viaduct), as well as how they would be impacted by the Build Alternatives (e.g., relocated, protected or not impacted). Underground utilities, such as water/wastewater infrastructure, could conflict with construction of the Build Alternatives, particularly where the track would be below grade or is built directly over the utility. Embankment and viaduct construction may avoid some conflicts with underground utilities because piers could be spaced around the underground utility. Overhead utilities could conflict where the Build Alternatives would be on viaduct and there is not sufficient vertical clearance for the HSR system infrastructure beneath the overhead utility.

Table 3.9-11: Impacts to Existing Water Utilities

Type	Relocate	Protect	No Impact
Dallas County – Segment 1			
Water	--	--	9
Stormwater	--	--	19
Ellis County – Segment 2A			

Water	--	2	--
Ellis County – Segment 2B			
Water	--	2	--
Harris County – Segment 5			
Water	3	6	6
Stormwater	--	2	2
Harris County – Segment 5: Northwest Transit Center Terminal Option			
Water	--	4	1
Stormwater		4	1
Total	**3**	**20**	**38**

Source: AECOM, 2017

Table 3.9-12: Impacts to Wastewater Utilities

Type	Relocate	Protect	No Impact
Dallas County – Segment 1			
Sanitary	1	1	18
Harris County – Segment 5			
Sanitary	--	4	--
Wastewater	--	1	--
Harris County- Segment 5: Northwest Transit Center Terminal Option			
Wastewater	--	2	--
Total	**1**	**8**	**18**

Source: AECOM, 2017

Table 3.9-13: Impacts to Communication Lines

Type	Relocate	Protect	No Impact
Dallas County – Segment 1			
Communication	--	1	2
Ellis County – Segment 2A			
Communication	--	--	3
Ellis County- Segment 2B			
Communication	--	--	3
Navarro County – Segment 3A			
Communication	1	--	--
Navarro County- Segment 3C			
Communication	1	--	--
Freestone County – Segment 4			
Communication	--	--	1
Leon County – Segment 4			
Communication	--	--	8
Waller County – Segment 5			
Communication	1	2	10
Harris County –Segment 5			
Communication	35	1	14
Harris County - Segment 5: Industrial Site Terminal Option			

Communication	1	--	--
Harris County - Segment 5- Northwest Mall Terminal Option			
Communication	3	--	--
Harris County - Segment 5- Northwest Transit Center Terminal Option			
Communication	13	--	--
Total	**55**	**4**	**41**

Source: AECOM, 2017

As seen in **Tables 3.9-11** and **3.9-12**, potential impacts to water and wastewater utilities would primarily occur in Dallas and Harris counties. As seen in **Table 3.9-13**, potential impacts to communication lines would primarily occur in Harris County. The majority of the impacts to water, wastewater and communication lines would be in the urban counties like Dallas and Harris, which include common segments of all the Build Alternatives.

Water Demand

Construction activities would involve the use of water to prepare concrete, increase the water content of soil for dust control and re-seed temporarily disturbed areas at the completion of construction. It is anticipated that non-potable water would be used for the construction activities. Potable and non-potable water for construction would likely be supplied from existing surface or groundwater supply systems in the Study Area, and would be trucked throughout the Study Area, as needed. Since the Build Alternatives would be essentially the same length, no difference in construction-period water demand would be anticipated between the Build Alternatives. Construction-period water demand would not be anticipated to require construction or expansion of a water treatment facility, or expanded water entitlements. Therefore, construction-period water demand would not be significant.

Operation of the Build Alternatives would primarily use water at the stations, TMFs and MOW facilities. Trains would be equipped with restrooms for passenger use that would provide a small amount of potable water from a closed system. This water would be collected at the MOW facilities. TCRR provided estimates of daily and yearly water demand for the stations, TMFs and MOW facilities, as shown in **Table 3.9-14**. The total daily water demand for the Build Alternatives would be approximately 275,000 gallons/day or 100,595,460 gallons/year. The contracted water supply volume of the relevant providers listed in **Table 3.9-4** could meet the anticipated operational demand.

Table 3.9-14 Projected Build Alternatives Water Demand

Facility	Demand (gallons per day)	Demand (acre-feet per day)	Demand (gallons per year)	Demand (acre-feet per year)
Dallas Terminal	90,900	0.28	33,178,500	101.9
Brazos Valley Station	29,654	0.091	10,823,710	33.2
Houston Terminal	93,060	0.29	33,966,900	104.3
TMFs (two)	61,440	0.18	22,425,600	68.8
MOW Facilities (seven)	550	0.002	200,750	0.6
Total	**275,604**	**0.84**	**100,595,460**	**307.7**

Source: TCRR, 2016
Note: acre-feet is equivalent to 325,851 gallons.

Station water demand would be associated with restrooms, maintenance/cleaning, restaurant/food service and car rental/car wash services. At the MOW facilities, water demand would be associated with train washing, associated maintenance activities, train water supply and routine employee usage for consumption and restrooms. As shown in **Table 3.9-14**, very little water would be required at the MOWs (no more than 550 gpd). Due to the distance of the MOWs to the water supply providers in the rural areas, it would be cost prohibitive to construct tie-ins to these providers. Drilling local water wells to meet water needs would be more cost effective in these more rural locations. The Prairielands Groundwater Conservation District is the regulating entity for groundwater wells in Ellis County.

The Dallas Terminal Station option, TMF and MOW facility would be located in the City of Dallas and would generate an estimated water demand of 136.8 acre-feet per year. Water for these facilities would be provided by Dallas Water Utilities. The 136.8 acre-feet per year would be well within the service capabilities of the Dallas Water Utilities, and represents less than 0.03 percent of the Dallas Water Utilities contracted volume of 497,526 acre-feet per year. TCRR would coordinate with Dallas Water Utilities to complete a "Development Impact Report"[41] prior to construction to more accurately determine the needs of the Dallas area facilities.

The Brazos Valley Station would generate an estimated water demand of 33.2 acre-feet per year. This station lies in the certificated service area of Anderson Water Company, which has a permitted capacity of 12.9 acre-feet per year. The demand estimated for the Brazos Valley Station exceeds the annual water usage of the Anderson Water Company. Capacity expansion would be required to accommodate the demand of the Build Alternatives. TCRR would coordinate with the Anderson Water Company to complete a development review prior to construction to more accurately determine the new infrastructure needs to support Additionally, the Anderson Water Company would require a permit amendment with the Bluebonnet Groundwater Conservation District for additional contracted water rights.

In lieu of capacity expansion at Anderson Water Company, the service areas of the Wickson Creek SUD is located less than one-half mile to the north, south or west of the Brazos Valley Station site. A six-inch water line currently exists along County Road 226. The Wickson Creek SUD has 1,710 acre-feet per year under contract through 2020.[42] The estimated demand for water at the Brazos Valley Station would represent approximately 1.9 percent of contracted capacity of the Wickson Creek SUD. TCRR would need to tie-in to the existing six-inch water line in order to access the Wickson Creek SUD.

The Houston Terminal Station options and Houston TMF would generate an estimated water demand of 138.7 acre-feet per year. Water for these facilities would be provided by the City of Houston. The 138.7 acre-feet per year would be within the service capabilities of the City of Houston, and would represent less than 0.2 percent of the city's contracted volume of 740,678 acre-feet per year. TCRR would coordinate with the City of Houston to complete a development review prior to construction to more accurately determine the needs of the Houston facilities.

Operations water demand would not be anticipated to exceed the capacity of the City of Dallas Utilities or City of Houston; however, the water demand for the Brazos Valley Station would require new infrastructure from either Anderson Water Company or Wickson Creek SUD. Water for operation at the MOWs would come from local water wells. Therefore, the impact to water demand during operations would not be significant.

[41] City of Dallas, "Development Design Procedure and Policy Manual," October 2015.
[42] HDR, Inc. and Freese and Nichols, Inc. 2015. 2016 Brazos G Regional Water Plan for Texas Water Development Board, Volume 1, Table 3.1-3. December.

Wastewater Capacity

Since the Build Alternatives would be essentially the same length, no difference in the quantity of construction-period wastewater would be anticipated. Wastewater generated during the construction-period that would not be connected to an existing wastewater treatment system would be trucked to a treatment plant for proper disposal. Wastewater generated during the construction-period that would be connected to an existing wastewater treatment system would be treated by existing plants in the Study Area.

Operation of the Build Alternatives would generate wastewater at the stations, TMFs and MOW facilities. Trains would be equipped with restrooms for passenger use that would collect wastewater in a closed system. This wastewater would be collected at the MOW facilities or TMFs.

Station wastewater would be generated by restrooms, maintenance/cleaning, restaurant/food service and car rental/car wash services. The Dallas Terminal Station option, TMF and MOW facility would be located within the City of Dallas and would generate an estimated wastewater demand of 122,170 gallons per day, or 0.12 mgd. Wastewater from the Dallas Terminal Station option would be directed to the Central Wastewater Treatment Plant, operated by the City of Dallas, which currently has a capacity of 150 mgd. The wastewater generated by the Build Alternatives would be well within the Central Wastewater Treatment Plant's capacity, representing 0.08 percent of its capacity.

The Brazos Valley Station would generate an estimated wastewater demand of 29,654 gallons per day, or 0.03 mgd. Wastewater from the Brazos Valley Station could be directed to Carter's Creek Wastewater Treatment Plant, operated by the City of College Station, which has a capacity of 9.5 MGD. However, Carter's Creek Wastewater Treatment Plan is almost 20 miles east of the station and would require an extension of service. Therefore, TCRR would construct an on-site water treatment system. This facility would be classified as a Large Capacity On-Site Sewage System, and be regulated by the TCEQ as a Class V Injection Well.[43] Prior to construction, TCRR would be required to submit an application and the final design of the Class V injection well to the TCEQ Underground Injection Control Program for approval.

The Houston Terminal Station options and TMF would generate an estimated wastewater demand of 124,330 gallons per day, or 0.12 mgd. Wastewater from the Houston Terminal Station options would be directed to the 69th Street Wastewater Treatment Plant, operated by the City of Houston, which has a capacity of 200 mgd. The wastewater generated by the Build Alternatives would be well within the 69th Street Wastewater Treatment Plant's capacity, representing 0.06 percent of its capacity.

At the MOW facilities, wastewater demand would be generated by train washing, maintenance activities and routine employee usage for consumption and restrooms. The six additional MOW facility options (excluding the Dallas MOW discussed above) would each generate an estimated 550 gallons of wastewater per day. All of the proposed MOW locations would be located outside established wastewater service areas. The Bardwell MOW Facility would be located approximately 6 miles northeast of the wastewater service area of the Avalon Water and Sewer Service Corporation. The Fairfield MOW Facility would be located approximately 1.25 miles south of the wastewater service area of the City of Fairfield. The Centerville MOW Facility would be located approximately 18 miles southeast of the wastewater service area of the City of Buffalo. The Wortham MOW Facility would be located approximately 9 miles northeast of the wastewater service area of the City of Mexia. The Jewett MOW Facility would be located approximately 13 miles southwest of the wastewater service area of the City of

[43] Texas Administrative Code, Title 30 Environmental Quality, Chapter 331 Underground Injection Control.

Buffalo. The Bedias MOW Facility would be located approximately 15 miles southwest of the wastewater service area of the City of Madisonville. The Houston MOW Facility in Waller County would be located approximately 7 miles north of the wastewater service area of the City of Waller.

It would be cost prohibitive to extend service to these facilities. Therefore, TCRR would construct and operate on-site treatment (septic) as part of the Build Alternatives. TCEQ has granted authority to Texas counties to manage regulations regarding permits and enforcement of on-site sewage facilities.[44] Prior to the construction of an on-site septic system for each of the MOWs, TCRR would file on-site sewage facilities applications, which once approved, would be given to a licensed sceptic installer. An extension of service would result in a significant impact, requiring additional construction and infrastructure.

Wastewater generated during operation would be treated at existing Wastewater Treatment Plants where accessible, and at on-site treatment facilities constructed as part of the Build Alternatives. Operations period wastewater demand would not exceed the capacity of the City of Dallas or the City of Houston; however, on-site wastewater services would need to be constructed to serve the Brazos Valley Station and the MOWs. These on-site facilities would be constructed in accordance with applicable state and local regulations. Therefore, operations period wastewater demand would not be a significant impact.

3.9.5.2.2 Energy

Electricity

Electricity demand during construction of the Build Alternatives would be limited to power requirements (primarily lighting and power tools) at laydown areas and facilities construction sites. Construction power usage would not require significant additional capacity, or result in a significant peak electric demand or base-period electric demand. Given the linear nature of the Build Alternatives, construction energy (electricity) needs would be spread throughout the Study Area with concentrations in the cities of Dallas and Houston near the stations and TMFs. As discussed in **Section 3.9.4.2**, the 2014 annual hourly electric demand on the ERCOT system was 58.4 percent of capacity and the 15-minute electric demand was 58.3 percent of capacity, which indicates there would be sufficient capacity to cover the construction energy (electricity) needs of the Build Alternatives. Therefore, the construction impact would be not significant.

Operational energy consumption would include the electricity needed to power the HSR trains, stations, TMFs and MOW facilities. The Build Alternatives would obtain electricity from the major electrical service providers in the Study Area. Due to the size and expected electrical demand of the Build Alternatives, it is likely that statewide electricity reserves and electrical transmission capacity would be affected. The Build Alternatives would obtain electricity from the statewide grid, managed by ERCOT, resulting in an overall effect on statewide energy use. Power consumption for the operation of the HSR was estimated using the methods described in **Section 3.9.3.2**. As shown in **Table 3.9-15,** the total energy (electrical) demand of the Build Alternatives is estimated to be 467,143 MWh per year, or 1,593,959 Million BTUs (MMBTUs) per year, including power losses from transmission and transformers.

[44] Texas Administrative Code, Title 30 Environmental Quality, Chapter 285 On-site Sewage Facilities.

Table 3.9-15 Projected Build Alternatives Power Demand

Facility	Power Consumption (MWh per day)	Power Consumption (MMBTU per day)	Power Consumption (MWh per year)	Power Consumption (MMBTU per year)
HSR Trains (80 per day)	680.0	2,320	248,200	846,894
Dallas Terminal Station	101.9	348	37,194	126,909
Brazos Valley Station	29.5	101	10,768	36,740
Houston Terminal Station	107.5	367	39,238	133,884
TMFs (two) and accompanying MOWs	129.3	441	47,195	161,034
MOW Facilities (five)	34.4	117	12,556	42,843
Switching and Substations	109.8	375	40,077	136,748
Signaling and Communication Houses (twenty)	26.5	90	9,673	33,004
Total	1,218.9	4,159	444,899	1,518,057
Power Losses at 5%	60.9	208	22,245	75,903
Total plus Losses	**1,279.8**	**4,367**	**467,143**	**1,593,959**

Source: AECOM, 2016.
Note: MWh – megawatt hours
MMBTU – Millions of British Thermal Units

The TPSS would provide the electric power to the trains and would be composed of the following components: 138kV electrical transmission line connections, TPSS substations, sectioning posts, sub-sectioning posts, auto transformer posts and a 25kV 60 cycle overhead catenary system. Therefore, the energy (electricity) required for propulsion of the HSR trains between Dallas and Houston is estimated at 248,200 MWh per year, or 846,894 MMBTUs per year.

Stations would require energy (electricity) to power the public areas (e.g., restrooms, concourses, restaurants, parking), ticketed passenger spaces (e.g., restaurants, restrooms, secured concourses), facilities to service the train (e.g., custodial equipment, loading dock and yard, kitchen areas, employee service corridors), security spaces (e.g., control rooms, security offices) and staff welfare areas (e.g., employee parking, lockers, offices, break rooms). The Dallas Terminal Station and the Houston Terminal Station are estimated to use 37,194 MWh per year and 39,238 MWh per year, respectively, or collectively, 126,909 MWh per year, or 260,793 MMBTUs per year. The Brazos Valley Station would be smaller and estimated to use 10,768 MWh per year or 36,740 MMBTUs per year.

TMF and MOW facilities would require energy (electricity) to power the train storage areas, inspection and overhaul shops, train wash areas, stabling tracks, administrative offices and staff welfare areas (e.g., employee parking, lockers, offices, break rooms). Combined, the TMF facilities are estimated to use 47,195 MWh per year, or 161,034 MMBTUs per year. Combined, the seven MOW facilities are estimated to use 12,556 MWh per year, or 42,843 MMBTUs per year. Switching and substations, which regulate and switch power on and off to trains traveling long the high speed track, are estimated to use 40,077 MWh per year or 136,748 MMBTUs per year. Signaling houses that relay operational monitoring data from power, control and security systems, would consist of approximately 20 main, intermediate, and sub signal houses distributed along the length of each Build Alternative, and would require approximately 9,673 MWh per year or 33,004 MMBTUs.

As Texas grows, so would its demand for energy (electricity). As shown in **Table 3.9-6**, the electrical load in the state is projected by ERCOT to increase between years 2015 and 2020. To accommodate the future electricity demand, ERCOT is expecting additions to the system to be developed through the year 2029, as shown in **Table 3.9-7**. The net added capacity would provide an additional 489,840 MWh of daily generation. The daily HSR power consumption of 1,279.80 MWh, as shown in **Table 3.9-14,** would represent 0.26 percent of this net added capacity. By contrast, ERCOT has established a reserve margin target of 13.75 percent of peak demand, which means that net added capacity would be targeted to provide 13.75 percent more MWhs than forecasted peak demand.[45] Even if it were not accounted for in planned or forecasted demand, the daily demand of the Build Alternatives would represent significantly less than the reserve margin considering its percentage of the planned added capacity. Current near-term reserve margin forecasts for 2017 to 2026 using more certain ("firm") load forecasts range from 15.9 percent to 25.4 percent of reserve margin.[46]

However, as part of the pre-construction design, planning and permitting process, TCRR would coordinate with and plan the HSR demand with power service providers, and this demand would have to be known and planned for within ERCOT. TCRR would coordinate with CenterPoint, Entergy, Mid-South Synergy, Oncor and San Bernard to complete development reviews prior to construction to more accurately determine the electricity needs of the Build Alternatives and available power supplies. Therefore, the Build Alternatives would not be a significant impact on energy (electricity) supply.

3.9.5.2.3 Fuel

Crude Oil and Natural Gas

Table 3.9-16 summarizes oil and gas utility crossings and how they would be impacted by the Build Alternatives (i.e., relocated, protected or not impacted). Oil and gas utilities within the Study Area would be either relocated outside the restricted access areas of the HSR ROW, or modified (e.g., encased in a pipe sturdy enough to withstand the weight of the HSR system and allow for maintenance access), to avoid conflict. Because of utility relocations and protective actions, construction of the Build Alternatives would result in scheduled and/or accidental interruptions of oil and gas utility services. Final design and phasing of construction activities would minimize interruptions.

Relocation of a utility may also necessitate additional land or easement acquisition, temporary facilities during relocation, and reimbursement or penalties for disruption of service. The final oil and gas utility crossing decisions would be determined on a case-by-case basis between TCRR and the utility provider during final design. Oil and gas utility relocation and/or protection methods, for construction or post-construction purposes, typically would not negatively impact the effectiveness of the utility infrastructure. Therefore, construction conflicts with oil and gas utility crossings would be not significant.

Table 3.9-16: Impacts to Oil and Gas Utilities

Type	Relocate	Protect	No Impact
Dallas County – Segment 1			
Natural Gas	--	2	--
Ellis County – Segment 2A			
Crude Oil	--	3	--
Natural Gas	--	7	--
Ellis County – Segment 2B			
Crude Oil	--	1	--

[45] ERCOT. Resource Adequacy. 2016. http://www.ercot.com/gridinfo/resource. Accessed 9/7/2016.
[46] ERCOT. Summer Summary. *Report on the Capacity, Demand and Reserves (CDR) in the ERCOT Region, 2017-2026*. Capacity, Demand and Reserves Report. May 3, 2016. http://www.ercot.com/content/wcm/lists/96607/CapacityDemandandReserveReport_May2016.xlsx. Accessed 9/7/2016.

Table 3.9-16: Impacts to Oil and Gas Utilities			
Type	**Relocate**	**Protect**	**No Impact**
Natural Gas	--	10	--
Navarro County – Segment 3A			
Crude Oil	--	1	--
Empty	--	1	--
Gasoline/Jet Fuel/Diesel	--	1	--
Natural Gas	--	1	--
Natural Gas Liquids	--	2	--
Navarro County – Segment 3B			
Crude Oil	--	2	--
Empty	--	1	--
Gasoline/Jet Fuel/Diesel	--	1	--
Natural Gas	--	1	--
Natural Gas Liquids	--	2	--
Navarro County – Segment 3C			
Crude Oil	--	8	3
Empty	--	1	--
Gasoline/Jet Fuel/Diesel	--	1	--
Natural Gas	--	1	--
Freestone County – Segment 3C			
Crude Oil	3	10	1
Gasoline/Jet Fuel/Diesel	--	1	1
Liquefied Petroleum Gas	--	1	--
Natural Gas	--	13	--
Natural Gas Liquids	--	1	--
Freestone County – Segment 4			
Crude Oil	--	4	--
Liquefied Petroleum Gas	--	1	--
Natural Gas	--	6	--
Natural Gas Liquids	--	1	--
Limestone County – Segment 4			
Natural Gas	--	3	--
Leon County – Segment 3C			
Gasoline/Jet Fuel/Diesel	--	1	--
Natural Gas	--	2	--
Natural Gas Liquids	--	1	--
Leon County – Segment 4			
Natural Gas	--	8	--
Madison County – Segment 3C			
Natural Gas	--	1	--
Madison County – Segment 4			
Natural Gas	--	1	--
Grimes County – Segment 5			
Crude Oil	--	1	1
Natural Gas	--	6	--
Refined Products	--	1	--
Y Grade Products	--	1	--
Y Grade NGL	--	1	--
Waller County – Segment 5			
Crude Oil	--	1	--
Natural Gas	--	1	--
Harris County –Segment 5			

Table 3.9-16: Impacts to Oil and Gas Utilities			
Type	**Relocate**	**Protect**	**No Impact**
Crude Oil	--	3	--
Natural Gas	2	16	--
Natural Gas Liquids	--	1	--
Total	**5**	**134**	**6**

Source: AECOM, 2017

Construction of the Build Alternatives would affect oil and gas wells, their associated access roads and drilling well pads located within the LOD. Conflicts with oil and gas wells would result in the abandonment of the wells. Well abandonment would include removal of all oil and gas equipment, well plugging to prevent fluid migration between subsurface zones (to protect aquifers and minerals), placement of a permanent abandonment marker and restoration of surface terrain to pre-development vegetative conditions. The State of Texas requires inactive wells to be plugged within one year of operations ceasing.

Table 3.9-17: Surface Wells Within the LOD						
	ALT A	**ALT B**	**ALT C**	**ALT D**	**ALT E**	**ALT F**
Surface Well Count	34	31	24	34	31	24

Source: TCRR, 2016

TCRR would communicate its intent to oil and gas owners, conduct coordination to identify opportunities to avoid conflicts and agreements would be completed before construction begins with concurrence from the Texas Railroad Commission. TCRR would follow federal and state[47] requirements for the abandonment of oil and gas wells prior to the construction of the Build Alternatives. Therefore, there would be no construction conflicts with oil and gas wells. The impact of well abandonment or relocation is also discussed under parcel acquisition in **Section 3.13.6.2.5, Land Use**.

The LOD of the Build Alternatives would impact current access drives to operating oil and gas wells, indirectly impacting these facilities. Therefore, TCRR would construct new access drives as part of the Build Alternatives to maintain connectivity to the oil and gas wells. The affect would mainly be associated with minor inconveniences of increased travel times due to access diversions for oil and gas operators. This would not impact the operation of these oil and gas wells.

Fuel and Energy Consumption

During the construction period, fuel would be consumed to produce and transport materials needed to construct the Build Alternatives. Operating and maintaining construction equipment would also consume fuel. Per **Section 3.9.3.2**, fuel consumption was calculated and is summarized in **Table 3.9-18**. For conservative purposes, Build Alternative A power consumption was used, as it is estimated to have the highest power consumption amongst the Build Alternatives, although the difference with the alternative estimated to consume the least power (Alternative E) is negligible at one percent. As discussed in **Section 3.2.3.2.1, Air Quality**, the energy consumption estimate during construction of the Build Alternatives would be approximately 57,331 MMBTUs).

[47] Texas Natural Resources Code, Title 3. Oil and Gas, Subtitle B, Conservation and Regulation of Oil and Gas, Chapter 91, Subchapter D Prevention of Pollution.

Table 3.9-18: Construction Fuel Consumption Estimate			
Facility	**Total Working Hours**	**Total Fuel Used (gallons)**	**Total MMBTU of Energy Consumed**
Rail Line	1,054,996	210,999	24,159.40
Dallas Terminal	229,593	45,919	5,257.70
Brazos Valley Station	75,765	15,153	1,735.00
Houston Terminal	229,593	45,919	5,257.70
Heavy Maintenance Facility	183,674	36,735	4,206.10
Light Maintenance Facility	183,674	36,735	4,206.10
MOW Facilities	546,273	109,255	12,509.60
Total Hours/Fuel Used	2,503,568	500,714	-
Total BTU of Energy	-	-	**57,331.70**

Source: AECOM, 2016
Notes: Total equipment working hours from the air quality analysis in Section 3.2, Air Quality was used as the basis of construction energy
One gallon of gasoline produces approximately 114,500 BTUs

Since the Build Alternatives would use electricity to power the trains, stations and other HSR facilities, changes in operational fuel consumption would primarily be from changes in passenger vehicle travel, which would decrease as HSR use replaces trips made by passenger vehicles between Dallas and Houston. Therefore, HSR operations would represent an increase in energy consumption, and passenger vehicle travel would represent a decrease in energy consumption. Energy savings was based on specific vehicle travel data used in **Section 3.2.3.2, Air Quality**. **Table 3.9-19** provides the estimated fuel consumption savings**.**

Table 3.9-19: Annual Operation Energy Savings Estimate

Auto Trip	Round Trip Distance (miles)	Total Cars/Year (000s)	VMT (Million)	2014 CAFE Standard (miles per gallon)	Gallons of Gas Used in One Round Trip	Total Fuel Saved (000s) [gallons]	Total Annual MMBTU of Energy Saved
Passenger Vehicle Travel Energy Saved							
Dallas to Houston	478	5,340	2,553	31.3	15.3	81,550	9,337,561
HSR Operation Energy Consumption							
Total Annual Energy Consumed (MMBTU)							1,593,959
Net Energy Saved (MMBTU) [Energy Saved – Energy Consumed]							**7,743,602**

Source: NHTSA, 2009 and AECOM, 2016
Notes: BTU – British

The fuel consumption savings estimated for the Build Alternatives by reducing passenger vehicle travel would be approximately 81.5 million gallons of gasoline, or 9,337,561 MMBTUs annually. This data does not include passengers traveling by air. By comparison, the annual operation of the HSR would consume approximately 1,593,959 MMBTUs, resulting in a net savings in energy of 7,743,602 MMBTUs. Because the Build Alternatives would save more energy annually (7,743,602 MMBTUs) than it would take to construct the HSR system (57,331 MMBTUs one-time expenditure), the long-term impact on energy consumption would be beneficial.

3.9.6 Avoidance, Minimization and Mitigation

Design features were employed to avoid and minimize impacts to the natural, social, physical and cultural environment. Within the Build Alternatives, 53 percent of the LOD, on average, would be located adjacent to existing road, rail or utility infrastructure. Adjacency to existing utility infrastructure offers direct connections to the electric grid, which would minimize impacts resulting from new transmission lines connections. Other design features include maximizing the use of viaduct to minimize impacts to parallel utilities and potentially avoid impacts to utilities crossing the LOD. Approximately 60 percent of the Build Alternatives would be on viaduct. Pier locations would be adjusted to avoid direct impacts to utilities.

3.9.6.1 Compliance Measures

The following Compliance Measures (CM) would be required for Build Alternatives A through F:

EU-CM#1: Development Impact Report. During final design, TCRR shall coordinate with the City of Dallas and complete a Development Impact Report prior to construction to determine the utility needs of the Dallas Terminal Station and TMF. This assessment would take into account the size and purpose of the station and ancillary facilities to determine the appropriate infrastructure needs (e.g., the size of water or wastewater lines) and how best to connect to existing City of Dallas/Dallas Water Utilities systems.

EU-CM#2: Accommodate Bardwell MOW Water Demand. TCRR or its contractor shall drill local water wells in Ellis County to meet the water demand (550 gpd) needs of the Bardwell MOW facility. This would be coordinated with the Prairielands Groundwater Conservation District.

EU-CM#3: Accommodate Brazos Valley Station Water Demand. Prior to construction, TCRR shall evaluate options to provide the estimated 33.2 annual acre/feet of water demand at the Brazos Valley Station. One option could include adding capacity to Anderson Water Company, which would require a permit amendment with the Bluebonnet Groundwater Conservation District. This option would likely require a development review prior to construction to more accurately determine the needs of the Brazos Valley Station. Another option would include partnering with the neighboring Wickson Creek SUD, which does have capacity.

EU-CM#4: Accommodate Brazos Valley Station Wastewater Demand. Prior to construction, TCRR shall evaluate options to accommodate the 0.03 mgd of wastewater that would be generated at the station. One option would include a connection to the Carter's Creek WWTP (approximately 20 miles east of the station. Another option would be to develop a large capacity onsite sewage system, which would be regulated by TCEQ as a Class V Injection Well.

EU-CM#5: TCEQ Permits. Contingent upon **EU-CM#4**, during final design, TCRR shall coordinate with TCEQ for applicable state permits pertaining to the development of Class V injection wells at the Brazos Valley Station.

EU-CM#6: Wastewater Capacity Reservation Application. During final design, TCRR shall coordinate with the City of Houston to complete a Wastewater Capacity Reservation Application prior to construction to more accurately determine the needs of the Houston Terminal Station and TMF.

EU-CM#7: Abandonment of Oil and Gas Wells. During final design, TCRR shall close and abandon all oil and gas wells within the LOD of the Build Alternatives. The abandonment of wells would be conducted in accordance with the Railroad Commission of Texas Statewide Rule 14, Plugging, Revised.

EU-CM#8: Relocation of Oil and Gas Well Permit. During final design, TCRR shall file a drilling permit and/or amend an existing permit with the Railroad Commission of Texas Statewide Rule 13 to relocate an oil and gas well head outside of the LOD of the Build Alternatives.

See also **WQ-CM#2: TPDES General Construction Permit** discussed in **Section 3.3.6.1, Water Quality**, and**WQ-CM#3: Stormwater Management/Stormwater Pollution Prevention Plan** discussed in **Section 3.3.6.1, Water Quality**.

3.9.6.2 Mitigation Measures

The following Mitigation Measures (MM) would be implemented for Build Alternatives A through F:

EU-MM#1: Identification of Utilities. During final design, TCRR shall perform below ground utility exploration to verify exact locations and depths of known subsurface utilities. This data may inform or modify TCRR's approach to the protection and/or relocation of these utilities.

EU-MM#2: Relocation of Major Utilities. During final design and construction, TCRR shall resolve conflicts with each major utility provider (water, wastewater, oil and gas, electric transmission, etc.). As of the publication of the Draft EIS, the Build Alternatives collectively impact more than 400 major utilities, which are owned by 35 different providers. Where utilities must be relocated, TCRR or its contractor shall coordinate multiple relocations of the same type to combine relocations, where possible. Because of utility relocations, construction of the Build Alternatives would result in scheduled and/or accidental interruptions of utility services. TCRR shall coordinate with the utility provider during final design and phasing of construction activities to minimize interruptions during the relocation process.

EU-MM#3: Protection and Encasement of Major Utilities. During final design and construction, TCRR shall resolve conflicts with each major utility provider (water, wastewater, oil and gas, electric transmission, etc.). As of the publication of the Draft EIS, the Build Alternatives collectively impact more than 400 major utilities, which are owned by 35 different providers. Where utilities must be protected or extended, TCRR or its contractor shall protect or encase utilities in place rather than relocate, as often as practicable. Protective actions include activities during construction (e.g., shoring) and/or operations (e.g., encasement). Due to utility protection and encasement, construction of the Build Alternatives would result in scheduled and/or accidental interruptions of utility services. TCRR shall coordinate with the utility provider during final design and phasing of construction activities to minimize interruptions during the protection or encasement process.

EU-MM#4: Relocation of Minor Utilities. During final design and construction, TCRR shall coordinate with the respective utility providers to resolve conflicts with minor utilities (fiber optic, telecommunications, etc.) to avoid service interruptions.

EU-MM#5: Electric Utility Provider Coordination. During final design, TCRR shall coordinate with utility providers such as Oncor and CenterPoint to provide connections to the electric grid. The modifications required to make these connections include relocating existing lines, connecting new lines and vertically adjusting existing poles. The location of these modifications would be determined by the utility provider. The utility provider may choose to include these modifications into existing plans to support the operation of their system. As the owner of the utility, the provider would manage and lead the environmental process associated with the modifications to provide the connections to TCRR's infrastructure. This coordination shall also include TCRR working with the utility provider to notify utility customers via phone, email, mail, newspaper and/or other means at least two weeks in advance of scheduled outages, unless there is an emergency. These disruptions, when possible, shall be scheduled during off-business hours and never exceed a 24-hour period except under unusual circumstances, where feasible.

EU-MM#6: Discovery of Unidentified Utility. During construction, TCRR and/or its construction contractor shall cease construction in the area should a utility line be discovered that was not previously identified. Coordination with the utility owner shall be initiated.

EU-MM#7: Implementation of Water Saving Devices. During construction, TCRR shall install water saving devices and/or strategies at all facilities. These may include water efficient fixtures in restrooms and kitchens in the stations, TMFs and MOWs.

EU-MM#8: Landscape Plan. During final design, TCRR shall develop a landscape plan to be reviewed and approved by FRA that uses drought resistant or native vegetation that would require less water for landscaping at the station, TMFs and MOWs. During construction, TCRR and/or its construction contractor shall implement the landscape plan.

3.9.7 Build Alternatives Comparison

The summary of utilities and energy impacts is shown in **Table 3.9-20**. All of the Build Alternatives would require coordination with electric utility providers to relocate or adjust existing overhead transmission lines. Build Alternatives C and F would require fewer electrical relocations and pole adjustments compared to Build Alternatives A, B, D and E. Additionally, all of the Build Alternatives would require the abandonment of active oil and gas wells; however, Build Alternatives C and F would impact fewer wells.

There would be no discernable difference between the Build Alternatives for water use and wastewater generation. Additionally, there would be no discernable difference between the Build Alternatives for the energy required to operate the HSR system, as well as the anticipated energy saved as a result of the Project.

Table 3.9-20: Comparison of Utility Impacts by Build Alternative

	ALT A	ALT B	ALT C	ALT D	ALT E	ALT F
New Electric TPSS Connections	9	8	10	9	8	10
Electric Utility Pole Adjustments	88	90	75	93	95	80
Total Electric Connections	109	108	88	114	113	94
Abandoned Oil and Gas Wells	34	31	24	34	31	24

Source: AECOM, 2017

This page intentionally left blank.